



RESEARCH CENTER

FIELD

Activity Report 2013

Section Partnerships and Cooperations

Edition: 2014-03-19

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AXIS Project-Team

7. Partnerships and Cooperations

7.1. Regional Initiatives

7.1.1. CPER Telius - FocusLab Platform (2010 - 2013)

Participant: Brigitte Trousse [correspondent].

This grant, funded by Regional and European support, covers several areas. AxIS is being funded through the experimental platform on the usage of information systems called Focus (and renamed FocusLab). Our goal is to support the observation and analysis of user behaviors within ICT-based experimental projects adopting a user driven approach. Hardware, software and documentation are proposed within this platform (<http://focuslab.inria.fr>).

Let us cite AxIS projects which used FocusLab platform: TIC TAC, ECOFFICES, ECOFAMILIES and ELLIOT. In addition to AxIS, others Inria teams (WIMMICS,REVES,MAESTRO,PLANETE) and external organisations or teams (I3M laboratory from University of Nice Sophia Antipolis, CSTB Sophia Antipolis, the Ergonauts Association, two Elliot partners) have used elements of FocusLab.

7.1.2. Labex UCN@Sophia

Participant: Brigitte Trousse [correspondent].

Title: User-Centered Network

URL: <http://www.ucnlab.eu/node/5>

Instrument: Labex

Coordinator: University of Nice - Sophia Antipolis

Others partners: I3S (UNS / CNRS), LEAT (UNS / CNRS), Inria, EURECOM

Abstract: The Labex UCN@Sophia proposes a research program for researchers of the ICT Campus at Sophia Antipolis, program motivated by a vision which positions the user at the centre of the network. Five scientific and strategic directions are proposed: a) Data Centric Networking, b) Distributed and Ubiquitous Computing, c) Security, privacy and network neutrality, d) Infrastructures: Heterogeneity and Efficiency and e) Energy Efficiency. Two application domains have been selected: Homecare services for persons with reduced autonomy and Intelligent Transport Systems.

See : <http://www.ucnlab.eu/>

AxIS research aimed mainly several of the addressed domains and research of user-centred design and co-creation with users (cf. Sections 4.2 and 4.4).

7.1.3. ICT Usage Lab: collaboration with University of Nice Sophia Antipolis

Participants: Brigitte Trousse [correspondent], Céline Lacroix.

In 2013 we had many activities.

First ICT Usage Lab started its involvement in **EIT KIC Labs** via three funded tasks (see Sections 7.3.3 , 7.3.5 and 7.3.4). We describe the Experience & living labs facilities and services offered by EIT partners of ICT Usage Lab based on the EIT ICT Labs template elaborated by E&LL research catalyst (cf. Section 7.3.3).

This year was the occasion for Inria to collaborate for **the first time in the context of EIT KIC Labs** with researchers from **University of Nice - Sophia Antipolis**:

- **I3S laboratory** - University of Nice Sophia Antipolis: F. Baude (EIT contact) from OASIS research-team project on one KIC ICT Labs task (cf. Section 7.3.4),
- **I3M laboratory** - University of Nice Sophia Antipolis: C. Lacroix (ICT Usage lab contact), F. Debos and P. Rasse (leader) related to two KIC ICT labs Call 2013 submissions: TravelDashboard2 led by Thales including Arles Inria research-team and CityCrowdSource2 led by Loria (Madynes Inria research team-project) following the 2013 activity we have supported (cf. Section ell).

Secondly as supporting partner of the European IDEALL project, we prepared a presentation of Ecofamilies and ELLIoT projects for a France Living Labs talk at the last IDEALL meeting (Barcelona) in January 2014.

Inria and ICT Usage Lab are official partners of the Innovative City Convention event from 2012 (Nice Côte d'Azur): <http://www.innovative-city.fr/partenaires/partners/>. In this context we invited three speakers: in 2012 Michael Nilsson (CDT, Lulea, Finland) and Khaldoun El Agha (ICT Labs - EIT, Paris) and in 2013 Jarmo Eskelinen (Forium Virium Helsinki, ENoLL).

Thirdly the ELLIoT project via Green Services Use case (2011-2013) was rich in a lot of new assets for ICT Usage Lab (cf. Section 7.3.1):

- IoT: Constitution of a pollution IoT database from ICT Usage Lab citizen mobile and fixed sensors with around 4 millions of pollution measures,
- IoT: Interesting ideas (issued from co-creation workshops) of new smart objects (mainly for asthmatic people) and user feedback on the green watch,
- IoT: Acquisition of four types of pollution stations,
- IoT: Three improved IoT user guides of our ICT Usage Lab stations,
- IoT: A first validation of our prototype of a new low cost dust (PM10) station (with Rasburry and Arduino),
- Citizen Sensing: MyGreenServices platform (cf. Section 6.5.1),
- User production: Qualitative database based on User productions,
- User production: Usage database issued from logs of MyGreenServices portal,
- Knowledge: Improved know-how in modeling and measuring user experience of an IoT-based service based on KSB UX model and FocusLab advanced data analysis methods (cf. Section 6.5.3),
- Knowledge: Development of a new version (v1.3) of Focuslab server (cf. Section 6.6),
- Knowledge: Elaboration and test of two new Ideation methods (Aloha!, GenIoT).

We pursued our informal contacts with Noel Conryut from the living lab "UR.LL.TL" for Teaching and Learning (Island of the Reunion) and with the urban community CINOR related to the deployment of LL projects on this territory.

Finally various tutorials related to Focuslab hardware and software (cf. Section 6.6) have been organised and proposed to Inria members and collaborators (I3S and I3M laboratories from University of Nice Sophia Antipolis, CSTB, CHU Nice). B. Senach took contact with C. Tallec from Utilisacteur in order to plan in the future a workshop about Participative Service Design in Sophia Antipolis.

7.1.4. Collaboration Agorantic-Inria

Participants: Guillaume Pilot, Bernard Senach, Brigitte Trousse.

As the craze for culture and exhibition is increasing, museums have to deal with crowds, stronger expectations about information quality and quantity and requirements for planned personalized visits.

A collaboration began this year between ICT and HSS teams from Agorantic and Inria Sophia Antipolis, including AxIS, Maestro and Wimmics, conducting interdisciplinary ICT-HSS research. This initial collaboration resulted in setting up a ANR proposal of a project for analyzing, designing, and evaluating a recommendation system helping visitors (or groups of visitors) to follow through a museum a tailored path within an exhibition, according to their specific profile. In this ANR proposal called SyReMuse ("Système de recommandation pour la visite des musées et des expositions"), AxIS researchers were involved in the modelling of the visitors (or group of visitors)' cultural experience which will support the design and evaluation of the recommender system and in specifying recommendation computation. A preliminary study of the logs from the Web site of Grenoble Museum (France) providing recommendations according to types of user profiles (families, professionals, students, scholars and groups) has been made in order to better evaluate the research problem to be addressed.

A Inria collaborative project (named "Color") proposal for 2014 is under preparation as a first step of our collaboration.

7.1.5. Involvement in Regions

PACA Region

- B. Trousse was invited at the strategical orientation committee of the PACALABS instrument (PACA Region, Marseille, June 12th) about the evaluation of the 4 past years of Pacalabs and to prepare the programme of the next PACALABS
- B. Trousse for ICT Usage lab has increased contacts with University of Nice Sophia Antipolis (mainly the laboratories I3M via Céline Lacroix and Paul Rasse et I3S via Françoise Baude) disseminating the living lab approach and involving them as ICTUL partners for two KIC ICT Labs 2013 Call submissions (TravelDashboard2, CityCrowdSource2).
- Green Services use case from the European Elliot project was deployed in Nice Côte d'Azur with several experiments
- Participation in the organisation of invited talks of the Innovative City Convention (Nice, 2012).

Midi Pyrénées Region

- AxIS (C. Detraux and D. L. Scapin) are involved in ANR-PIMI project (cf. Sections 7.2.1 and 6.4.1) where the Midi-Pyrénées region and IUT Tarbes are pilot-partners.

7.2. National Initiatives

7.2.1. ANR PIMI (2010 - 2013)

Participants: Claudia Detraux, Dominique Scapin [correspondent].

Title: PIMI

Type: ANR

Defi: Personal Information Space

Instrument: Verso 2010

Duration: 2010 - 2013

Coordinator: Genigraph

Others partners: LRI, IRIT, Institut Telecom, Montimage, The Grand Duchy of Luxembourg

Abstract: PIMI Project aims at the definition of a design environment and a deployment platform for Personal Information Management system (PIM). The future PIM must provide the end-user personal data access with services that are relevant to his needs. In order to take mobility into account, the PIM will be accessed both by mobile devices (smartphone) and personal computers.

The main contributions this year are described in Section 6.4.1 .

7.2.2. *FIU FIORA (2012-2015)*

Participants: Yves Lechevallier [correspondent], Thierry Despeyroux.

Program: FIU (14th call)

Project acronym: FIORA

Project title: Moteur d'inférences pour la personnalisation

Duration: 2012-2015

Coordinator: Michel Manago (SME KIOLIS)

Other partners: Editions SOLAR, Mondeca, Inria (AxIS), ISEP, UNiversity of Paris XIII

Abstract: This project aims the design and the development of FIORA an engine offering personalised content. Personalisation will be based on context parameters related to the user and available semantic information. The main result will be to develop an engine merging case-based reasoning technics, recommandation technics based on collaborative filtering and data mining. The proof concept will be experimented in two domains: a) Nutrition and b) tourism and Health (use of the cohort Nutrinet with more than 200 users) and b) e-tourism.

This project starts at the end of 2012. See our work in Section 6.2.9 .

7.2.3. *LIMOS, University of Clermont-Ferrand*

A collaboration has been initiated during 2013 with the LIMOS laboratory managed by Enjelbert Mephu Nguifo and Olivier Raynaud in the context of the supervision committee of Dia Diyé 's PhD thesis on the topics security/trust, usage mining and recommender systems. B. Trousse participated in two PhD Thesis meetings: September 27 (working meeting) and October 9th (annual PhD thesis supervision committee meeting).

7.2.4. *Lorraine Smart Cities Living Lab and ERPI - University of Lorraine Living*

B. Trousse as President of France Living Labs and Inria representative of ICT Usage lab had various collaborations this year with the ERPI laboratory of the University of Lorraine:

- Common Work with Laurent Dupont on a template describing a living Lab;
- Workshop on Co-creation with Users at Innovative City Convention (Nice, June): Claudine Guidat and Laure Morel both Professors at ERPI lab gave a talk on the Lorraine Smart Cities Living Lab;
- Study of an interdisciplinary approach of the Accelerated Citizen Co-Creation in the context of Living Labs : from usage scenarios to 3D representations (including PhD thesis subjects).

7.2.5. *Living Lab of Cité du Design - St Etienne*

B. Trousse as President of France Living Labs had various collaborations this year with "Cité du Design"

- Participation as supporting partner of the European project called IDeALL managed by Isabelle Verihlac from "the Cité du Design". Preparation of a **presentation** related to the French supporting partners as Living labs at the last meeting of the project (January 2014, Barcelona);
- F2L Support of an ANR proposal related to silver economy called DECMA: this proposal is on "the design in the context of the day life of Alzheimer patients and help people" (leader Cité du design St Etienne) - "Sociétés innovantes, intégrant et adaptatives. Axe : Innovations".

7.2.6. *France Living Labs*

URL: <http://www.france-livinglabs.fr/>

In 2013 our activities were multiple.

First ENoLL and France Living Labs signed a formal cooperation agreement (MoU - Memorandum of Understanding) on February 24th in order to have closer communication and cooperation in their activities and initiatives through meetings, exchanging of information, knowledge, experiences and best practice. See the video on <http://www.youtube.com/watch?v=EJNXQ2VUtFU>.

Secondly three working groups started:

- Design & Living labs with more than 13 living labs (cf. our presentation at the last IDeALL project [Slides](#))
- Living Labs for Silver Economy and
- Cartography and evaluation of living lab projects inside F2L members on two aspects (co-creation methods and territory role).

Thirdly France Living Labs supported two proposal submissions of the 2013 ANR Call: one with University of Lorraine and "Cité du Design" and another proposal with "Cité du design".

Finally some F2L members were involved various working groups in order to make proposals for the contract "Economy Silver". This contract was signed on December 12th and France Living Labs is mentioned at the page 86 as a key actor for the action 6.2 (Support to the development of living labs in Silver Economy both at the national and international levels). See the contract [here](#)

7.3. European Initiatives

7.3.1. FP7 ICT ELLIOT project (2010-2013)

Participants: Xavier Augros, Florian Bonacina, Mylène Leitzelman, Anne-Laure Negri, Guillaume Pilot, Bernard Senach, Caroline Tiffon, Brigitte Trousse [correspondent].

Type: COOPERATION

Challenge: Internet of Things (IoT) and enterprise environments

Instrument: Specific Targeted Research Project

Objective: Internet of Things and Enterprise environments

Duration: September 2010 - June 2013

Coordinator: TXT Polymemia (Italy)

Partners: University of Nottingham (UK), University of Readings (UK), BIBA (Germany), Hospital San Rafael (Italy), CENG (Italy), Fing (France), Vulog SME(France)

Inria contact: Brigitte Trousse

See also: <http://www.elliott-project.eu/>

Abstract: The ELLIOT project (Experiential Living Labs for the Internet of Things) aims at developing an IoT experiential platform where users/citizen are directly involved in co-creating, exploring and experimenting new ideas, concepts and technological artifacts related to IOT applications and services. Based on a three levels experiential model issued from previous European projects, the study will capitalize on existing practices of co-creation in IoT contexts. It will allow the exploration of the potential impact of IOT and of the Future Internet in the context of the Open User Centered Innovation paradigm followed in the Living Lab approach.

This year we conducted various tasks related to the Green Services Use case:

- Implementation of MyGreenServices application which collects IoT data from electric cars and citizens sensors. stored usage data for sending to the ELLIOT platform (cf. Section [6.5.1](#))
- Specification of the methodology for user experience measurement for Green Services Use case (cf. Section [6.5.3](#)).
- Two experiments of MyGreenServices (February and June).
- Dissemination at Innovative City Convention with Special ELLIOT Citizen Awards.

Inria hosted two ELLIOT meetings on user experience measurement (KSB model and use cases) as well as general meetings. We contributed in the various deliverables including the two public ones [\[38\]](#) and [\[37\]](#). See also our results in Section [6.5](#).

Finally the Elliot project (2011-2013) was very rich in terms of new assets for Inria and for ICT Usage Lab (cf. 7.1.3).

MyGreenServices was evaluated as Good Practice by the international Design for All foundation (for the 2014 awards).

7.3.2. COST TwinTide (2010-2013)

Participant: Dominique Scapin [correspondent].

Program: COST IC0904

Project acronym: TwinTide

Project title: Towards the Integration of Transectorial IT Design and Evaluation

Duration: 2010 - 2013

Coordinator: Effie Lai-Chong Law - Swiss Federal Institute of Technology (ETH Zürich), Switzerland (CH) / University of Leicester, UK

Other partners: see <http://www.irit.fr/recherches/ICS/projects/twintide>

Abstract: Towards the Integration of Transectorial IT Design and Evaluation is a usability and user experience research community running under the auspices of COST (<http://www.cost.esf.org/>). The main objective is to harmonize research and practice on design and evaluation methodologies for computing artefacts, across sectors and disciplines, bringing together researchers and D&E professionals.

7.3.3. EIT KIC ICT Labs (2013) : Experience & Living Labs Research Catalyst

Participants: Brigitte Trousse [correspondent], Caroline Tiffon, Florian Bonacina.

Program: EIT ICT Labs

Project acronym: Activity E&LL Catalyst Coordination activity from Research Catalysts, included for 2014 in Technology Experimentation Catalyst.

Project title: E&LL Catalyst Coordination Activity

Duration: 2013

Coordinator: F. Pianiesi (Trento Rise, Italy)

Other partners: Inria, (Hungary), TUBerlin, U. Bologna, Telecom Italia, Siemens/VMZ (Germany), DFKI (Germany)

Abstract: The Catalyst Coordination Activity will boost the usage of the E&LLs Catalyst by means of a set of service provision programs. Tasks and Activities from the Action Lines represent the customers of the Catalyst Coordination Activity. The catalyst involves a Team of Experts and leverage assets from available "Open E&LLs", as a set of accessible facilities. "Open E&LLs" function as a one-stop-shop for user-centered research services, as well as hosts of experimentation activities by customers.

This year, we were involved in various works:

- Support to Loria (mainly Madynes research-project team - Thomas Siverston and Abdelkader Lahmadi) related to the CityCrowdSource activity and within the context of the *crowdout* application (with targeted users such city administrators and citizen). Our support relied mainly on the improvement of the ergonomics aspects of the application and pre-tests with users of the first prototype. Redaction of deliverable (17 pages);
- Dissemination of E&LL research catalyst to the Management Committee of the French EIT node and to the Smart Cities action line;
- Support to EIT partners during EIT 2013 Call event (April, Paris), mainly those interested by the two action lines , Smart Cities and Cloud Computing, which are lead by the french EIT KIC labs node;
- Contribution to the elaboration of a Service Provisioning template for Open Living Labs.
- Collectinf data from EIT E&LL facilities from the French EIT node in order to make them visible on an internal EIT Web site (developed by ELL catalyst - Trento);

7.3.4. *EIT KIC ICT Labs (2013) : CityCrowdSource Activity - Urban Life and Mobility*

Participants: Brigitte Trousse [correspondent], Guillaume Pilot.

Program: EIT ICTLabs

Project acronym: Activity 13 052 from Intelligent Mobility and Transportation Systems action line - Allocation 7396 (IMS), renamed Future Urban Life and Mobility (ULM) mid 2013

Project title: Multimodal Mobility

Duration: 2013, from June to December

Coordinator: F. Baude (OASIS Inria-UNS) and B. Kwella (Fraunhofer Gesellschaft)

Other partners: Inria, BME (Hungary), TUBerlin, U. Bologna, Telecom Italia, Siemens/VMZ (Germany), DFKI (Germany)

Abstract: The activity seeks to specify the building blocks, a platform and a prototype for the provision of multimodal mobility. The main motivation is to facilitate the use of ICT to support the efficient organization of Accessible Mobility (support for people with special needs, economical optimization of mobility and transportation, trip planning, information on available transport modes, etc). It therefore provides the basis for sustainable future mobility.

AXIS was involved in the implementation of a Play-based demonstrator and implements, in collaboration with OASIS Inria research-project an interface between MyGreenServices platform and the PLAY platform for elaborating a use case based on our environmental sensors.

7.3.5. *EIT KIC ICT Labs (2013) : Q&A - Doctoral School*

Participants: Brigitte Trousse [correspondent], Caroline Tiffon.

Program: EIT ICT Labs

Project acronym: DSL

Project title: Activit  DSL 13108-Support Evaluation

Duration: 2013, from March to December

Coordinator: C. Queinnec (UMPC, Paris, France)

Other partners: Inria, University of Turku, etc.

Abstract: EIT Doctortal School

Inria (ICT Usage lab) for its expertise in usage analysis was requested by the DSL leader to support the University of Turku to managae the Q/A tasks for the doctoral school. We made some recommendation for improving questionnaires and anticipating future analysis in terms of data coding. We analysed (with Sphinx IQ) students questionnaires from EIT Doctoral school, and reported results in an internal EIT KIC Labs document. A preliminary study on how to measure the main I&E outcomes of I&E courses based on Bloom'experiential learning [56] has been started.

7.4. International Initiatives

7.4.1. *Participation in other International Programs*

7.4.1.1. *FACEPE CM2ID, Brazil 2003-2013*

Participants: Yves Lechevallier, Marc Csernel.

During 2013 we continued a collaboration on social network data analysis with F.A.T. De Carvalho from Federal University of Pernambuco (Recife) and Orpailleur (Inria Nancy Grand Es -LORIA).

A scientific project **Combining Numerical and Symbolical Methods for the Classification of Multi-valued and Interval Data (CM2ID)** submitted by Francisco de Carvalho and A. Napoli has been accepted for 2013 by FACEPE and Inria. The project started on January and will end on 12/2013. Researchers and students are concerned by this project from Orpailleur, AXIS and CIn-UFPE side. It aims at developing Numerical and Symbolical methods of clustering on Multi-valued and Interval Data.

This project aims at developing and comparing clustering algorithms for interval and multi-valued data. Two families of algorithms are studied, namely clustering algorithms based on the use of a similarity or a distance for comparing the objects, and classification algorithms in Formal Concept Analysis (FCA) based on attribute sharing between objects. The objectives here are to combine the facilities of both families of algorithms for improving the potential of each family in dealing with more complex and voluminous datasets, in order to push the complexity barrier farther in the mining of complex data. Biological data, namely gene expression data, are used for test and evaluation of the combination of algorithms. The project involves three teams, one Brazilian team and two French Inria teams (AxIS and Orpailleur), including specialists of clustering and classification methods. Thus the complementarity of the teams is ensured and, in addition, close contacts exist with experts of the domain of data for carrying on a complete evaluation of the results obtained by the combined algorithms expected to be designed during the project.

7.4.2. Informal International Partners

B. Trousse maintained collaborations with Morocco (cf. Section 6.2.10):

- ENSAM - Meknès (E.L. Moukthar Zemmouri [75]),
- National High School of Electrical and Mechanical engineering (ENSEM)Casablanca (H. Behja).

7.4.3. Participation to Standards in Ergonomics

Participant: Dominique Scapin [correspondent].

Standardization in ergonomics is increasingly important due to the application of the European directives about the introduction of measures to encourage improvements in the safety and health of workers (e.g., 2006/42CE on security of machinery); as well as taking into consideration national and international legislation, including accessibility. Standardization in ergonomics covers many issues. The contributions from AxIS (D. L. Scapin) at Inria concern mainly software ergonomics, in the context of AFNOR X35A, X35E, as well as ISO mirror groups:

- National: AFNOR X35A ("Ergonomie") (expert); AFNOR X35E ("Ergonomie des Logiciels Interactifs"), AFNOR groupe de travail "Normes de processus ergonomiques" (chair) [71].
- International: ISO/TC 159/SC4/WG5 (Software ergonomics and human-computer dialogues) (expert); ISO/TC 159/SC4/WG6 (Human-centred design processes for interactive systems) (expert); ISO/TC 159/SC4/WG9 (Tactile and Haptic Interactions) (expert); ISO/TC 159/SC4/WG28 (System and software product Quality Requirements and Evaluation - Common industry Format) (expert); ISO/TC 159/SC1/WG1 (Ergonomic principles) (expert).

7.5. International Research Visitors

7.5.1. Visits of International Scientists

AxIS Rocquencourt welcomed various international scientists from Brazil:

- Francisco de Carvalho (UFPE, Brazil) [20],
- Sergio Queiroz (UFPE, Brazil) [19],

GALAAD Project-Team

8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. GEOLMI

GEOLMI - Geometry and Algebra of Linear Matrix Inequalities with Systems Control Applications - is an ANR project working on topics related to the Geometry of determinantal varieties, positive polynomials, computational algebraic geometry, semidefinite programming and systems control applications.

The partners are LAAS-CNRS, Univ. de Toulouse (coordinator), LJK-CNRS, Univ. Joseph Fourier de Grenoble; Inria Sophia Antipolis Méditerranée; LIP6-CNRS Univ. Pierre et Marie Curie; Univ. de Pau et des Pays de l'Adour; IRMAR-CNRS, Univ. de Rennes.

More information available at <http://homepages.laas.fr/henrion/geolmi>.

8.1.2. ANEMOS

ANEMOS - Advanced Numeric for ELMs (Edge Localized Mode) : Modeling and Optimized Schemes - is an ANR project devoted to the numerical modelling study of such ELM control methods as Resonant Magnetic Perturbations (RMPs) and pellet ELM pacing both foreseen in ITER. The goals of the project are to improve understanding of the related physics and propose possible new strategies to improve effectiveness of ELM control techniques. The study of spline spaces for isogeometric finite element methods is proposed in this context.

The partners are IRFM, CEA, Cadarache; JAD, University of Nice - Sophia Antipolis; Inria, Bacchus; Maison de la Simulation CEA-CNRS-Inria-University of Orsay- University of Versailles St Quentin .

8.2. European Initiatives

8.2.1. FP7 Projects

8.2.1.1. TERRIFIC

Title: Towards Enhanced Integration of Design and Production in the Factory of the Future through Isogeometric Technologies

Type: COOPERATION (ICT)

Defi: PPP FoF: Digital factories: Manufacturing design and product lifecycle manage

Instrument: Specific Targeted Research Project (STREP)

Duration: September 2011 - August 2014

Coordinator: SINTEF, Oslo (Norway)

Others partners:

Alenia Aeronautica (Italy); Inria Méditerranée (France); Jozef Kepler universitet, Linz (Austria); JOTNE, Oslo (Norway); MAGNA, Steyr (Austria); Missler Software (France); Siemens AG (Germany); Technische Universität Kaiserslautern (Germany); University of Pavia (Italy).

See also: <http://terrific-project.eu>

Abstract: The project aims at significant improvement of the interoperability of computational tools for the design, analysis and optimization of functional products. An isogeometric approach is applied for selected manufacturing application areas (cars, trains, aircrafts) and for computer-aided machining. Computer Aided Design (CAD) and numerical simulation algorithms are vital technologies in modern product development, yet they are today far from being seamlessly integrated. Their interoperability is severely disturbed by inconsistencies in the mathematical approaches used. Efficient feedback from analysis to CAD and iterative refinement of the analysis model is a feature of isogeometric analysis, and would be an essential improvement for computer-based design optimization and virtual product development. Our vision is to provide and disseminate tangible evidence of the performance of the isogeometric approach in comparison to traditional ones in four important application areas as well as addressing interoperability and other issues that necessarily arise in a large-scale industrial introduction of isogeometry.

8.2.2. Collaborations in European Programs, except FP7

8.2.2.1. PHC TOURNESOL FL

Program: TOURNESOL

Project acronym: PHC TOURNESOL FL 2012 - 26409SH

Project title: Extracting multidimensional shapes

Duration: January 2012 - December 2013

Coordinator: E. Hubert (Inria), A. Cuyt (Universiteit Antwerpen)

Other partners: Inria Sophia-Antipolis (France); Universiteit Antwerpen (Belgium)

Abstract: We are working on the shape-from-moments problem : from measurement-like data, reconstructing a desired object. For many years, this problem has been solved and optimized in the 2D-case thanks to use of complex numbers. Thanks to a new formula, we want to stay in the real domain in order to generalize this problem to multidimensional shapes - in particular 3D-shapes. For more details about our project TOURNESOL: <http://www-sop.inria.fr/teams/galaad/joomla/index.php/international-collaborations-147/173-tournesol.html>. For more details about the program TOURNESOL: <http://www.campusfrance.org/fr/tournesol-communaute-francaise>.

8.3. International Initiatives

8.3.1. Participation In International Programs

We have a bilateral collaboration between Galaad and the University of Athens-DIT team ERGA, headed by Ioannis Emiris for the period August 2013-August 2014. It is supported by both Inria and the University of Athens.

Title: Algebraic algorithms in optimization

Abstract: In the past decade, algebraic approaches to optimization problems defined in terms of multivariate polynomials have been intensively explored and studied in several directions. One example is the work on semidefinite optimization and, more recently, convex algebraic geometry. This project aims to focus on algebraic approaches for optimization applications in the wide sense. We concentrate on specific tools, namely root counting techniques, the resultant, the discriminant and non-negative polynomials, on which the two teams have extensive collaboration and expertise. We examine applications in convex algebraic geometry as well as to a newer topic for the two teams, namely game theory. A common thread to these approaches is to exploit any (sparse) structure.

8.4. International Research Visitors

8.4.1. Visits of International Scientists

Wen-Shin Lee and Annie Cuyt (University of Antwerp, Belgium) visited from Monday June 3rd to Friday June 7th in the context of the TOURNESOL project.

8.4.2. Visits to International Teams

Evelyne Hubert was invited to La Trobe university for the whole month of January to carry on a collaboration with Peter van der Kamp on geometric curve flows and their integrability.

Evelyne Hubert and Bernard Mourrain were invited to the Institute of Mathematical Science at the National University of Singapore to participate to the 2 month long program *Inverse Moment Problems: the Crossroads of Analysis, Algebra, Discrete Geometry and Combinatorics*.

Evelyne Hubert and Bernard Mourrain visited Wen-Shin Lee and Annie Cuyt (University of Antwerp, Belgium) on November 20-21 in the context of the TOURNESOL project.

ABSTRACTION Project-Team

8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. ANR

8.1.1.1. *AbstractCell*

Title: Formal abstraction of quantitative semantics for protein-protein interaction cellular network models

Instrument: ANR-Chair of Excellence (Junior, long term)

Duration: December 2009 - December 2013

Coordinator: Inria (France)

Others partners: None

See also: <http://www.di.ens.fr/feret/abstractcell>

Abstract: The overall goal of this project is to investigate formal foundations and computational aspects of both the stochastic and differential approximate semantics for rule-based models. We want to relate these semantics formally, then we want to design sound approximations for each of these semantics (by abstract interpretation) and investigate scalable algorithms to compute the properties of both the stochastic and the differential semantics. Jérôme Feret is the principal investigator for this project.

8.1.1.2. *AstréeA*

Title: Static Analysis of Embedded Asynchronous Real-Time Software

Type: ANR Ingénierie Numérique Sécurité 2011

Instrument: ANR grant

Duration: January 2012 - December 2015

Coordinator: Airbus France (France)

Others partners: École normale supérieure (France)

See also: <http://www.astreea.ens.fr>

Abstract: The focus of the **ASTRÉE** project is on the development of static analysis by abstract interpretation to check the safety of large-scale asynchronous embedded software. During the **THÉSÉE** ANR project (2006–2010), we developed a concrete and abstract models of the ARINC 653 operating system and its scheduler, and a first analyzer prototype. The gist of the **ASTRÉE** project is the continuation of this effort, following the recipe that made the success of **ASTRÉE**: an incremental refinement of the analyzer until reaching the zero false alarm goal. The refinement concerns: the abstraction of process interactions (relational and history-sensitive abstractions), the scheduler model (supporting more synchronisation primitives and taking priorities into account), the memory model (supporting volatile variables), and the abstraction of dynamical data-structures (linked lists). Patrick Cousot is the principal investigator for this project.

8.1.1.3. *Verasco*

Title: Formally-verified static analyzers and compilers

Type: ANR Ingénierie Numérique Sécurité 2011

Instrument: ANR grant

Duration: Septembre 2011 - September 2015

Coordinator: Inria (France)

Others partners: Airbus France (France), IRISA (France), Inria Saclay (France)

See also: <http://www.systematic-paris-region.org/fr/projets/verasco>

Abstract: The usefulness of verification tools in the development and certification of critical software is limited by the amount of trust one can have in their results. A first potential issue is *unsoundness* of a verification tool: if a verification tool fails (by mistake or by design) to account for all possible executions of the program under verification, it can conclude that the program is correct while it actually misbehaves when executed. A second, more insidious, issue is *miscompilation*: verification tools generally operate at the level of source code or executable model; a bug in the compilers and code generators that produce the executable code that actually runs can lead to a wrong executable being generated from a correct program.

The project **VERASCO** advocates a mathematically-grounded solution to the issues of formal verifying compilers and verification tools. We set out to develop a generic static analyzer based on abstract interpretation for the C language, along with a number of advanced abstract domains and domain combination operators, and prove the soundness of this analyzer using the Coq proof assistant. Likewise, we will continue our work on the CompCert C formally-verified compiler, the first realistic C compiler that has been mechanically proved to be free of any miscompilation will be continued. Finally, the tool qualification issues that must be addressed before formally-verified tools can be used in the aircraft industry, will be investigated.

8.2. European Initiatives

8.2.1. FP7 Projects

8.2.1.1. MemCad

Type: IDEAS

Defi: Design Composite Memory Abstract Domains

Instrument: ERC Starting Grant

Objectif: Design Composite Memory Abstract Domains

Duration: October 2011 - September 2016

Coordinator: Inria (France)

Partner: None

Inria contact: Xavier Rival

Abstract: The MemCAD project aims at setting up a library of abstract domains in order to express and infer complex memory properties. It is based on the abstract interpretation frameworks, which allows to combine simple abstract domains into complex, composite abstract domains and static analyzers. While other families of abstract domains (such as numeric abstract domains) can be easily combined (making the design of very powerful static analyses for numeric intensive applications possible), current tools for the analysis of programs manipulating complex abstract domains usually rely on a monolithic design, which makes their design harder, and limits their efficiency. The purpose of the MemCAD project is to overcome this limitation.

Our proposal is based on the observation that the complex memory properties that need to be reasoned about should be decomposed in combinations of simpler properties. Therefore, in static analysis, a complex memory abstract domain could be designed by combining many simpler domains, specific to common memory usage patterns. The benefit of this approach is twofold: first it would make it possible to simplify drastically the design of complex abstract domains required to reason about complex softwares, hereby allowing certification of complex memory intensive softwares by automatic static analysis; second, it would enable to split down and better control the cost of the analyses, thus significantly helping scalability. As part of this project, we propose to build a static analysis framework for reasoning about memory properties, and put it to work on important classes of applications, including large softwares.

8.3. International Initiatives

8.3.1. Informal International Partners

Research on Kappa and its applications involves several close international partners:

- Vincent Danos (University of Edinburgh, UK);
- Walter Fontana (Harvard Medical School, US);
- Hein Koepl and Tatjana Petrov (ETH Zürich, SW);
- Jonathan Hayman and Glynn Winskel (Cambridge, UK).

Research on abstract domains for memory states involves the group of Bor-Yuh Evan Chang (University of Colorado at Boulder, Colorado, USA).

8.4. International Research Visitors

8.4.1. Visits of International Scientists

Bor-Yuh Evan Chang visited the team from June to August 2013, as part of his collaboration with Xavier Rival.

8.4.1.1. Internships

Abdellatif Atki is a student at École Polytechnique (Palaiseau, France). He performed his M1 internship from April 2013 to July 2013 under the supervision of Antoine Miné on the Two variables per inequality abstract domain [27].

Matthias Bry is a student at École Polytechnique (Palaiseau, France). He performed his M1 internship from April 2013 to July 2013 under the supervision of Antoine Miné on analysis of concurrent programs [28].

Huisong Li is a master student at the Institute of Software, at the Chinese Academy of Sciences (Beijing, China) and is doing a research internship under the supervision of Xavier Rival.

8.4.2. Visits to International Teams

Xavier Rival visited the ROSAEC Team in Seoul National University (team of Professor Kwangkeun Yi).

ALF Project-Team

8. Partnerships and Cooperations

8.1. International Initiatives

8.1.1. Participation In International Programs

8.1.1.1. Imhotep (Egypt)

Program: PHC

Title: Code obfuscation through JIT compilation

Inria principal investigator: Erven ROHOU

International Partner (Institution - Laboratory - Researcher):

Egypt-Japan University for Science and Technology (Egypt)

Duration: Jan 2013 - Dec 2013

This project leverages JIT compilation to make software tamper-proof. The idea is to constantly generate different versions of an application, even while it runs, to make reverse engineering much more complex. A strong random number generator guarantees that generated code is not reproducible – though the semantics is the same. In the course of the project, we also studied new forms of On-Stack-Replacement that let us recompile code even from the middle of a function. Finally, we studied how threads can be exploited to generate new forms of obfuscation, leveraging the fact that parallelism is error-prone, and difficult to debug and reverse-engineer.

8.1.2. Informal International Partners

The ALF team has informal collaborations with several international teams: Carnegie Mellon (Pr Mutlu), Georgia Tech (Pr Qureshi), University of Wisconsin (Pr Wood), University of Cyprus (Pr Sazeides), University of Ghent (Dr Eyerma), XLNS Research (Dr Arnold), UFMG Brazil (Pr Pereira), Barcelona Supercomputing center (Pr Cazorla and Pr Abella),

8.2. National Initiatives

8.2.1. Inria Project Lab: Multicore

Participants: Erven Rohou, Alain Ketterlin, Nabil Hallou.

The Inria Project Lab (formerly *Action d'Envergure*) started in 2013. It is entitled “Large scale multicore virtualization for performance scaling and portability”. Partner project-teams include: ALF, ALGORILLE, CAMUS, REGAL, RUNTIME, as well as DALI. This project aims to build collaborative virtualization mechanisms that achieve essential tasks related to parallel execution and data management. We want to unify the analysis and transformation processes of programs and accompanying data into one unique virtual machine.

8.2.2. ADT IPBS 2013-2015

Participants: Sylvain Collange, Erven Rohou, André Seznec, Thibault Person.

As multi-core CPUs and parallel accelerators become pervasive, all execution platforms are now parallel. Research on architecture, compilers and systems now focuses on parallel platforms. New contributions need to be validated against parallel applications that are expected to be representative of current or future workloads. The research community relies today on a few benchmarks sets (SPLASH, PARSEC, ..) Existing parallel benchmarks are scarce, and some of them have issues such as aging workloads or non-representative input sets. The IPBS initiative aims at leveraging the diversity of parallel applications developed within Inria to provide a set of benchmarks, named the Inria Parallel Benchmark Suite, to the research community.

8.2.3. ADT Padrone 2012–2014

Participants: Erven Rohou, Alain Ketterlin, Emmanuel Riou.

Computer science is driven by two major trends: on the one hand, the lifetime of applications is much larger than the lifetime of the hardware for which they are initially designed; on the other hand the diversity of computing hardware keeps increasing. The net result is that many applications are not optimized for their current executing environment. The objective of Padrone is to design and develop a platform for reoptimization of binary executables at run-time. There are many advantages: actual hardware is known, the whole application is visible (including libraries), profiling can be collected, and source code is not necessary (interesting in the case of proprietary applications).

8.2.4. ANR W-SEPT

Participants: Hanbing Li, Isabelle Puaut, Erven Rohou.

Critical embedded systems are generally composed of repetitive tasks that must meet drastic timing constraints, such as termination deadlines. Providing an upper bound of the worst-case execution time (WCET) of such tasks at design time is thus necessary to prove the correctness of the system. Static WCET estimation methods, although safe, may produce largely over-estimated values. The objective of the project is to produce tighter WCET estimates by discovering and transforming flow information at all levels of the software design process, from high level-design models (e.g. Scade, Simulink) down to binary code. The ANR W-SEPT project partners are Verimag Grenoble, IRIT Toulouse, Inria Rennes. A case study is provided by Continental Toulouse.

8.3. European Initiatives

8.3.1. FP7 Projects

8.3.1.1. DAL: ERC AdG 2010- 267175, 04-2011/03-2016

Type: IDEAS

Instrument: ERC Advanced Grant

Duration: April 2011 - March 2016

Coordinator: André Seznec

Inria contact: André Seznec

Abstract: In the DAL, Defying Amdahl's Law project, we envision that, around 2020, the processor chips will feature a few complex cores and many (may be 1000s) simpler, more silicon and power effective cores. In the DAL research project, we will explore the microarchitecture techniques that will be needed to enable high performance on such heterogeneous processor chips. Very high performance will be required on both sequential sections —legacy sequential codes, sequential sections of parallel applications— and critical threads on parallel applications —e.g. the main thread controlling the application. Our research will focus on enhancing single process performance. On the microarchitecture side, we will explore both a radically new approach, the sequential accelerator, and more conventional processor architectures. We will also study how to exploit heterogeneous multicore architectures to enhance sequential thread performance.

For more information, see http://www.irisa.fr/alf/index.php?option=com_content&view=article&id=55&Itemid=3&lang=en

8.3.2. Collaborations in European Programs, except FP7

8.3.2.1. HiPEAC3 NoE

Participants: François Bodin, Pierre Michaud, Erven Rohou, André Seznec.

F. Bodin, P. Michaud, A. Seznec and E. Rohou are members of the European Network of Excellence HiPEAC3. HiPEAC3 addresses the design and implementation of high-performance commodity computing devices in the 10+ year horizon, covering both the processor design, the optimizing compiler infrastructure, and the evaluation of upcoming applications made possible by the increased computing power of future devices.

8.3.2.2. *COST Action TACLe - Timing Analysis on Code-Level (<http://www.tacle.eu>) 10-2012/09-2015*

Participants: Damien Hardy, Isabelle Puaut.

Embedded systems increasingly permeate our daily lives. Many of those systems are business- or safety-critical, with strict timing requirements. Code-level timing analysis (used to analyze software running on some given hardware w.r.t. its timing properties) is an indispensable technique for ascertaining whether or not these requirements are met. However, recent developments in hardware, especially multi-core processors, and in software organization render analysis increasingly more difficult, thus challenging the evolution of timing analysis techniques.

New principles for building "timing-composable" embedded systems are needed in order to make timing analysis tractable in the future. This requires improved contacts within the timing analysis community, as well as with related communities dealing with other forms of analysis such as model-checking and type-inference, and with computer architectures and compilers. The goal of this COST Action is to gather these forces in order to develop industrial-strength code-level timing analysis techniques for future-generation embedded systems, through several working groups:

- WG1 Timing models for multi-cores and timing composability
- WG2 Tooling aspects
- WG3 Early-stage timing analysis
- WG4 Resources other than time

8.4. International Research Visitors

8.4.1. *Visits of International Scientists*

- Pr Ahmed El-Mahdy, from the Egyptian-Japanese University of Science and Technology visited the ALF project for 1 week in October 2013.
- Pr Onur Mutlu, from Carnegie Mellon visited the ALF project for 3 weeks June-July 2013.

AOSTE Project-Team

8. Partnerships and Cooperations

8.1. Regional Initiatives

8.1.1. CIM PACA Design Platform

Participants: Robert de Simone, Ameni Khecharem, Carlos Gomez Cardenas, Emilien Kofman.

This ambitious regional initiative is intended to foster collaborations between local PACA industry and academia partners on the topics of microelectronic design, though mutualization of equipments, resources and R&D concerns. We are active in the **Design Platform** (one of three platforms), of which Inria is a founding member. This provides opportunities for interactions with local companies, leading indirectly to more formal collaborations at times. Phase 3 of the CIM PACA programme should be launched in 2014, and was subject of extensible preparation at the end of 2013.

The ANR HOPE project [8.2.1.2](#) is conducted under the auspices of the CIM PACA Design Platform, which also hosts prototype and commercial software products contributed by project members (Synopsys, Docea Power, and Magillem, see [8.2.1.2](#)). Similarly, the CLISTINE FUI project was recently accepted, and supported by the platform.

8.2. National Initiatives

8.2.1. ANR

8.2.1.1. HeLP

Participants: Carlos Gomez Cardenas, Ameni Khecharem, Robert de Simone, Jean-Vivien Millo.

The **ANR HeLP** project dealt with joint modeling of functional behavior and energy consumption for the design of low-power heterogeneous SoCs. Partners were ST Microelectronics and Docea Power (SME) as industrial; Inria, UNS (UMR LEAT), and VERIMAG (coordinator) as academics. Our goal in this project was twofold: first, combine SoC modeling with temporal behavior and logical time with energy/power modeling as extra annotations on MARTE models; second, link the modeling abilities of MARTE with those of the domain-specific standard IP-XACT.

The project ended in April 2013, with some of its findings taken up and extended in the more recent ANR project HOPE.

8.2.1.2. HOPE

Participants: Carlos Gomez Cardenas, Ameni Khecharem, Emilien Kofman, Robert de Simone.

The **ANR HOPE** project focuses on hierarchical aspects for the high-level modeling and early estimation of power management techniques, with potential synthesis in the end if feasible.

The PhD defense of Carlos Gomez Cardenas was held in Dec 2013 [[16](#)], in strong connection with the project (as a follow-up of HeLP).

Although this project was officially started in November, it was in part postponed due to the replacement of a major partner (Texas Instruments) by another one (Intel). Current partners are CNRS/UNS UMR LEAT, Intel, Synopsys, Docea Power, Magillem, and ourselves.

8.2.1.3. GeMoC

Participants: Matias Vara Larsen, Julien Deantoni, Frédéric Mallet.

This project is administratively handled by CNRS for our joint team, on the UMR I3S side. Partners are Inria (Triskell EPI), ENSTA-Bretagne, IRIT, Obeo, Thales TRT.

The project focuses on the modeling of heterogeneous systems using Models of Computation and Communication for embedded and real-time systems, described using generic means of MDE techniques (and in our case the MARTE profile, and most specifically its Time Model, which allows to specify precise timely constraints for operational semantic definition).

8.2.2. *FUI*

8.2.2.1. *FUI P*

Participants: Abderraouf Benyahia, Dumitru Potop Butucaru, Yves Sorel.

The goal of project P is to support the model-driven engineering of high-integrity embedded real-time systems by providing an open code generation framework able to verify the semantic consistency of systems described using safe subsets of heterogeneous modeling languages, then to generate optimized source code for multiple programming (Ada, C/C++) and synthesis (VHDL, SystemC) languages, and finally to support a multi-domain (avionics, space, and automotive) certification process by providing open qualification material. Modeling languages range from behavioural to architectural languages and present a synchronous and asynchronous semantics (Simulink/Matlab, Scicos, Xcos, SysML, MARTE, UML),

See also: <http://www.open-do.org/projects/p/>

Partners of the project are: industrial partners (Airbus, Astrium, Continental, Rockwell Collins, Safran, Thales), SMEs (AdaCore, Altair, Scilab Enterprise, STI), service companies (ACG, Aboard Engineering, Atos Origins) and research centers (CNRS, ENPC, Inria, ONERA).

8.2.2.2. *FUI PARSEC*

Participants: Dumitru Potop Butucaru, Thomas Carle, Zhen Zhang, Yves Sorel.

The PARSEC Project aims at providing development tools for critical real-time distributed systems requiring certification according to the most stringent standards such as DO-178B (avionics), IEC 61508 (transportation) or Common Criteria for Information Technology Security Evaluation. The approach proposed by PARSEC provides an integrated toolset that helps software engineers to meet the requirements associated to the certification of critical embedded software. Partners of the project are: Alstom, Thales, Ellidiss, OpenWide, Systerel, CEA, InriaS, Telecom ParisTech.

See also: http://www.systematic-paris-region.org/sites/default/files/exports/projets/fichiers/ProjetPARSEC_BookSystematic2012.pdf.

8.2.2.3. *FUI CLISTINE*

Participants: Robert de Simone, Amin Oueslati, Emilien Kofman.

This contract has just been accepted, with a kick-off meeting in Dec 2013. Partners are SynergieCAD (coordinator), Avantis, Optis, and the two EPIs Aoste and Nachos. The goal is to study the feasibility of building a low-cost, low-power "supercomputer", reusing ideas from SoC design, but this time with out-of-chip network "on-board", and out-of-the-shelf processor elements organized as an array. The network itself should be time predictable and highly parallel (far more than PCI-e for instance).

8.2.3. *Investissements d'Avenir*

8.2.3.1. *DEPARTS*

Participants: Liliana Cucu-Grosjean, Adriana Gogonel, Codé Lo, Cristian Maxim.

This project is funded by the BGLE Call (*Briques Logicielles pour le Logiciel Embarqué* of the national support programme *Investissements d'Avenir*. Formally started on October 1st, 2012, but the kick-off meeting was only held on April, 2013 for administrative reasons. Initially this contract was handled by the TRIO team in Nancy, but at this end of TRIO moved to Aoste Rocquencourt with the people involved. Research will target solutions for probabilistic component-based models, and a Ph.D. thesis will start early 2014 on this topic. The goal is to allow designers to unify in a common framework probabilistic scheduling techniques with compositional assume/guarantee contracts that have different levels of criticality. Our contribution is based on the schedulability analysis presented in [39].

8.3. European Initiatives

8.3.1. FP7 Projects

8.3.1.1. PROXIMA

Participants: Liliana Cucu-Grosjean, Adriana Gogonel, Codé Lo, Cristian Maxim.

Type: COOPERATION

Defi: Mixed-Criticality Systems

Instrument: Integrated Project

Objectif: Development of probabilistic approaches for mixed-criticality systems on multi-core and many-core platforms

Duration: October 2013 - September 2016

Coordinator: Barcelona Supercomputing Center (Spain)

Inria contact: Liliana Cucu-Grosjean PROXIMA started on October 1st, 2013 with a kick-off meeting in November 2013.

The project claims that probabilistic analysis techniques can provide efficient (tractable) and effective (tight) analysis of the temporal behaviour of complex mixed-criticality applications, while running on novel multicore and manycore platforms. Solid research results from the former FP7 STREP PROARTIS project sustain this claim. The concept is based on using probabilistic analysis techniques to derive safe and tight bounds on the temporal behaviour of applications. Such bounds should reflect requirements on failure rates commensurate with their criticality.

PROXIMA defines architectural paradigms that break causal dependence in the timing behaviour of execution components at hardware and software level that can give rise to pathological cases. The risk is then reduced to quantifiably small levels. The changes needed in the hardware and software components beneath the application (processing cores, interconnects, memory hierarchies and controllers, real-time operating system, middleware, compilers) remain modest.

8.3.2. Collaborations in European Programs, except FP7

8.3.2.1. ARTEMIS PRESTO

Participants: Frédéric Mallet, Arda Goknil, Julien Deantoni, Marie-Agnès Peraldi Frati, Robert de Simone, Jean-Vivien Millo.

Type: ARTEMIS

Project title: PRESTO

Duration: April 2011 - March 2014

Coordinator: Miltech (Greece)

Others partners: TELETEL S.A. (Greece), THALES Communications (France), Rapita Systems Ltd. (United Kingdom), VTT (Finland), Softeam (France), THALES (Italy), MetaCase (Finland), Inria (France), University of L'Aquila (Italy), MILTECH HELLAS S.A (Greece), PragmaDev (France), Prismtech (United Kingdom), Sarokal Solutions (Finland).

See also: <http://www.cesarproject.eu/>

Abstract: The PRESTO project aims at improving test-based embedded systems development and validation, while considering the constraints of industrial development processes. This project is based on the integration of test traces exploitation, along with platform models and design space exploration techniques. Such traces are obtained by execution of test patterns, during the software integration design phase, meant to validate system requirements. The expected result of the project is to establish functional and performance analysis and platform optimisation at early stage of the design development. The approach of PRESTO is to model the software/hardware allocation, by the use of modelling frameworks, such as the UML profile for model-driven development of Real Time and Embedded Systems (MARTE). The analysis tools, among them timing analysis including Worst Case Execution Time (WCET) analysis, scheduling analysis and possibly more abstract system-level timing analysis techniques will receive as inputs on the one hand information from the performance modelling of the HW/SW-platform, and on the other hand behavioural information of the software design from tests results of the integration test execution.

8.4. International Initiatives

8.4.1. Inria Associate Teams

8.4.1.1. DAESD

Title: Distributed/Asynchronous and Embedded/synchronous Systems Development

Inria principal investigator: Robert de Simone (Aoste) / Eric Madelaine (Oasis)

International Partner (Institution - Laboratory - Researcher):

East China Normal University (China) - SEI-Shone - Robert De Simone

Duration: 2012 - 2014

See also: <https://team.inria.fr/DAESD/>

The development of concurrent and parallel systems has traditionally been clearly split in two different families: distributed and asynchronous systems on one hand, now growing very fast with the recent progress of the Internet towards large scale services and clouds; embedded, reactive, or hybrid systems on the other hand, mostly of synchronous behaviour. The frontier between these families has attracted less attention, but recent trends, e.g. in industrial systems, in Cyber-Physical systems (CPS), or in the emerging Internet of Things, give a new importance to research combining them.

The aim of the DAESD associate team is to combine the expertise of the Oasis and Aoste teams at Inria, the SEI-Shone team at ECNU-Shanghai, and to build models, methods, and prototype software tools inheriting from synchronous and asynchronous models. We plan to address modelling formalisms and tools, for this combined model; to establish a method to analyze temporal and spatial consistency of embedded distributed real-time systems; to develop scheduling strategies for multiple tasks in embedded and distributed systems with mixed constraints.

A dedicated Spring School was organized this year in Shanghai (April 27-30th), with participation of Robert de Simone and Frédéric Mallet from Aoste.

8.4.2. Inria International Labs

8.4.2.1. LIAMA

The DAESD associated-team goals have been extended to a LIAMA project named HADES (Heterogeneous Asynchronous Distributed / Embedded Synchronous), again with the SEI-Shone lab of ECNU Shanghai. The kick-off meeting was held next to the thematic Spring School (see 8.4.1.1), in presence of Chinese and French officials.

8.5. International Research Visitors

8.5.1. Visits of International Scientists

8.5.1.1. Internships

Franco Pestarini

Subject: Threads scheduling on multicore processors

Date: from Feb 2013 until Jul 2013

Institution: Universidad Nacional de Rosario (Argentina)

ARIC Project-Team

8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. ANR HPAC Project

Participants: Claude-Pierre Jeannerod, Nicolas Louvet, Clément Pernet, Nathalie Revol, Damien Stehlé, Philippe Théveny, Gilles Villard.

“High-performance Algebraic Computing” (HPAC) is a four year ANR project that started in January 2012. The Web page of the project is <http://hpac.gforge.inria.fr/>. HPAC is headed by Jean-Guillaume Dumas (CASYS team, LJK laboratory, Grenoble); it involves AriC as well as the Inria project-team MOAIS (LIG, Grenoble), the Inria project-team PolSys (LIP6 lab., Paris), the ARITH group (LIRMM laboratory, Montpellier), and the HPC Project company.

The overall ambition of HPAC is to provide international reference high-performance libraries for exact linear algebra and algebraic systems on multi-processor architecture and to influence parallel programming approaches for algebraic computing. The central goal is to extend the efficiency of the LinBox and FGB libraries to new trend parallel architectures such as clusters of multi-processor systems and graphics processing units in order to tackle a broader class of problems in lattice-based cryptography and algebraic cryptanalysis. HPAC conducts researches along three axes:

- A domain specific parallel language (DSL) adapted to high-performance algebraic computations;
- Parallel linear algebra kernels and higher-level mathematical algorithms and library modules;
- Library composition, their integration into state-of-the-art software, and innovative high performance solutions for cryptology challenges.

8.1.2. ANR TaMaDi Project

Participants: Nicolas Brisebarre, Florent de Dinechin, Guillaume Hanrot, Vincent Lefèvre, Jean-Michel Muller, Damien Stehlé, Serge Torres.

The TaMaDi project (Table Maker’s Dilemma, 2010-2013) was funded by the ANR and headed by Jean-Michel Muller. It started in October 2010 and ended in October 2013. The other French teams involved in the project are the Marelle team-project of Inria Sophia Antipolis-Méditerranée, and the PEQUAN team of LIP6 lab., Paris.

The aim of the project was to find “hardest to round” (HR) cases for the most common functions and floating-point formats. In floating-point (FP) arithmetic having fully specified “atomic” operations is a key-requirement for portable, predictable, and provable numerical software. Since 1985, the four arithmetic operations and the square root are IEEE specified (it is required that they should be correctly rounded: the system must always return the floating-point number nearest the exact result of the operation). This is not fully the case for the basic mathematical functions (sine, cosine, exponential, etc.). Indeed, the same function, on the same argument value, with the same format, may return significantly different results depending on the environment. As a consequence, numerical programs using these functions suffer from various problems. The lack of specification is due to a problem called the Table Maker’s Dilemma (TMD). To compute $f(x)$ in a given format, where x is a FP number, we must first compute an approximation to $f(x)$ with a given precision, which we round to the nearest FP number in the considered format. The problem is the following: finding what the accuracy of the approximation must be to ensure that the obtained result is always equal to the “exact” $f(x)$ rounded to the nearest FP number. In the last years, our team-project and the CACAO team-project of Inria Nancy-Grand Est designed algorithms for finding hardest-to-round cases. These algorithms do not allow to tackle with large formats. The TaMaDi project mainly focuses on three aspects:

- big precisions: we must get new algorithms for dealing with precisions larger than double precision. Such precisions will become more and more important (even if double precision may be thought as more than enough for a final result, it may not be sufficient for the intermediate results of long or critical calculations);
- formal proof: we must provide formal proofs of the critical parts of our methods. Another possibility is to have our programs generating certificates that show the validity of their results. We should then focus on proving the certificates;
- aggressive computing: the methods we have designed for generating HR points in double precision require weeks of computation on hundreds of PCs. Even if we design faster algorithms, we must massively parallelize our methods, and study various ways of doing that.

The various documents on the project can be found at http://tamadiwiki.ens-lyon.fr/tamadiwiki/index.php/Main_Page.

8.1.3. PEPS Quarenum

Participants: Nicolas Louvet, Nathalie Revol.

“Quarenum” is an abbreviation for *Qualité et Reproductibilité Numériques dans le Calcul Scientifique Haute Performance*. This project focuses on the numerical quality of scientific software, more precisely of high-performance numerical codes. Numerical validation is one aspect of the project, the second one regards numerical reproducibility.

8.2. European Initiatives

8.2.1. FP7 Projects

Damien Stehlé was awarded in 2013 a “starting” ERC grant for his project “Euclidean lattices: algorithms and cryptography” (LattAC).

8.3. International Initiatives

8.3.1. Inria Associate Teams

QOLAPS (Quantifier elimination, Optimization, Linear Algebra and Polynomial Systems) is an Associate Team between the Symbolic Computation Group at North Carolina State University (USA), the PolSys team at LIP6, Paris 6, and the AriC team. Participants: Clément Pernet, Nathalie Revol, Gilles Villard.

8.3.2. Inria International Partners

8.3.2.1. Declared Inria International Partners

We contributed to the creation in 2008 of the IEEE 1788 working group on the standardization of interval arithmetic <http://grouper.ieee.org/groups/1788/>. and N. Revol chairs this group since its creation. More than 140 persons from over 20 countries take part in the discussions, around 2500 public messages were exchanged in 2013. The deadline granted by IEEE is December 2014. In 2013 we managed to elaborate a close-to-final draft of the standard text. This last year will be devoted to the final ballot from the working group and to a sponsor ballot, by experts designated by IEEE.

The annual in-person meeting, chaired by N. Revol, took place at the end of the IFSA-NAFIPS 2013 conference in Edmonton, Canada, the 25th of June.

V. Lefèvre participated in various discussions, either in the mailing-list or in small subgroups (he sent around 390 email messages in 2013).

8.3.2.2. *Informal International Partners*

Our international academic collaborators are from Courant Institute of Mathematical Sciences (USA), Hamburg University of Technology (Germany), Imperial College (UK), Macquarie University (Australia), Mc Gill University (Canada), Monash University (Australia), Nanyang Technological University (Singapore), North Carolina State University (USA), Technical University of Cluj-Napoca (Romania), University of California, Los Angeles (USA), University of Delaware (USA), University of Southern Denmark (Denmark), University of Western Ontario (Canada), University of Waterloo (Canada), Uppsala University (Sweden).

We also collaborate with Intel (Portland, USA).

8.3.3. *Participation In other International Programs*

CANTAL (Cryptography, Algorithmic Number Theory and Lattices) is a CNRS Associate Team between the cryptography group of Macquarie University (Australia), the cryptography group of Monash University (Australia) and the AriC team. Participants: Nicolas Brisebarre, Guillaume Hanrot, Fabien Laguillaumie, Adeline Langlois, Damien Stehlé.

Damien Stehlé is a Partner Investigator in the Australian Research Council Discovery Grant on Cryptography and Algorithmic Number Theory, headed by Christophe Doche (Macquarie U.), Igor Shparlinski (U. of New South Wales), and Ron Steinfeld (U. of Monash), and in a Singaporean Ministry of Education grant of Code-based and Lattice-based cryptography, headed by San Ling (Nanyang Technological U.) and Huaxiong Wang (Nanyang Technological U.).

8.4. International Research Visitors

8.4.1. *Visits of International Scientists*

Xiao-Wen Chang (McGill U., Canada) visited the team from mid-April to mid-June 2013, under the invited professor scheme from ENS de Lyon.

Warwick Tucker (Uppsala U., Sweden) visited the team from mid-February to the end of March 2013, both under the invited professor scheme from ENS de Lyon and thanks to a funding provided by the LIP laboratory.

Peter Kornerup (U. of Southern Denmark) visited the team the last two weeks of September 2013.

8.4.1.1. *Internships*

Saruchi (IIT Delhi) did a 3-month Master degree internship under the supervision of Damien Stehlé, from April to June 2013.

8.4.2. *Visits to International Teams*

Nicolas Brunie was invited for 6 months by Intel (Portland, USA) to work on the implementation of elementary functions.

ATEAMS Project-Team

6. Partnerships and Cooperations

6.1. National Initiatives

6.1.1. Master Software Engineering

ATEAMS is the core partner in the Master Software Engineering at Universiteit van Amsterdam. This master is a collaboration between SWAT/ATEAMS, Universiteit van Amsterdam, Vrije Universiteit and Hogeschool van Amsterdam.

6.1.2. Early Quality Assurance in Software Production

The EQUA project is a collaboration among Hogeschool van Amsterdam (main partner) Centrum Wiskunde & Informatica (CWI), Technisch Universiteit Delft, Laboratory for Quality of Software (LaQuSo), Info Support, Software Improvement Group (SIG), and Fontys Hogeschool Eindhoven.

6.1.3. Model-Driven Engineering in Digital Forensics

In this project ATEAMS works with the Dutch National Forensics Institute on next generation carving software for recovering evidence from damaged or erased data storage media.

6.1.4. Next Generation Auditing: Data-assurance as a service

This collaboration between Centrum Wiskunde & Informatic (CWI) PriceWaterhouseCoopers (PWC), Belastingdienst (National Tax Office), and Computational Auditing, is to enable research in the field of computational auditing.

6.2. European Initiatives

6.2.1. FP7 Projects

OSSMETER aims to extend the state-of-the-art in the field of automated analysis and measurement of open-source software (OSS), and develop a platform that will support decision makers in the process of discovering, comparing, assessing and monitoring the health, quality, impact and activity of open-source software. The project started in October 2012. ATEAMS contributes to this project by focusing on software analysis and related areas.

6.3. International Research Visitors

6.3.1. Visits of International Scientists

- Oscar Nierstrasz, PhD, Professor - Professor of Computer Science at the Institute of Computer Science (IAM) of the University of Bern
- Anya Helene Bagge, PhD - University of Bergen, Norway
- Sebastian Erdweg, PhD - TU Darmstadt

6.3.1.1. Internships

- Kevin van der Vlist
- Davy Meers
- Wouter Kwakernaak
- Jimi van der Woning
- Ioana Rucareanu
- Ioannis Tzanellis
- George Marminidis
- Vlad Lep
- Dimitrios Kyritsis
- Chris Mulder

CAIRN Project-Team

7. Partnerships and Cooperations

7.1. National Initiatives

The CAIRN team has currently some collaboration with the following laboratories: CEA List, CEA Leti, LEAT Nice, Lab-Sticc (Lorient, Brest), LIRMM (Montpellier, Perpignan), LIP6 Paris, IETR Rennes, Ireena Nantes; and with the following Inria project-teams: Aric, Compsys, Socrate.

The team participates in the activities of the following research organization of CNRS (GdR for in French "Groupe de Recherche"):

- GdR SOC-SIP (*System On Chip & System In Package*), working groups on reconfigurable architectures, embedded software for SoC, low power issues. E. Casseau is in charge of the architecture topic of the reconfigurable platform working group.
- GdR ISIS (*Information Signal ImageS*), working group on *Algorithms Architectures Adequation*.
- GdR ASR (*Architectures Systèmes et Réseaux*)
- GdR IM (*Informatique Mathématiques*), C2 working group on Codes and Cryptography and ARITH working group on Computer Arithmetic

7.1.1. ANR Blanc - PAVOIS (2012–2016)

Participants: Arnaud Tisserand, Emmanuel Casseau, Romuald Rocher, Philippe Quémerais, Jérémie Métairie, Nicolas Veyrat-Charvillon, Nicolas Estibals, Thomas Chabrier, Karim Bigou.

PAVOIS (in French: *Protections Arithmétiques Vis à vis des attaques physiques pour la cryptographie basée sur les courbes elliptiques*) is a project on Arithmetic Protections Against Physical Attacks for Elliptic Curve based Cryptography. It involves IRISA-CAIRN (Lannion) and LIRMM (Perpignan and Montpellier). This project will provide novel implementations of curve based cryptographic algorithms on custom hardware platforms. A specific focus will be placed on trade-offs between efficiency and robustness against physical attacks. One of our goal is to theoretically study and practically measure the impact of various protection schemes on the performance (speed, silicon cost and power consumption). Theoretical aspects will include an investigation of how special number representations can be used to speed-up cryptographic algorithms, and protect cryptographic devices from physical attacks. On the practical side, we will design innovative cryptographic hardware architectures of a specific processor based on the theoretical advancements described above to implement curve based protocols. We will target efficient and secure implementations for both FPGA and ASIC circuits. For more details see <http://pavois.irisa.fr>.

7.1.2. ANR INFRA 2011 - FAON (2012-2015)

Participants: Raphaël Bardoux, Arnaud Carer, Matthieu Gautier, Pascal Scalart.

The FAON (Frequency based Access Optical Networks) project objectives are to demonstrate the technology and feasibility of a new type of Passive Optical Network (PON) for broadband access which uses a Frequency based shared access technique known as Frequency Division Multiplexing (FDM). These goals completely fall into the line of the expected capacity increase in PON which is today forecasted to go from 100 Mbps per user to 1 Gbps. For more details, see <http://www.anr-faon.fr/>. Faon involves Orange Labs, CEA-LETI, University of South Brittany (Lab-STICC laboratory) and University of Rennes 1 (Foton laboratory and CAIRNteam). CAIRN aims at developing a high-rate architecture at the receiver side. Specific receiver algorithms (synchronization and equalization) and FPGA implementation are the key issues that will be addressed.

7.1.3. Equipex FIT - Future Internet (of Things)

Participants: Vaibhav Bhatnagar, Arnaud Carer, Matthieu Gautier, Ganda-Stéphane Ouedraogo, Olivier Sentieys.

FIT is one of 52 winning projects from the first wave of the French Ministry of Higher Education and Research's "Équipements d'Excellence" (Equipex) research grant programme. FIT involves UPMC, Inria, LSIIT and the Institut Mines-Telecom and runs over a nine-year period. FIT offers a federation of several independent experimental testbeds to provide a larger-scale, more diverse and higher performance platform for accomplishing advanced experiments. For more details, see <http://fit-equipex.fr/>. Inria (CAIRN and Socrate teams) develops the cognitive radio testbed that will provide a full experimental environment for evaluating the coexistence and the cooperation between heterogeneous multistandard nodes. To this aim, a fully open architecture based on software defined radio nodes is developed. CAIRN aims at proposing an FPGA based software defined radio with high level specifications. Cognitive radio testbed development is supported by an ADT funding of Inria.

7.1.4. ANR Ingénierie Numérique et Sécurité - ARDyT (2011-2015)

Participants: Arnaud Tisserand, Thomas Chabrier, Philippe Quémerais.

ARDyT (in French: *Architecture Reconfigurable Dynamiquement Tolérante aux fautes*) is a project on a Reliable and Reconfigurable Dynamic Architecture. It involves IRISA-CAIRN (Lannion), Lab-STICC (Lorient), LIEN (Nancy) and ATMEL. The purpose of the ARDyT project is to provide a complete environment for the design of a fault tolerant and self-adaptable platform. Then, a platform architecture, its programming environment and management methodologies for diagnosis, testability and reliability have to be defined and implemented. The considered techniques are exempt from the use of hardened components for terrestrial and aeronautics applications for the design of low-cost solutions. The ARDyT platform will provide a European alternative to import ITAR constraints for fault-tolerant reconfigurable architectures. For more details see <http://ardyt.irisa.fr>.

7.1.5. ANR Ingénierie Numérique et Sécurité - COMPA (2011-2015)

Participants: Emmanuel Casseau, Steven Derrien, Antoine Courtay, Mythri Alle.

COMPA (model oriented design of embedded and adaptive multiprocessor) is a project which involves CAIRN, IETR (Institut d'Electronique et de Télécommunications de Rennes), Lab-STICC (University of Bretagne Sud), CAPS Entreprise, and Modae Technologies. The goal of the project is to design adaptive multiprocessor embedded systems to the execute dataflow programs. The use case is Reconfigurable video coding (RVC) standard. More specifically, we focus on the portable and platform-independent RVC-CAL language to describe the applications. We use transformations to refine, increase parallelism and translate the application model into software and hardware components. Task mapping, instruction and processor allocation, and specific scheduling are also investigated for runtime execution and reconfiguration.

7.1.6. ANR Ingénierie Numérique et Sécurité - DEFIS (2011-2015)

Participants: Olivier Sentieys, Daniel Menard [external collaborator], Romuald Rocher, Nicolas Simon.

DEFIS (Design of fixed-point embedded systems) is a project which involves CAIRN, LIP6 (University of Paris VI), LIRMM (University of Perpignan), CEA LIST, Thales, Inpixon. The main objectives of the project are to propose new approaches to improve the efficiency of the floating-point to fixed-point conversion process and to provide a complete design flow for fixed-point refinement of complex applications. This infrastructure will reduce the time-to-market by automating the fixed-point conversion and by mastering the trade-off between application quality and implementation cost. Moreover, this flow will guarantee and validate the numerical behavior of the resulting implementation. The proposed infrastructure will be validated on two real applications provided by the industrial partners. For more details see <http://defis.lip6.fr>.

7.1.7. ANR ARPEGE - GRECO (2010-2013)

Participants: Olivier Sentieys, Olivier Berder, Arnaud Carer, Trong-Nhan Le.

Sensor network technologies and the increase efficiency of photovoltaic cells show that it is possible to reach communicating objects solutions with low enough power consumption to foresee the possibility of developing autonomous objects. Greco (GREen wireless Communicating Objects) is a project on the design of autonomous communicating object platforms (i.e. self-powered sensor networks). The aim is to optimize the power consumption based on (i) a modeling of the performance and power of the required blocks (RF front-end, converters, modem, peripherals, digital architecture, OS, software, power generator, battery, etc.) (ii) heterogeneous simulation models and tools, and (iii) the use of a real-time global "Power Manager". The final validation will be performed on various case studies: a monitoring system and an audio communication between firemen. A HW/SW prototyping (based on an CAIRN's PowWow platform with energy harvesting) and a simulation associating a precise modeling (virtual platform) of an object inserted in a network simulator-like environment will be developed as demonstrators. Greco involves Thales, Irista-CAIRN, CEA List, CEA Leti, Im2nP, LEAT, Insight-SiP. For more details see <http://greco.irisa.fr>.

7.1.8. Images and Networks competitiveness cluster - 100GFlex project (2010-2013)

Participants: Olivier Sentieys, Arnaud Carer, Remi Pallas, Pascal Scalart.

Speed and flexibility are quickly increasing in the metropolitan networks. In this context, 100GFLEX studies the relevance of a new transmission scheme: the multiband optical OFDM at very-high rates (up to 100 Gbits/s). In this project we will study efficient algorithms (e.g. synchronization) and high-speed architectures for the digital signal processing of the optical transceivers. Due to the high rate of analog signals (sampling at more than 10Gsample/s), synchronizing and processing is real challenge. 100Gflex involves Mitsubishi-Electric R&D Center Europe, Institut Télécom, Ekinops, France Télécom, Yenista Optics, Foton and CAIRN.

7.2. European Initiatives

7.2.1. FP7 FLEXILES

Participants: Olivier Sentieys, Emmanuel Casseau, Antoine Courtay, Daniel Chillet, Philippe Quémerais, Christophe Huriaux, Quang-Hoa Le.

Program: FP7-ICT-2011-7

Project acronym: Flexiles

Duration: Oct. 2011 - Sep. 2014

Coordinator: Thales

Other partners: Thales (FR), UR1 (FR), KIT (GE), TU/e (NL), CSEM (SW), CEA LETI (FR), Sundance (UK)

Project title: Self Adaptive Heterogeneous Manycore Based on Flexible Tiles

A major challenge in computing is to leverage multi-core technology to develop energy-efficient high performance systems. This is critical for embedded systems with a very limited energy budget as well as for supercomputers in terms of sustainability. Moreover the efficient programming of multi-core architectures, as we move towards manycores with more than a thousand cores predicted by 2020, remains an unresolved issue. The FlexTiles project will define and develop an energy-efficient yet programmable heterogeneous manycore platform with self-adaptive capabilities. The manycore will be associated with an innovative virtualisation layer and a dedicated tool-flow to improve programming efficiency, reduce the impact on time to market and reduce the development cost by 20 to 50%. FlexTiles will raise the accessibility of the manycore technology to industry - from small SMEs to large companies - thanks to its programming efficiency and its ability to adapt to the targeted domain using embedded reconfigurable technologies.

7.2.2. FP7 ALMA

Participants: Steven Derrien, Romuald Rocher, Olivier Sentieys, Maxime Naullet, Ali Hassan El-Moussawi.

Program: FP7-ICT-2011-7

Project acronym: Alma

Project title: Architecture oriented parallelization for high performance embedded Multicore systems using scilab

Duration: Sep. 2011 - Aug. 2014

Coordinator: KIT

Other partners: KIT (GE), UR1 (FR), Recore Systems (NL), Univ. of Peloponnese (GR), TEI-MES (GR), Intracom SA (GR), Fraunhofer (GE)

The mapping process of high performance embedded applications to today's multiprocessor system on chip devices suffers from a complex toolchain and programming process. The problem here is the expression of parallelism with a pure imperative programming language which is commonly C. This traditional approach limits the mapping, partitioning and the generation of optimized parallel code, and consequently the achievable performance and power consumption of applications from different domains. The Architecture oriented parallelization for high performance embedded Multicore systems using scilab (ALMA) project aims to bridge these hurdles through the introduction and exploitation of a Scilab-based toolchain which enables the efficient mapping of applications on multiprocessor platforms from high-level abstraction descriptions. This holistic solution of the toolchain allows the complexity of both the application and the architecture to be hidden, which leads to a better acceptance, reduced development cost and shorter time-to-market. Driven by the technology restrictions in chip design, the end of Moore's law and an unavoidable increasing request of computing performance, ALMA is a fundamental step forward in the necessary introduction of novel computing paradigms and methodologies. ALMA helps to strengthen the position of Europe in the world market of multiprocessor targeted software toolchains. The challenging research will be achieved by the unique ALMA consortium which brings together industry and academia. High class partners from industry such as Recore and Intracom, will contribute their expertise in reconfigurable hardware technology for multi-core systems-on-chip, software development tools and real world applications. The academic partners will contribute their outstanding expertise in reconfigurable computing and compilation tools development.

7.2.3. Collaborations with Major European Organizations

Imec (Belgium), Scenario-based fixed-point data format refinement to enable energy-scalable of Software Defined Radios (SDR)

Lund University (Sweden), Constraints programming approach application in the reconfigurable data-paths synthesis flow

Code and Cryptography group of University College Cork (Ireland), Arithmetic operators for cryptography, side channel attacks for security evaluation, and WSN for health monitoring

Ecole Polytechnique Fédérale de Lausanne - EPFL (Switzerland), Optimization of systems using fixed-point arithmetic

Technical University of Madrid - UPM (Spain), Optimization of systems using fixed-point arithmetic

Technical University of Tampere, University of Oulu (Finland), Reconfigurable Video Coding

7.3. International Initiatives

7.3.1. Inria International Partners

7.3.1.1. Declared Inria International Partners

Computer Science Department, Colorado State University in Fort-Collins (USA), Loop parallelization, development of high-level synthesis tools, Inria Associate Team (2010-2012)

Electrical and Computer Engineering Department, University of Massachusetts at Amherst (USA), CAD tools for arithmetic datapath synthesis and optimization

7.3.1.2. *Informal International Partners*

LRTS laboratory, Laval University in Québec (Canada), Architectures for MIMO systems, Wireless Sensor Networks, Inria Associate Team (2006-2008)

LSSI laboratory, Québec University in Trois-Rivières (Canada), Design of architectures for digital filters and mobile communications

7.3.2. **CNRS PICS - SPiNaCH (2012 - 2014)**

Title: Secure and low-Power sensor Networks Circuits for Healthcare embedded applications

Principal investigator: Arnaud Tisserand, Olivier Berder, Olivier Sentieys

International Partner (Institution - Laboratory - Researcher): Code&Crypto group in University College Cork (Ireland)

Duration: 2012 - 2014

Biomedical sensor networks may be used more and more in the future. For instance, they allow patient's health-care parameters to be remotely monitored at home. In this project, we plan to address two important challenges in the design of biomedical sensors networks: i) design of low-power sensor devices for embedded autonomous systems (health monitoring, pace-maker...) with long battery life; ii) confidentiality and security aspects and especially with public key cryptography processor that are robust against side channel attacks (measure of the computation time, the power consumption or the electromagnetic radiations of the circuit) and with limited power-energy resources.

7.4. International Research Visitors

7.4.1. *Visits of International Scientists*

Prof. Russel Tessier (University of Massachusetts, UMass Reconfigurable Computing Group, USA) for one month in June-July (Visiting professor position from University Rennes 1).

Prof. Liam Marnane (University College Cork, Ireland) for one month in June (Visiting professor position from University Rennes 1).

Prof. Emanuel Popovici (University College Cork, Ireland) for two weeks in July (Visiting professor position from University Rennes 1).

Prof. Manav Bhatnagar, (Department of Electrical Engineering, Indian Institute of Technology, Delhi, India) for two weeks in December (Visiting professor position from University Rennes 1).

Dr. Michele Magno, post-doc, (University College Cork, Ireland) for one week in July (funded by CNRS PICS SpiNaCH project).

7.4.2. *Internships*

Participant: Simara Pérez Zurita.

Subject: Optimizing Computational Precision in High-level Synthesis of Signal Processing Systems: Theory and Implementation using TDS and GECOS

Date: from Oct 2012 until Aug 2013

Institution: *Technical University of Kaiserslautern* (Kaiserslautern, Germany)

Participant: Rengarajan Ragavan.

Subject: Reconfigurable Microtasks for Ultra-Low Power Wireless Sensor Network Nodes

Date: from Jan 2013 until Jul 2013

Institution: *Linkoping University* (Linkoping, Sweden)

Participant: Amith Vikram Pai.

Subject: Design and Validation of a Low-Power Embedded FPGA

Date: from Jan 2013 until Jun 2013

Institution: Birla Institute of Technology and Science, Pilani (India)

CAMUS Team

8. Partnerships and Cooperations

8.1. National Initiatives

Philippe Clauss, Alain Ketterlin, Cédric Bastoul and Vincent Loechner are involved in the Inria Large Scale Initiative entitled “Large scale multicore virtualization for performance scaling and portability” and regrouping several french researchers in compilers, parallel computing and program optimization. The project started officially in January 2013. In this context and since January 2013, Philippe Clauss is co-advising with Erven Rohou of the Inria team ALF, Nabil Hallou’s PhD thesis focusing on dynamic optimization of binary code.

The CAMUS team is taking part of the NANO 2017 national research program with the company STMicroelectronics, starting January 2014.

8.2. European Initiatives

8.2.1. Collaborations in European Programs, except FP7

Program: ITEA

Project acronym: MANY

Project title: Many-core Programming and Resource Management for High-Performance Embedded Systems

Duration: 09/2011 - 08/2014

Coordinator: XDIN

Other partners: France: Thales Communications and Security, CAPS Entreprise, Telecom SudParis; Spain: UAB; Sweden: XDIN; Korea: ETRI, TestMidas, SevenCore; Netherlands: Vector Fabrics, ST-Ericsson, TU Eindhoven; Belgium: UMONS.

Abstract: Adapting Industry for the for the disruptive landing of many-core processors in Embedded Systems in order to provide scalable, reusable and very fast software development.

8.3. International Initiatives

8.3.1. Inria Associate Teams

8.3.1.1. ANCOME

Title: Memory and applications memory behavior

Inria principal investigator: Philippe Clauss

International Partner (Institution - Laboratory - Researcher):

University of Buenos Aires (Argentina) - Departamento de Computación, Facultad de Ciencias Exactas y Naturales - Philippe Clauss

Duration: 2011 - 2013

See also: <http://lafhis.dc.uba.ar/wiki/index.php/EA-Ancome>

This associate team focuses on developing original methods for the analysis of programs memory behavior, in particular in the context of applications using dynamic memory allocation. The proposed approaches consist in analyzing and modeling the runtime behavior, where extracted properties are then verified thanks to static analysis processes. Thus pure static approaches limits will be overpassed. Further, the case of multi-threaded applications run on multi-core architectures will be studied in order to elaborate and extend our analysis techniques and to extract properties specific to this context. The issues are mainly concerned with the conception of real-time applications using dynamic memory allocation.

8.3.2. Inria International Partners

8.3.2.1. Informal International Partners

The CAMUS team maintains regular contacts with the following entities:

- Reservoir Labs, New York, NY, USA
- Intel, Santa Clara, CA, USA
- UPMARC, University of Uppsala, Sweden
- University of Batna, Algeria
- University El Manar, Tunis, Tunisia
- Ohio State University, Columbus, USA
- Louisiana State University, Baton Rouge, USA
- Indian Institute of Science (IIS) Bangalore, India
- University of Delaware, DE, USA

8.4. International Research Visitors

8.4.1. Visits of International Scientists

Diego Garbervetsky, University of Buenos Aires, Argentina, has made three visits in the CAMUS team at the following dates: Dec. 1-14, Oct. 14-20 and Jan. 15-23.

Rachid Seghir, University of Batna, Algeria, visited the team from May the 30th to June the 13th.

8.4.1.1. Internships

Javier Corti

Subject: Certified Compiler for polyhedral transformations

Date: from Mar 2013 until Aug 2013

Institution: Universidad Nacional de Rosario (Argentina)

Imen Fassi

Subject: Multifor for Multicore

Date: from Mar 2013 until Aug 2013

Institution: Université de Tunis El Manar - Faculté des Sciences (Tunisia)

Dhruva Tirumala Bukkapatnam

Subject: Evaluation of the Kalray MPPA and extension of the Pluto compiler

Date: from Apr 2013 until Oct 2013

Institution: Birla Institute of Technology and Science, Birla (India)

8.4.2. Visits to International Teams

Philippe Clauss has spent one week in the LAFHIS team, University of Buenos Aires, Argentina, in October 2013.

CAMEL Project-Team

8. Partnerships and Cooperations

8.1. Regional Initiatives

8.1.1. *Function field sieve: implementation and hardware acceleration*

Participants: Jérémie Detrey [contact], Pierrick Gaudry, Hamza Jeljeli, Emmanuel Thomé.

The team has obtained for the years 2012 and 2013 a financial support from the Région Lorraine and Inria for a project focusing on the hardware implementation and acceleration of the function field sieve (FFS).

The FFS algorithm is currently the best known method to compute discrete logarithms in small-characteristic finite fields, such as may occur in pairing-based cryptosystems. Its study is therefore crucial to accurately assess the key-lengths which such cryptosystems should use. More precisely, this project aims at quantifying how much this algorithm can benefit from recent hardware technologies such as GPUs or CPU-embedded FPGAs, and how this might impact current key length recommendations.

While the more FPGA-related aspects of this project were put on hold in 2013, the GPU option was explored further. To this end, eight NVIDIA GeForce GTX 680 graphics cards were bought and installed in four nodes connected by an InfiniBand. Hamza Jeljeli was able to extend his GPU implementation of sparse linear algebra routines so as to take multi-GPU and multi-node computations into account. This setup was for instance used to break the discrete-logarithm record over an 809-bit binary field [15].

8.2. National Initiatives

The team participates in the “Calcul formel, arithmétique, protection de l’information” research pole of the GDR-IM (CNRS Research Groupon Mathematical Computer Science). The team is a member of the “Arithmétique”, “Calcul formel” and “Codage et Cryptographie” working groups.

8.2.1. *ANR CATREL (Cribles: Améliorations Théoriques et Résolution Effective du Logarithme discret)*

Participants: Razvan Barbulescu, Cyril Bouvier, Jérémie Detrey, Pierrick Gaudry, Hamza Jeljeli, Emmanuel Thomé [contact], Marion Videau, Paul Zimmermann.

The CATREL proposal has been accepted in ANR “programme Blanc” in 2012. This project involves CAMEL as a leading team, in cooperation with two other partners which are Inria project-team GRACE (Inria Saclay, LIX, École polytechnique), and the Arith team of the LIRMM Laboratory (Montpellier). The project targets the algorithms for solving the discrete logarithm problem in finite fields, using the Number Field Sieve and the Function Field Sieve algorithms. Actual work on the CATREL project started in January 2013. Three meetings have taken place already: in Nancy on Dec. 14th, 2012 (kick-off), in Palaiseau on June 19, 2013, and in Montpellier on November 12-13, 2013.

8.2.2. *GDR-IM supported travel for PhD students*

Hamza Jeljeli collaborated with Bastien Violla from LIRMM, Montpellier to integrate RNS-based code in $\text{mp}\mathbb{F}_q$ and CADO-NFS. This collaboration was funded by the GDR-IM program “visite de doctorants”.

8.3. International Research Visitors

8.3.1. *Visits of International Scientists*

Shi Bai from the univeristy of Auckland, NZ, visited us in June 2013.

Thorsten Kleinjung, from the EPFL, visited us in October 2013.

CARTE Project-Team

8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. ANR

- The team was a funding partner in ANR Complice (Implicit Computational Complexity, Concurrency and Extraction), ref.: ANR-08-BLANC-0211-01, that ended in april 2013 and whose aim was to extend the results of ICC to other paradigms (process languages, ...) and take benefice of proof extraction techniques in order to synthesize resource certificates. This ANR should be followed by a new ANR submission (ANR Elica proposal) involving Paris 7 PPS team, Paris 13 LCC team, ENS Lyon Plume team and Bologna Inria team Focus.
- The team is a funding partner in ANR Binsec, whose aim is to fill part of the gap between formal methods over executable code on one side, and binary-level security analyses currently used in the security industry. Two main applicative domains are targeted: vulnerability analysis and virus detection. Two other closely related applications will also be investigated: crash analysis and program deobfuscation.
- Emmanuel Jeandel is a member of ANR Blanche ANR-09-BLAN-0164 (EMC: *Emerging Phenomena in Computation Models*), that ended in April 2013.

8.1.2. PEPS

- Simon Perdrix is a member of a PEPS INS2I “Information et Communication Quantique: Cryptographie et Calcul Quantiques Distribués.” with partners in Telecom ParisTech and other labs.
- Mathieu Hoyrup is principal investigator of a PEPS INS2I “Approches Topologiques de l’Information et de la Calculabilité”, with Emmanuel Jeandel and Laurent Bienvenu (CNRS, LIAFA).

8.2. European Initiatives

8.2.1. FP7 Projects

8.2.1.1. FI-WARE

Title: Morphus

Type: COOPERATION

Defi: PPP FI: Technology Foundation: Future Internet Core Platform

Instrument: Integrated Project (IP)

Objectif: PPP FI: Technology Foundation:Future Internet Core Platform

Duration: September 2011 - May 2014

Coordinator: Telefonica (Spain)

Other Partners: Thales, SAP, Inria

Inria contact: Olivier Festor

Abstract: See also: <http://www.fi-ware.eu/>. FI-WARE will deliver a novel service infrastructure, building upon elements (called Generic Enablers) which offer reusable and commonly shared functions making it easier to develop Future Internet Applications in multiple sectors. This infrastructure will bring significant and quantifiable improvements in the performance, reliability and production costs linked to Internet Applications for building a true foundation for the Future Internet.

8.3. International Initiatives

8.3.1. Inria International Partners

8.3.1.1. Informal International Partners

The team has an informal partnership with Pr. James Royer (University of Syracuse) and PhD. Norman Danner (Wesleyan University) on the study of program higher order complexity (an Inria associated team proposal has been submitted on this domain). On the Implicit Computational Complexity part, the team has strong contacts with Universita di Torino (Pr Simona Ronchi Della Rocca), Dundee University(PhD Marco Gaboardi), Universita di Bologna (Pr Simone Martini and PhD Ugo Dal Lago).

8.4. International Research Visitors

8.4.1. Visits of International Scientists

Subramanian Kumbakonam Govindarajan, professor in Universiti Sains Malaysia, was visiting Carte team in february. He works on computational models and Parikh matrices.

Neil Jones, professor in the University of Copenhagen, visited Carte team for one month in March. He is currently working on program transformation and program obfuscation, which have obvious applications to Computer Virology.

8.4.2. Visits to International Teams

Mathieu Hoyrup visited Universidad Andres Bello in Santiago de Chile during february. He worked there with Cristobal Rojas on extending the results [22] from functions to relations.

CASCADE Project-Team

5. Partnerships and Cooperations

5.1. ANR Projects with Industrials

- **SAPHIR-II** (*Sécurité et Analyse des Primitives de Hachage Innovantes et Récentes*)
Security and analysis of innovating and recent hashing primitives.
Participants: Patrick Derbez, Jérémy Jean.
 From April 2009 to March 2013.
 Partners: France Telecom R&D, Gemalto, EADS, SAGEM, DCSSI, Cryptolog, Inria/Secret, UVSQ, XLIM, CryptoExperts.
- **BEST: Broadcast Encryption for Secure Telecommunications.**
Participants: David Pointcheval, Elizabeth Quaglia, Mario Streffer, Damien Vergnaud, Aurore Guillevic, Sorina Ionica.
 From December 2009 to December 2013.
 Partners: Thales, Nagra, CryptoExperts, Univ. Paris 8.
This project aims at studying broadcast encryption and traitor tracing, with applications to the Pay-TV and geolocalisation services.
- **PRINCE: Proven Resilience against Information leakage in Cryptographic Engineering.**
Participants: Fabrice Ben Hamouda, Sonia Belaid, Alain Passelègue, Michel Ferreira Abdalla, David Pointcheval.
 From December 2010 to December 2014.
 Partners: UVSQ, Oberthur Technologies, Ingenico, Gemalto, Tranef.
We aim to undertake research in the field of leakage-resilient cryptography with a practical point of view. Our goal is to design efficient leakage-resilient cryptographic algorithms and invent new countermeasures for non-leakage-resilient cryptographic standards. These outcomes shall realize a provable level of security against side-channel attacks and come with a formally verified implementation. For this every practical aspect of the secure implementation of cryptographic schemes must be taken into account, ranging from the high-level security protocols to the cryptographic algorithms and from these algorithms to their implementation on specific devices which hardware design may feature different leakage models.
- **SIMPATIC: SIM and PAiring Theory for Information and Communications security.**
Participants: Damien Vergnaud, Olivier Sanders, David Pointcheval.
 From February 2013 to August 2016.
 Partners: Orange Labs, INVIA, Oberthur Technologies, STMicroelectronics, Université Bordeaux 1, Université de Caen Basse-Normandie, Université de Paris VIII
We aim at providing the most possible efficient and secure hardware/software implementation of a bilinear pairing in a SIM card.

5.2. ANR Projects within Academics

- **ProSe: Security protocols : formal model, computational model, and implementations.**
Participant: David Pointcheval.
 From December 2010 to November 2014.
 Partners: ENS Cachan-Inria/Secsi, LORIA-Inria/Cassis, Inria/Prosecco, Verimag.
The goal of the project is to increase the confidence in security protocols, and in order to reach this goal, provide security proofs at three levels: the symbolic level, in which messages are terms; the computational level, in which messages are bitstrings; the implementation level: the program itself.

- **ROMAnTIC: Randomness in Mathematical Cryptography.**
Participants: Damien Vergnaud, David Pointcheval, Adrian Thillard, Sylvain Ruhault.
From October 2012 to September 2016.
Partners: ANSSI, Univ. Paris 7, Univ. Paris 8.
The goal of this project is to get a better understanding of the interplay between randomness and cryptography and to study the security of various cryptographic protocols at different levels (information-theoretic and computational security, number-theoretic assumptions, design and provable security of new and existing constructions).
- **CLE: Cryptography from Learning with Errors.**
Participant: Vadim Lyubashevsky.
From October 2013 to September 2017.
Partners: UVSQ, Univ. Paris 8, Inria/SECRET.
The main objective of this project is to explore the potential practical implications of the Learning with Errors problem and its variants. The plan is to focus on the constructions of essential primitives whose use is prevalent in the real world. Toward the end of the project, the hope is to propose and standardize several public key and symmetric key schemes that have specific advantages over ones that are currently deployed.

5.3. European Initiatives

- **ECRYPT-II: Network of Excellence in Cryptology.**
From August 2008 to July 2013.
*There are three virtual labs that focus on the following core research areas: symmetric key algorithms (STVL), public key algorithms and protocols (MAYA), and secure and efficient implementations (VAMPIRE).
ENS/Inria/CASCADE leads the MAYA virtual lab.*
- **SecFuNet: Security for Future Networks.**
From July 2011 to April 2014.
The goal of the SECFUNET project is to design and develop a coherent security architecture for virtual networks and cloud accesses.

5.4. International Research Visitors

- Mario Cornejo (Ms student) – Chile
- Nuttapon Attrapadung – The National Institute of Advanced Industrial Science and Technology, Japan
- Yu Long – Shanghai Jiao Tong University, China

CASSIS Project-Team

8. Partnerships and Cooperations

8.1. Regional Initiatives

- Franche-Comté Region project SyVAD (SysML Verification and Validation), coordinated by Fabrice Bouquet, duration: 3 years, started in September 2011. This project focuses on the SysML models for the validation and verification of the micro-systems, in particular for distributed micro airduct. The project associates several team of FEMTO-ST institute.

8.2. National Initiatives

8.2.1. ANR

- ANR PROSE *Protocoles de sécurité : modèle formel, modèle calculatoire, and implémentations — Security protocols : formal model, computational model, and implementations*, duration: 4 years, started in December 2010. The goal of the project is to increase the confidence in security protocols, and in order to reach this goal, provide security proofs at three levels: (i) the symbolic level, in which messages are terms, (ii) the computational level, in which messages are bitstrings, and (iii) the implementation level: the program itself. Partners are EPI Prosecco and EPI Cascade Paris (leader), LSV Cachan, Cassis and Verimag Grenoble.
- ANR STREAMS *Solution for Peer-to-peer Real-Time Social Web*, duration: 3 years, starting in October 2010. This project proposes to design peer-to-peer solutions that offer underlying services required by real-time social web applications and that eliminate the disadvantages of centralised architectures. There exists a tension between sharing data with friends in a social network deployed in an open peer-to-peer network and ensuring privacy. One of the most challenging issues in social applications is how to balance collaboration with access control to shared objects. This project aims at providing theoretical solutions to these challenges as well as practical experimentations. Partners are: LORIA Score team (leader), Inria project-teams Regal, Asap, Cassis, and XWiki.
- ANR FREC *Frontiers of recognizability*, duration: 4 years, starting in October 2010. The goal of this project is to be a driving force behind the extension of the algebraic theory of regular languages made possible by recent advances. Four directions will be investigated: tree languages, λ -terms, automata with counters, algebraic and topological tools. Partners are LABRI (leader), LIAFA (University Paris 7). Pierre-Cyrille Héam is a member of this project, attached to Paris 7 for administrative facilities.
- ANR OSEP *Online and offline model-based testing of SEcurity Properties*, duration: 2 years, started in November 2011 and ended in November 2013. The goal of this project was to apply online and offline model-based testing approaches for security testing of cryptographic components and software radio case studies, used as a black boxes. This approach had to be compatible with our previous offline approaches to increase the number of artefacts that can be shared. So, we developed new algorithms to allow online testing, and a dedicated tool called MBeeTle. This project was an opportunity to reuse the results of the ANR TASCCE project, and to complete these approaches with security properties expressed in TOCL. This project involved the DGA and Smartesting.

8.2.2. Competitivity Clusters

- FUI SQUASH *Software QUality ASSurance enHancement*, duration: 2 years, starting in April 2011. This project aims to industrialize and to structure software testing activities. The project will provide a methodology and tools based on open source components.

- Project "Investissement d'Avenir - Développement de l'Economie Numérique" DAST (Dynamic Application Security Testing), duration: 2 years, starting in September 2012. The goal of this project is to generate automatically the tests to prevent vulnerabilities. We have proposed an automated model-based vulnerability testing approach, that focuses on Criss-Site Scripting vulnerabilities in web applications. It relies on a behavioral model that describes the web application and a set of security test patterns formalizing ways to detect the vulnerabilities. This partnership includes NBSys, Smartesting (coordinator), Thales, Trusted-Labs and Inria CASSIS.

8.3. European Initiatives

8.3.1. FP7 Projects

- Nessos is a Network of Excellence on Engineering Secure Future Internet Software Services and Systems in FP7-ICT (starting in October 2010 for a period of 42 months). Nessos has 12 partners and aims at constituting and integrating a long lasting research community on engineering secure software-based services and systems. Partner Inria is involved through project-teams Arles, Triskell and Cassis. Cassis will focus on developing tools for service security verification and testing tasks.
- ProSecure (2011-2016) ⁹— ERC Starting Grant Project on Provably secure systems: foundations, design, and modularity. This long-term project aims at developing provably secure systems such as security protocols. The goal is to propose foundations for a careful analysis and design of large classes of up-to-date protocols. To achieve this goal, we foresee three main tasks. First, we plan to develop general verification techniques for new classes of protocols that are of primary interest in nowadays life like e-voting protocols, routing protocols or security APIs. Second, we will consider the cryptographic part of the primitives that are used in such protocols (encryption, signatures, ...), obtaining higher security guarantees. Third, we aim at proposing modular results both for the analysis and design of protocols. Véronique Cortier is the leader of the project.

8.4. International Initiatives

8.4.1. Inria Associate Teams

BANANAS ¹⁰*Automated design and autonomous control of hybrid solver cooperations*. In order to tackle large scale instances and intricate problem structures, sophisticated solving techniques have been developed, combined, and hybridized to provide efficient solvers. A common idea to get more efficient and robust algorithms consists in combining several resolution paradigms in order to take advantage of their respective assets. Autonomous Search is a very attractive approach for designing adaptive systems with the capability of improving its solving performance by selecting and adapting its search strategies to the problem at hand. The main goal of the project is to apply the Autonomous Search approach to hybrid solver cooperations, by automating the selection and the cooperation of solvers, by tuning the cooperation parameters, and by adapting the cooperation during solving. The international partners are Technical University Federico Santa Maria, Valparaíso (Chile) — Department of Computer Science — Carlos Castro and Eric Monfroy; University of Chile (Chile) — Center for Mathematical Modeling — Jorge Amaya. The Inria principal investigator is Christophe Ringeissen.

8.4.2. Inria International Partners

- Collaboration with Bogdan Warinschi (Bristol University) on soundness of symbolic models w.r.t. cryptographic ones.
- Collaboration with Mark Ryan's group (University of Birmingham) on the formal analysis of e-voting protocols.
- Collaboration with Paliath Narendran's group (SUNY Albany) on automated deduction.

⁹<http://www.loria.fr/~cortier/ProSecure.html>

¹⁰<http://www.loria.fr/~ringeiss/CHILI/bananas>

- Collaboration with Hanifa Boucheneb's group (Ecole Polytechnique de Montréal) on model-checking of collaborative systems.
- Collaboration with John Mullins's group (Ecole Polytechnique de Montréal) on information hiding.

8.4.3. Participation in International Programs

French-Tunisian project on *Security Policies and Configurations of Firewalls: Compilation and Automated Verification*. We collaborate with SupCom Tunis and the Inria project-team Dahu in the context of STIC-Tunisia.

French-Canadian project on *Automata for Hiding and Disclosing Information*, in the framework of the CFQCU program. We collaborate with the CRAC team at the Ecole Polytechnique de Montréal, Canada, and the MoVe team/LIP6 at the UPMC, Paris, France.

8.5. International Research Visitors

8.5.1. Visits of International Scientists

- Myrto Arapinis (University of Edinburgh), one week in January 2013, two weeks in November 2013
- Florian Boehl (KIT University), one week in January 2013
- Luigi Grillo (Università di Catania), two weeks in April 2013
- Dominique Unruh (Tallin University), one week in February 2013
- Bogdan Warinschi (University of Bristol), one week in January 2013
- Paliath Narendran (SUNY Albany), one month in June-July 2013
- David Bouchard and Kim Gero (SUNY Albany), one week in September 2013
- Christoph Sprenger and Binh Nguyen (ETH Zürich) three days in April 2013

8.5.1.1. Internships

We have supervised the following internships.

Anisia Maria Magdalena Tudorescu

Subject: Integrating SMT solvers into Spike

Supervisors: Pascal Fontaine (project-team Veridis), Sorin Stratulat, and Christophe Ringeissen

Date: from Mar 2013 until May 2013

Institution: West Timisoara University (Romania)

Gisela-Carla Rossi

Subject: Formal Methods for Secure Service Composition

Supervisors: Walid Belkhir and Michaël Rusinowitch

Date: from Jun 2013 until Dec 2013

Institution: National University of Cordoba (Argentina)

Paula Chocrón

Subject: Non-disjoint combination for SMT solvers: sharing a fragment of arithmetic

Supervisors: Pascal Fontaine (project-team Veridis) and Christophe Ringeissen

Date: from Sep 2013 until Nov 2013

Institution: University of Buenos Aires (Argentina)

Gemma Puig-Quer

Subject: New protocols for private e-voting

Supervisors: David Galindo-Chacon and Véronique Cortier

Date: from Sep 2013 until Mar 2014

Institution: UPC Barcelona (Spain)

In addition, Steve Kremer has supervised the following students from the École des Mines de Nancy:

- Othmane El Omri, Analysis of a peer-to-peer E-wallet protocol (from Jul 2013 to Sep 2013)
- Pierre Lepeudry, Formalizing some combinatorial attacks in security protocols (from Sep 2013 to Jan 2014)

and Véronique Cortier and Cyrille Wiedling have supervised a group of three students from the École des Mines de Nancy on the implementation of a secure key management system on smartcards: Arnaud Kéranguéven, Hadrien Chastant, and Othmane El Omri (from Oct 2012 to June 2013).

8.5.2. Visits to International Teams

- Olga Kouchnarenko, August 2013 (10 days), Ecole Polytechnique de Montréal (the CRAC team), Canada, visit funded by the Conseil franco-québécois de coopération universitaire” (CFQCU).

CELTIQUE Project-Team

7. Partnerships and Cooperations

7.1. Regional Initiatives

The Celtique team collaborates with DGA-MI, a research laboratory belonging to the French army, and located in Rennes. The collaboration has several facets.

- We run a joint bi-monthly seminar on Security and Formal Methods. This seminar attracts attendance from academia and industry.
- DGA-MI is funding a PhD thesis, supervised jointly, on code obfuscation.
- Colas Le Guernic, a DGA-MI researcher, is external collaborator of Celtique on our activities on analysis of binary code.

7.2. National Initiatives

7.2.1. *The PiCoq ANR project*

Participants: Alan Schmitt, Petar Maksimovic.

Process calculi, Verification, Proof Assistants

The goal of the (PiCoq project) is to develop an environment for the formal verification of properties of distributed, component-based programs. The project's approach lies at the interface between two research areas: concurrency theory and proof assistants. Achieving this goal relies on three scientific advances, which the project intends to address:

- Finding mathematical frameworks that ease modular reasoning about concurrent and distributed systems: due to their large size and complex interactions, distributed systems cannot be analysed in a global way. They have to be decomposed into modular components, whose individual behaviour can be understood.
- Improving existing proof techniques for distributed/modular systems: while behavioural theories of first-order concurrent languages are well understood, this is not the case for higher-order ones. We also need to generalise well-known modular techniques that have been developed for first-order languages to facilitate formalization in a proof assistant, where source code redundancies should be avoided.
- Defining core calculi that both reflect concrete practice in distributed component programming and enjoy nice properties w.r.t. behavioural equivalences.

The project partners include Inria, LIP, and Université de Savoie. The project runs from November 2010 to October 2014.

7.2.2. *The ANR VERASCO project*

Participants: Sandrine Blazy, Delphine Demange, Vincent Laporte, André Oliveira Maroneze, David Pichardie.

Static program analysis, Certified static analysis

The VERASCO project (2012–2015) is funded by the call ISN 2011, a program of the Agence Nationale de la Recherche. It investigates the formal verification of static analyzers and of compilers, two families of tools that play a crucial role in the development and validation of critical embedded software. It is a joint project with the Inria teams ABSTRACTION, GALLIUM, The VERIMAG laboratory and the Airbus company.

7.2.3. *The ANR Binsec project*

Participants: Frédéric Besson, Sandrine Blazy, Pierre Wilke.

Binary code, Static program analysis

The Binsec project (2013–2017) is founded by the call ISN 2012, a program of the Agence Nationale de la Recherche. The goal of the BINSEC project is to develop static analysis techniques and tools for performing automatic security analyses of binary code. We target two main applicative domains: vulnerability analysis and virus detection.

Binsec is a joint project with the Inria CARTE team, CEA LIS, VERIMAG, EADS IW and VUPEN SECURITY. ABSTRACTION, The VERIMAG laboratory and the Airbus company.

7.2.4. *Labex COMIN Labs Seccloud project*

Participants: Frédéric Besson, Nataliia Bielova, Thomas Jensen, Alan Schmitt, Martin Bodin.

The SecCloud project, started in 2012, will provide a comprehensive language-based approach to the definition, analysis and implementation of secure applications developed using Javascript and similar languages. Our high level objectives is to enhance the security of devices (PCs, smartphones, ect.) on which Javascript applications can be downloaded, hence on client-side security in the context of the Cloud. We will achieve this by focusing on three related issues: declarative security properties and policies for client-side applications, static and dynamic analysis of web scripting programming languages, and multi-level information flow monitoring.

This is a joint project with Supelec Rennes and Ecole des Mines de Nantes.

7.3. International Initiatives

7.3.1. *Inria International Partners*

7.3.1.1. *Informal International Partners*

A strong collaboration is ongoing with researchers from Imperial College (UK) in the setting of the JSCert project (<http://jscert.org/>). This project aims at really understanding JavaScript by building models of ECMA Script semantics in the Coq proof assistant, and certifying automated logical reasoning tools built on those semantics. We are closely working with Philippa Gardner and Sergio Maffei. This collaboration has resulted in a large Coq development including a formal semantics for JavaScript and a certified JavaScript interpreter. These results are described in our POPL 2014 paper [24].

In 2013, Martin Bodin, Thomas Jensen, and Alan Schmitt visited Imperial College twice. Daiva Naudziuniene, a PhD student of Philippa Gardner, also did a one month internship in the Celtique team in the setting of this collaboration.

David Pichardie was on sabbatical in 2012, in Jan Vitek's group at Purdue University, Indiana, USA. The strong collaboration is still ongoing, and an Associate Team proposal for 2014-2016 has been submitted in 2013 as part of an Inria International program. The JCert project research aims at verifying the compilation of concurrent managed languages, following the previous outcomes of the informal collaboration – a new memory model for concurrent Java that is more suitable to formal verification [26], as well as refinement-based proof methodology (under submission) that allows to reason compositionally about the atomicity of low-level concurrent code fragments. If the proposal is accepted, David Pichardie would be the Inria principal investigator of the JCert project, and Delphine Demange, Thomas Jensen, and Vincent Laporte will also be active participants.

7.4. International Research Visitors

7.4.1. Visits of International Scientists

7.4.1.1. Internships

Patricio Palladino

Subject: Protection from Web Tracking: Analysis of web browser fingerprints

Date: from Mar 2013 until Apr 2013

Institution: University of Buenos Aires (Argentina)

7.4.2. Visits to International Teams

David Pichardie took a sabbatical year and visited Greg Morrisett's group at Harvard University, Cambridge, USA in 2013. During this sabbatical, he worked on the DARPA SAFE project with Harvard University and UPenn University [17].

COMETE Project-Team

7. Partnerships and Cooperations

7.1. National Initiatives

7.1.1. ANR projects

7.1.1.1. ANR-09-BLAN-0169-01

- **Project acronym:** PANDA
- **Project title:** Analysis of Parallelism and Distribution
- **Duration:** October 2009 - March 2013
- **URL:** <http://lipn.univ-paris13.fr/~mazza/Panda/>
- **Coordinator:** Catuscia Palamidessi, Inria Saclay
- **Other PI's and partner institutions:** Dale Miller, EPIs Parsifal at Inria Saclay. Emmanuel Haucourt, CEA Saclay. Damiano Mazza, Pôle Parisien (ENS Cachan, Paris VII and Paris XIII). Emmanuel Godard, Pôle Méditerranéen (ENS Lyon and the University of Marseille). Jean Souyris, Airbus.
- **Abstract:** The aim of PANDA is to bring together different mathematical models of parallel and concurrent computation (geometric models, rewriting theory, higher category theory, stochastic processes), along with theoretical frameworks for static analysis (spatial logics, proof construction), in order to guide the development of software tools that meet industrial needs of program specification and verification (in particular, fault detection of parallel programs involved in avionics).

7.1.1.2. ANR-09-BLAN-0345-02

- **Project acronym:** CCP
- **Project title:** Confidence, Proof and Probabilities
- **Duration:** October 2009 - March 2013
- **URL:** <http://www.lix.polytechnique.fr/~bouissou/cpp/>
- **Coordinator:** Jean Goubault-Larrecq, ENS Cachan
- **Other PI's and partner institutions:** Catuscia Palamidessi, Inria. Olivier Bouissou, CEA LIST. Gilles Fleury, Supelec SSE. Michel Kieffer, Supelec L2S.
- **Abstract:** In the context of proofs of safety properties for critical software, The CPP project proposes to study the joint use of probabilistic and formal (deterministic) semantics and analysis methods, in a way to improve the applicability and precision of static analysis methods on numerical programs.

7.1.2. Large-scale initiatives

- **Project acronym:** CAPPRIIS
- **Project title:** Collaborative Action on the Protection of Privacy Rights in the Information Society
- **Duration:** October 2011 - September 2015
- **URL:** <https://cappriis.inria.fr/>
- **Coordinator:** Daniel Le Metayer, Inria Grenoble
- **Other partner institutions:** The project involves four Inria research centers (Saclay, Saphia-Antipolis, Rennes and Grenoble), CNRS-LAAS, Eurecom and the university of Namur. Besides computer scientists, the consortium also includes experts in sociology and in law, thus covering the complementary areas of expertise required to reach the objectives.

- **Abstract:** The goal of this project is to study the challenges related to privacy in the modern information society, trying to consider not only the technical, but also the social and legal ones, and to develop methods to enhance the privacy protection.

7.2. European Initiatives

7.2.1. FP7 Projects

7.2.1.1. MEALS

Program: FP7-PEOPLE-2011-IRSES

Project acronym: MEALS

Project title: Mobility between Europe and Argentina applying Logic to Systems

Duration: October 2011 - September 2015

URL: <http://www.meals-project.eu/>

Coordinator: Holger Hermans, Saarland University, Germany

Coordinator for the Inria sites: Catuscia Palamidessi, Inria Saclay

Other partner institutions: Rheinisch-Westfälische Technische Hochschule Aachen, Germany. Technische Universität Dresden, Germany. Inria, France. Imperial College of Science, Technology and Medicine, UK, University of Leicester, UK. Technische Universiteit Eindhoven, NL. Universidad Nacional de Cordoba, AR. Universidad de Buenos Aires, AR. Instituto Tecnológico de Buenos Aires, AR. Universidad Nacional de Rio Cuarto, AR.

Abstract: In this project we focus on three aspects of formal methods: specification, verification, and synthesis. We consider the study of both qualitative behavior and quantitative behavior (extended with probabilistic information). We aim to study formal methods in all their aspects: foundations (their mathematical and logical basis), algorithmic advances (the conceptual basis for software tool support) and practical considerations (tool construction and case studies).

7.3. International Initiatives

7.3.1. Inria Associate Teams

7.3.1.1. PRINCESS

Title: Protecting privacy while preserving data access

Inria principal investigator: Catuscia Palamidessi

International Partners:

Geoffrey Smith, Florida International University (United States)

Andre Scedrov, University of Pennsylvania (United States)

Duration: 2013 - 2016

URL: <http://www.lix.polytechnique.fr/comete/Projects/Princess/>

Abstract: PRINCESS is an Inria associated team focusing on the protection of privacy and confidential information. In particular, we study the issues related to the leakage of confidential information through public observables.

We aim at developing a meaningful notion of measure in order to quantify the leakage of information, and to design mechanisms to limit the amount of leakage, without interfering too severely with the utility of the information that is meant to be disclosed.

The main topics currently investigated are quantitative information flow, where we are developing a decision-theoretic approach, and differential privacy, where we are developing an extension which lifts the basic notion of privacy meant for databases to arbitrary domains.

7.3.2. Inria International Partners

7.3.2.1. Informal International Partners

- **Charles Carroll Morgan**, Professor, University of New South Wales
- **Moreno Falaschi**, Professor, University of Siena
- **Mario Ferreira Alvim Junior**, Assistant Professor, Federal University of Minas Gerais
- **Annabelle Mciver**, Associate Professor, Macquarie University
- **Carlos Olarte**, Associate Professor, Universidad Javeriana Cali

7.3.3. Participation In other International Programs

7.3.3.1. PACE

- **Program:** ANR Blanc International
- **Project title:** Beyond plain Processes: Analysis techniques, Coinduction and Expressiveness
- **Duration:** January 2013 - December 2016
- **URL:** <http://perso.ens-lyon.fr/daniel.hirschhoff/pace/>
- **Coordinator:** Daniel Hirschhoff , Ecole Normale Supérieure de Lyon
- **Other PI's and partner institutions:** Catuscia Palamidessi, Inria Saclay. Davide Sangiorgi, University of Bologna (Italy). Yuxi Fu, Shanghai Jiao Tong University (China).
- **Abstract:** This project objective is to enrich and adapt these methods, techniques, and tools to much broader forms of interactive models, well beyond the realm of "traditional" processes.

7.3.3.2. LOCALI

- **Program:** ANR Blanc International
- **Project title:** Logical Approach to Novel Computational Paradigms
- **Duration:** October 2011 - September 2015
- **URL:** <http://lcs.ios.ac.cn/~locali2013/>
- **Coordinator:** Gilles Dowek, Inria Rocquencourt
- **Other PI's and partner institutions:** Catuscia Palamidessi, Inria Saclay. Thomas Erhard, Paris VII. Ying Jiang , Chinese Academy of Science in Beijing (China).
- **Abstract:** This project aims at exploring the interplays between logic and sequential/distributed computation in formalisms like the lambda calculus and the π calculus. Going back to the fundamentals of the definitions of these calculi, the project plans to design new programming languages and proof systems via a logical approach.

7.4. International Research Visitors

7.4.1. Visits of International Scientists

- **Nikita Borisov**, Associate Professor, University of Illinois at Urbana-Champaign, from Nov 2013 until Dec 2013
- **Moreno Falaschi**, Professor, University of Siena, from Sep 2013 until Sep 2013
- **Mario Ferreira Alvim Junior**, Assistant Professor, Federal University of Minas Gerais, from Nov 2013 until Dec 2013
- **Fabio Gadducci**, Associate Professor, University of Pisa, from Jun 2013 until Aug 2013
- **Dominik Luecke**, Postdoc, from Apr 2013 until Apr 2013
- **Annabelle Mciver**, Associate Professor, Macquarie University, from Dec 2013 until Dec 2013
- **Charles Carroll Morgan**, Professor, University of New South Wales, from Dec 2013 until Dec 2013

- **Carlos Olarte**, Associate Professor, Universidad Javeriana Cali, from June 2013 until Jul 2013
- **Camilo Rueda**, Professor, Universidad Javeriana Cali, from Nov 2013 until Dec 2013
- **Vladimiro Sassone**, Professor, University of Southampton, from Apr 2013 until May 2013
- **Mauricio Toro Bermudez**, Postdoc, University of Cyprus, from Jun 2013 until Jun 2013

7.4.2. Internships

7.4.2.1. Xiao Wang

- **Duration:** From May 2013 until August 2013
- **Subject:** Differential privacy and applications of privacy protection in location-based services
- **Institution:** LIX, Ecole Polytechnique

7.4.2.2. Fernán Martinelli

- **Duration:** From September 2012 until March 2013
- **Subject:** Computation of bounds on the information flow
- **Institution:** University of Rio Cuarto, Argentina
- **Support:** FP7 project MEALS

7.4.3. Visits to International Teams

Catuscia Palamidessi visited the team of Andre Scedrov and Benjamin Pierce at the University of Pennsylvania. July 2013.

COMPSYS Project-Team

8. Partnerships and Cooperations

8.1. Regional Initiatives

Compsys has increased its relationship with the CITI laboratory (Insa-Lyon) and, in particular, the team of Tanguy Risset (Socrate Inria project <http://www.citi-lab.fr/team/socrate/>). Compsys and Socrate made several common working groups in 2012 and 2013, and are mutually invited to seminars organized by the other team. Streaming languages are a common topic of interest. In this context, Socrate, with the help of Compsys, will organize a thematic day (April 14, 2014) on the “compilation and execution of streaming programs”, in Domaine des Hautannes, St Germain au Mont d’Or. Lionel Morel and Laure Gonnord have also common topics of interest.

Compsys has stronger connections with the Grame music/computer laboratory (<http://www.grame.fr>) in Lyon and, in particular, Yann Orlarey, also due to common interests on streaming languages, in particular the language Faust developed by Grame. Yann Orlarey was one of the invited speaker of the keynotes on parallel languages (see the description the thematic quarter on compilation in Section 9.1.2). Alexandre Isoard’s Master 1 training period was on Faust, co-advised by Alain Darté and Yann Orlarey. For 2014, Laure Gonnord and Yann Orlarey proposed a Master research topic on the generation of invariants for the Faust language.

Compsys is also involved in the Labex MILYON (Mathématiques et Informatique Fondamentale de Lyon), which regroups Institut Camille Jordan, and the mathematics and computer science labs of ENS-Lyon. The aim of MILYON is “to strengthen our international relationships, in particular by organizing thematic quarters which will allow world experts of a subject to gather in Lyon and work together in a stimulating environment.” In this context, Compsys organized a thematic quarter on compilation from April 2013 to July 2013, see details in Section 9.1.2 . Compsys also follows or participates to the activities of LyonCalcul (<http://lyoncalcul.univ-lyon1.fr/>), a network to federate activities on computing in Lyon.

8.2. National Initiatives

8.2.1. CNRS PEPS

Christophe Alias and Laure Gonnord initiated with the DART/Emeraude team at LIFL Laboratory (University of Lille) a CNRS PEPS (“Projets Exploratoire Premier Soutien”) called “HLS and real time” (8 Keuros/year, during two years in 2011-2013). The goal of this project is to investigate how to introduce real-time constraints in the high-level synthesis workflow.

8.2.2. Inria AEN MULTICORE

Fabrice Rastello is part of an Inria Large Scale Initiative (AEN: action d’envergure nationale) called MULTICORE, which regroups researchers from seven teams: Camus, Regal, Alf, Runtime, Algorille, Dali, and thus Compsys on “Large scale multicore virtualization for performance scaling and portability”. One of the goals of this project is to enable loop transformations by combining dynamic and static analysis/compilation techniques.

8.2.3. French Compiler Community

The french compiler community is now well identified and is visible through its web-page <http://compilation.gforge.inria.fr/>. The “journées françaises de la compilation” were initiated in 2010 and are still animated by Fabrice Rastello and Laure Gonnord as a biannual event. Their local organization is handled alternately by the different research teams: Lyon (by Compsys) in Summer 2010, Aussois in Winter 2010, Dinard in Spring 2011, St Hippolyte in Autumn 2011, Rennes in Summer 2012, Annecy (by Compsys again) in Spring 2013, Dammarie-les-lys in December 2013.

8.3. European Initiatives

8.3.1. Collaborations with Major European Organizations

Alain Darte, Paul Feautrier, and Fabrice Rastello are members or affiliate members of the European Network of Excellence on High Performance and Embedded Architecture and Compilation (HiPEAC). Fabrice Rastello attended the computing system week in may 2013 (Paris), and the computing system week in October 2013 (Tallinn). He participated to the organization of two thematic sessions in Paris: Thread Level Speculation (as chair) and Intermediate Representation (as co-organizer). The thematic quarter on compilation (see Section 9.1.2) was presented in HIPEAC info 35 (July 2013), the HIPEAC quarterly newsletter (<http://www.hipeac.net/content/hipeacinfo-35-july-2013>) and the keynotes on HPC languages (third event) recognized as an HIPEAC event.

8.4. International Initiatives

8.4.1. Inria International Partners

8.4.1.1. Declared Inria International Partners

- Compsys and, in particular Fabrice Rastello, has a regular collaboration with P. Sadayappan from Ohio State University (USA). This year, this collaboration led to several results, see Sections 6.2, 6.4, 6.5, and 6.6.
- Fabrice Rastello and Laure Gonnord have a regular collaboration with Fernando Magno Quintao Pereira from the University of Mineas Gerais (Brazil). This year, this collaboration led to several results, see Sections 6.1 and 6.3. Compsys also hosted Raphael Ernani Rodrigues, from the group of F. Pereira, who made part of his master in Lyon supervised by Laure Gonnord and Christophe Alias.
- Compsys and, in particular Christophe Alias, has a regular collaboration with S. Rajopadhye from Colorado State University (CSU). Guillaume Iooss is preparing a PhD through a PhD convention between Ecole normale supérieure de Lyon and Colorado State University, co-advised by Christophe Alias and Sanjay Rajopadhye. In 2013, Guillaume Iooss spent part of the summer at CSU, joined by Christophe Alias for a week. Paul Feautrier and Fabrice Rastello also made regular visits at Colorado State University in the previous years. This year, this collaboration led to several results, see Sections 6.10, 6.11, and 6.13.

8.5. International Research Visitors

8.5.1. Visits of International Scientists

8.5.1.1. Invited Researchers

Fernando Magno Quintão Pereira is visiting Fabrice Rastello for 1.5 month in early 2014. The goal of his visit is to work on dynamic analysis and cloning for loop transformations (so called hybrid compilation).

8.5.1.2. Internships

Raphael Ernani Rodrigues made part of his master Internship in Lyon in June/July 2013 under the supervision of Laure Gonnord and Christophe Alias. He worked on synthesizing preconditions that (may) ensure termination. We are currently pursuing the collaboration with him and his supervisor in Brazil, Fernando Magno Quintao Pereira (Univ. Mineas Gerais).

8.5.2. Visits to International Teams

Fabrice Rastello visited the group of P. Sadayappan (OSU) during two months, in June-July 2013, in addition to shorter stays. He worked on dynamic analysis and generalized tiling.

Alexandre Isoard did an internship at Xilinx, during 2.5 months, from June to September 2013, under the supervision of Stephen Neuendorffer, working on exploring polyhedral tools for Xilinx HLS tool.

CONTRAINTEs Project-Team

8. Partnerships and Cooperations

8.1. National Initiatives

- The OSEO BioIntelligence coordinated by Dassault-Systèmes, with EPI Orpailleur, Sobios, Aureus pharma, Ipsen, Pierre Fabre, Sanofi-Aventis, Servier, Bayer CropScience, INSERM, Genopole Evry (2009-2014).
- ANR Investissement Avenir Iceberg project (2011-2016) “From population models to model populations”, coordinated by Grégory Batt, with Pascal Hersen (MSC lab, Paris Diderot Univ./CNRS), Reiner Veitia (Institut Jacques Monod, Paris Diderot Univ./CNRS), Olivier Gandrillon (BM2A lab, Lyon Univ./CNRS), Cedric Lhoussaine (LIFL/CNRS), and Jean Krivine (PPS lab, Paris Diderot Univ./CNRS).
- ANR Blanc Net-WMS-2 (2011-2015) on “constraint optimization in Warehouse Management Systems”, coordinated by F. Fages, with N. Beldiceanu, Ecole des Mines de Nantes, EPI TASC, and Abder Aggoun, KLS optim.
- ANR Cosinus **Syne2arti** project (2010-2013) coordinated by Grégory Batt, with Oded Maler, CNRS Verimag, Dirk Drasdo, EPI Bang, and Ron Weiss, MIT.
- ANR Blanc **BioTempo** project (2010-2014) coordinated by Anne Siegel, CNRS IRISA Rennes, with Ovidiu Radulescu, U. Montpellier, Irina Rusu, U. Nantes.
- AE **REGATE** (2008-2013) on the “REGulation of the GonAdoTropE axis”, coordinated by Frédérique Clément, SISYPHE, with E. Reiter, INRA Tours, J.P. Françoise, Univ. Paris 6, B. Laroche Orsay, P. Michel Centrale Lyon, N. Ayache ASCLEPIOS, A. Goldbeter, ULB Bruxelles.
- AE **COLAGE** (2008-2013) on the “control of growth and aging in *E. coli* using synthetic biology approaches”, coordinated by H. Berry, COMBINING, with F. Taddei, A. Lindner, INSERM Necker, H. de Jong, D. Ropers, IBIS, H. Geiselman, Grenoble Univ., J.-L. Gouzé, and M. Chaves, COMORE.
- GENCI (2009-) attribution of 300000 computation hours per year on the Jade cluster of 10000 processors of GENCI at CINES, Montpellier.

8.2. European Initiatives

8.2.1. Collaborations in European Programs, except FP7

Program: EraNet SysBio

Project acronym: **C5Sys**

Project title: Circadian and cell cycle clock systems in cancer

Duration: march 2010 - march 2013

Coordinator: Francis Lévi, INSERM Hopital Paul Brousse, Villejuif, France and David Rand, Warwick Systems Biology, UK,

Other partners: EPI BANG, Erasmus University Medical Center, Rotterdam, University College London, UK, CNRS Nice, and L2S, Orsay.

Abstract: Mammalian cells are endowed with biological oscillators which time their activities. The circadian clock (circa, about; dies, day) generates a 24-hour rhythm which controls both cellular metabolism and cell division. The cell division cycle is an oscillator which times DNA synthesis, mitosis, and related apoptosis and DNA repair. Our understanding of the molecular mechanisms at work in both oscillators has greatly improved. In sharp contrast, little is known about how these two crucial oscillators interact, and how these interactions affect cellular proliferation in normal or cancer cells. On the one hand, the disruption of circadian clocks impairs cell physiology and quality of life. On the other hand, disruption of cell cycle, DNA repair or apoptosis impacts on cell and organism survival. Experimental and clinical data show that circadian disruption accelerates malignant proliferation, and that DNA damage can reset the circadian clock. The central question addressed is how interactions between the circadian clock and cell cycle affect cellular proliferation and genotoxic sensitivity in normal and cancer cells, and how this knowledge translates into new prevention or therapeutic applications. Seven teams in France, Netherlands and United Kingdom integrate experimental, mathematical and bioinformatic approaches, so as to develop novel cell lines, biomarker monitoring methods and mathematical tools. C5Sys triggers innovative chronotherapeutic research for human cancers and advances systems medicine for improving patient care.

8.3. International Initiatives

8.3.1. Inria Associate Teams

8.3.1.1. TISHOM

Title: Artificial tissue homeostasis: combining synthetic and computational biology approaches

Inria principal investigator: Grégory Batt

International Partner (Institution - Laboratory - Researcher):

Massachusetts Institute of Technology (United States) - Weiss Lab

Duration: 2012 - 2014

See also: [TISHOM](#)

Cell-based gene therapy aims at creating and transplanting genetically-modified cells into a patient in order to treat an illness. Ideally, actively-growing cells are used to form a self-maintaining tissue in the patient, thus permanently curing the disease. Propelled forward by the development of stem cell biology, this research domain has recently attracted significant interest. Still, before any real therapeutic use, many important issues need to be addressed. In particular, one should guarantee tissue homeostasis, that is, that the size of the newly-introduced tissue remains within admissible bounds.

Using a synthetic biology approach, we propose to reprogram mammalian cells so as to enforce tissue homeostasis. The proposed design relies on growth control and cell-cell communication mechanisms. The design and tuning of such engineered tissues are particularly challenging. Indeed, the correct functioning of the system depends on its specific molecular implementation. To relate cell population behavior with molecular details, extensive modelling work and in-depth in silico analysis are needed. Therefore, a tight integration between dry lab and wet lab efforts will be essential for the success of the project.

8.4. International Research Visitors

8.4.1. Internships

Hui-Ju Katherine Chiang (from Jul 13 until Sep 13) on program compilation in biochemical reaction networks.

8.4.2. Visits to International Teams

Grégory Batt: one week with the Weiss lab at MIT

François Bertaux: two weeks with the Weiss lab at MIT

Xavier Duportet: 3 months and 1 week with the Weiss lab at MIT

CONVECS Project-Team

8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. FSN (*Fonds national pour la Société Numérique*)

8.1.1.1. *OpenCloudware*

Participants: Rim Abid, Hugues Evrard, Frédéric Lang, Gwen Salaün [correspondent], Lina Ye.

OpenCloudware¹⁰ is a project funded by the FSN. The project is led by France Telecom / Orange Labs (Meylan, France) and involves 18 partners (among which Bull, OW2, Thalès, Inria, etc.). OpenCloudware aims at providing an open software platform enabling the development, deployment and administration of cloud applications. The objective is to provide a set of integrated software components for: (i) modelling distributed applications to be executed on cloud computing infrastructures; (ii) developing and constructing multi-tier virtualized applications; and (iii) deploying and administrating these applications (PaaS platform) possibly on multi-IaaS infrastructures.

OpenCloudware started in January 2012 for three years and nine months. The main contributions of CONVECS to OpenCloudware (see § 6.5.3) are the formal specification of the models, architectures, and protocols (self-deployment, dynamic reconfiguration, self-repair, etc.) underlying the OpenCloudware platform, the automated generation of code from these specifications for rapid prototyping purposes, and the formal verification of the aforementioned protocols.

8.1.1.2. *Connexion*

Participants: Hubert Garavel [correspondent], Frédéric Lang, Raquel Oliveira.

Connexion¹¹ (*CONtrôle commande Nucléaire Numérique pour l'EXport et la rénovatION*) is a project funded by the FSN, within the second call for projects “*Investissements d’Avenir — Briques génériques du logiciel embarqué*”. The project, led by EDF and supported by the *Pôles de compétitivité* Minalogic, Systematic, and *Pôle Nucléaire Bourgogne*, involves many industrial and academic partners, namely All4Tech, Alstom Power, ArevA, Atos Worldgrid, CEA-LIST, CNRS/CRAN, Corys Tess, ENS Cachan, Esterel Technologies, Inria, LIG, Predict, and Rolls-Royce. Connexion aims at proposing and validating an innovative architecture dedicated to the design and implementation of control systems for new nuclear power plants in France and abroad.

Connexion started in April 2012 for four years. In this project, CONVECS will assist another LIG team, IIHM, in specifying human-machines interfaces formally using the LNT language and in verifying them using CADP (see § 6.5.6).

8.1.2. Competitiveness Clusters

8.1.2.1. *Bluesky for I-Automation*

Participants: Hubert Garavel, Fatma Jebali, Jingyan Jourdan-Lu, Frédéric Lang, Eric Léo, Radu Mateescu [correspondent].

Bluesky for I-Automation is a project funded by the FUI (*Fonds Unique Interministériel*) within the *Pôle de Compétitivité* Minalogic. The project, led by Crouzet Automatismes (Valence), involves the SMEs (*Small and Medium Enterprises*) Mootwin and VerticalM2M, the LCIS laboratory of Grenoble INP, and CONVECS. Bluesky aims at bringing closer the design of automation applications and the Internet of things by providing an integrated solution consisting of hardware, software, and services enabling a distributed, Internet-based design and development of automation systems. The automation systems targeted by the project are networks of programmable logic controllers, which belong to the class of GALS (*Globally Asynchronous, Locally Synchronous*) systems.

¹⁰<http://www.opencloudware.org>

¹¹<http://www.cluster-connexion.fr>

Bluesky started in September 2012 for three years. The main contributions of CONVECS to Bluesky (see § 6.5.4) are the definition of GRL, the formal pivot language for describing the asynchronous behaviour of logic controller networks, and the automated verification of the behaviour using compositional model checking and equivalence checking techniques.

8.1.3. Other National Collaborations

Additionally, we collaborated in 2013 with the following Inria project-teams:

- OASIS (Inria Sophia-Antipolis – Méditerranée): Eric Madelaine and Ludovic Henrio,
- TRISKELL (Inria Rennes – Bretagne Atlantique): Kevin Corre and Axel Legay,
- MEXICO (Inria Saclay – Île-de-France): Alban Linard.

Beyond Inria, we had sustained scientific relations with the following researchers:

- Gaëlle Calvary and Sophie Dupuy-Chessa (LIG, Grenoble),
- Fabrice Kordon and Lom Messan Hillah (LIP6, Paris),
- Alexandre Hamez and Jérôme Hugues (ISAE, Toulouse),
- Noël De Palma and Fabienne Boyer (LIG, Grenoble),
- Xavier Etchevers (Orange Labs, Meylan),
- Matthias Güdemann (Systerel, Aix-en-Provence),
- Meriem Ouederni (IRIT, Toulouse),
- Pascal Poizat (LIP6, Paris).

H. Garavel, F. Lang, and R. Oliveira attended two training days on the Scade and Scade Display software (given by Luc Coyette, Esterel Technologies) on March 6 and 24, 2013.

8.2. European Initiatives

8.2.1. FP7 Projects

8.2.1.1. SENSATION

Participants: Hubert Garavel [correspondent], Radu Mateescu, Wendelin Serwe.

SENSATION ¹² (*Self ENergy-Supporting Autonomous computATION*) is a European project no. 318490 funded by the FP7-ICT-11-8 programme. It gathers 9 participants: Inria (TRISKELL and CONVECS project-teams), Aalborg University (Denmark), RWTH Aachen and Saarland University (Germany), University of Twente (The Netherlands), GomSpace (Denmark), and Recore Systems (The Netherlands). The main goal of SENSATION is to increase the scale of systems that are self-supporting by balancing energy harvesting and consumption up to the level of complete products. In order to build such Energy Centric Systems, embedded system designers face the quest for optimal performance within acceptable reliability and tight energy bounds. Programming systems that reconfigure themselves in view of changing tasks, resources, errors, and available energy is a demanding challenge.

SENSATION started on October 1st, 2012 for three years. CONVECS contributes to the project regarding the extension of formal languages with quantitative aspects, studying common semantic models for quantitative analysis, and applying formal modeling and analysis to the case studies provided by the industrial partners.

The case study on rescaling video for handheld devices, proposed initially by STMicroelectronics, was abandoned in 2013 after the departure of this partner from the project. Therefore, we oriented our efforts on the EnergyBus case study (see § 6.5.5), in collaboration with Saarland University.

¹²<http://sensation-project.eu/>

8.2.2. Collaborations with Major European Organizations

The CONVECS project-team is member of the FMICS (*Formal Methods for Industrial Critical Systems*) working group of ERCIM ¹³. R. Mateescu is currently the chairman of the FMICS working group and H. Garavel is member of the FMICS board, in charge of dissemination actions.

H. Garavel was appointed to a new Working Group within Informatics Europe: “*Parallel Computing (Supercomputing) Education in Europe: State-of-Art*”. This is a relatively small working group (about 10 people) with the following missions: to show the need for urgent changes in higher education in the area of computational sciences, to compose a survey of the current landscape of parallel computing and supercomputing education in Europe with respect to different universities and countries, and to prepare a set of recommendations on how to bring ideas of parallel computing and supercomputing into higher educational systems of European countries.

8.2.3. Other European Collaborations

In addition to our partners in aforementioned contractual collaborations, we had scientific relations in 2013 with several European universities and research centers, including:

- Saarland University (Alexander Graf-Brill and Holger Hermanns),
- RWTH Aachen (Joost-Pieter Katoen),
- Oxford University (Ernst-Moritz Hahn and Marta Kwiatkowska),
- University of Birmingham (Dave Parker),
- Technical University of Eindhoven (Anton Wijs),
- University of Twente (Marieke Huisman and Jaco van de Pol),
- University of Málaga (Francisco Duran and Ernesto Pimentel).

Our partnership with Saarland University was sustained by the Humboldt Forschungspreis received by H. Garavel, who continued his regular visits to Saarland University.

8.3. International Initiatives

H. Garavel is a member of IFIP (*International Federation for Information Processing*) Technical Committee 1 (*Foundations of Computer Science*) Working Group 1.8 on Concurrency Theory chaired successively by Luca Aceto and Jos Baeten.

8.3.1. Other International Collaborations

We had sustained scientific relations with Tevfik Bultan (University of California at Santa Barbara, USA).

We also had scientific exchanges with Gianfranco Ciardo (University of California at Riverside, USA).

8.4. International Research Visitors

8.4.1. Visits of International Scientists

- Loïc Jezequel (Technical University of München, Germany) visited us on March 4–6, 2013. He gave a talk entitled “*Distributed Cost-Optimal Planning*” on March 4, 2013.
- Zhen Zhang (University of Utah, USA) visited us from September 1st to December 31, 2013.
- The annual CONVECS seminar was held in Col de Porte (France) on November 18–20, 2013. The following invited scientists attended the seminar:
 - Jérôme Hugues (Institute for Space and Aeronautics Engineering, Toulouse) gave on November 18, 2013 a talk entitled “*Model-Based, Model Checking: the Missing Bits*”.

¹³<http://fmics.inria.fr>

- Loïc Jezequel (Technical University of München, Germany) gave on November 19, 2013 a talk entitled “*Computation of Summaries using Net Unfoldings*”.
- Xavier Etchevers (Orange Labs, Meylan, France) gave on November 19, 2013 a talk entitled “*VAMP: Self-Deployment of Arbitrary Applications in the Cloud*”.
- Fabrice Kordon (LIP6, Paris) gave on November 20, 2013 a talk entitled “*Verification Approaches for Distributed Systems in LIP6/MoVe*”.
- Zhen Zhang (University of Utah, USA) gave on November 20, 2013 a talk entitled “*Modeling a Fault-Tolerant Wormhole Routing Algorithm using LNT*”.

CRYPT Team

5. Partnerships and Cooperations

5.1. National Initiatives

5.1.1. MOST's 973 Grant

Grant 2013CB834205

PIs Phong Nguyen and Xiaoyun Wang

Duration 2013-17

MOST is China's Ministry of Science and Technology.

5.1.2. NSFC Grant

Grant NSFC Key Project 61133013

PIs Phong Nguyen and Xiaoyun Wang

Duration 2013-16

NSFC is the National Natural Science Foundation of China.

5.2. European Initiatives

5.2.1. FP7 Projects

Phong Nguyen was leader of the Virtual Lab MAYA of FP7's ECRYPT-II Network of Excellence, which finished in 2013.

5.2.2. Collaborations with Major European Organizations

CWI: Ronald Cramer's crypto team (Netherlands). In December 2013, Cramer's crypto team officially became a partner of LIAMA's CRYPT international project: in particular, Marc Stevens expects to do joint work on the cryptanalysis of hash functions.

5.3. International Initiatives

5.3.1. Inria International Labs

- CRYPT is an international project from LIAMA in China, located at Tsinghua University in Beijing. It is a joint project between Inria, Tsinghua University and CAS Academy of Mathematics and System Sciences.
- Phong Nguyen is the new European director of LIAMA, since December 2013: previously, he was the scientific coordinator of LIAMA in 2013.

5.4. International Research Visitors

5.4.1. Visits of International Scientists

Shi Bai (Univ. of Auckland, New-Zealand)

Nicolas Gama (UVSQ and CNRS, France)

Ming-Deh Huang (Univ. Southern California, USA)

Gaëtan Leurent (UCL, Belgium)

Cheng Qi (Univ. Oklahoma, USA)

Marc Stevens (CWI, Netherlands)

Guangwu Xu (Univ. Wisconsin, USA)

DEDUCTEAM Exploratory Action

7. Partnerships and Cooperations

7.1. National Initiatives

7.1.1. ANR Locali

We are coordinators of the ANR-NFSC contract Locali with the Chinese Academy of Sciences. This year we organized the first Locali workshop in Beijing.

7.1.2. ANR BWare

We are members of the ANR *BWare*, which started on September 2012 (David Delahaye is the national leader of this project). The aim of this project is to provide a mechanized framework to support the automated verification of proof obligations coming from the development of industrial applications using the *B* method. The methodology used in this project consists in building a generic platform of verification relying on different theorem provers, such as first order provers and SMT solvers. We are in particular involved in the introduction of Deduction modulo in the first order theorem provers of the project, i.e. *Zenon* and *iProver*, as well as in the backend for these provers with the use of *Dedukti*.

7.1.3. ANR Tarmac

We are members of the ANR Tarmac, coordinated by Pierre Valarcher, on models of computation.

7.2. International Initiatives

7.2.1. Informal International Partners

Deducteam and the KWARC research group (Jacobs University, Germany), led by Michael Kohlhase, have organized a common workshop in Paris on the 12 of April. This workshop has led to the two tools dk2MMT and MMT2dk, and another workshop is planned on the 2014 year. See the program at <http://www.cri.ensmp.fr/people/hermant/deducteam/2013/kwarc-dedukti.html> or the webpage of the seminars.

7.3. International Research Visitors

7.3.1. Visits of International Scientists

Hermann Haeusler, Bruno Bruno Lopes and Cecilia Englander, from the University PUC Rio have visited Deducteam.

Ying Jiang from the Institute of software of the Chinese Academy of Sciences has visited Deducteam.

7.3.2. Visits to International Teams

Gilles Dowek has visited the University PUC Rio and the Institute of software of the Chinese Academy of Sciences.

DICE Team

8. Partnerships and Cooperations

8.1. Regional Initiatives

Dice is involved in a regional project of the Rhône-Alpes region, ARC6 "Innovative Services for Social Networks", with Telecom Saint Etienne.

8.2. National Initiatives

8.2.1. ANR

Dice is involved in two new ANR projects, to start at the end of 2013,

- C3PO, on Collaborative Creation of Contents and Publishing using Opportunistic networks, with LT2C Telecom Saint-Etienne, INSA LYON, IRISA, ChronoCourse, et Ecole des Mines de Nantes.
- Socioplug, Social Cloud over Plug Networks, Enabling Symmetric Access to Data and Preserving Privacy, with LINA / Université de Nantes, Université de Rennes 1, INSA Lyon.

8.3. European Initiatives

8.3.1. FP7 Projects

Dice is involved in the CSA project "Big data roadmap and cross-disciplinary community for addressing societal Externalities (BYTE)", Objective ICT-2013.4.2 Scalable data analytics (c) Societal externalities of Big Data roadmap.

DREAMPAL Team

8. Partnerships and Cooperations

8.1. Regional Initiatives

8.1.1. IRCICA project " Smart Cities"

Smart Cities is an interdisciplinary project, internal of IRCICA (<http://www.ircica.univ-lille1.fr/>), in collaboration with the laboratory of Civil Engineering of Lille I. It builds on the expertise of several teams hosted by IRCICA (RF networks, sensors, high-performance and real-time embedded systems computing, pattern recognition). The scientific problem, we tackle within this project, is to develop an intelligent platform for managing accidents and incidents in the drinking water and wastewater. In this platform, a permanent dialogue M2M (machine to machine) between servers, embedded systems (laptops, smartphones, tablets, ...), smart cameras, and sensors, will detect and solve problems in real time.

Scientific problems relate to the study of the possibility of linking objects (cameras, sensors, servers ...) all together, with a standardized mixed network (radio frequency wifi and internet). DreamPal is responsible for implementing the part of the hardware platform for high performance dedicated to intelligent video applications using the HoMade softcore. This work involves the processing of data, analysis of video images, the use of these data, and the integration of embedded reconfigurable components (on Xilinx Zynq 7000 board) as well as the existing RF network cards. It uses the video data acquisition to apply algorithms to detect such an anomaly on the water in a part of the building, or abnormal number of people in a given area, or any information about a specific person such as the recognition of face, the nature of motion. The work done during this year usefully supplements our platform by developing video modules dedicated to intelligent surveillance.

8.2. International Initiatives

We have a strong ongoing collaboration with Univ. Iasi, Romania, which includes (but is not limited to) the co-supervision of the PhD of Andrei Arusoae. Collaboration topics include language-independent techniques for analysis of programs, and their specialization to the languages designed in the Dreampal project (HiHope, HoMade assembler and machine code).

8.3. International Research Visitors

8.3.1. Visits of International Scientists

Prof. Dorel Lucanu, Assist. Prof./ Stefan Ciobaca, and PhD student Andrei Arusoae from Univ. Iasi (Romania) visited us in July 2013. We initiated work on language-independent program-verification techniques and on the formal definitions of the HiHope and HoMade assembler languages, as well as on the formally proved correctness of compilation between these languages.

8.3.2. Internships

Kanwarjeet Dhaliwal made his internship in the Dreampal team from May to July 2013. He worked on the formal semantics of the parallel version of Hihope, and also made a preliminary work to compile Hihope to the Kalray's MPPA platform. This work was partially funded by Kalray (<http://www.kalray.eu>).

8.3.3. Visits to International Teams

In June 2013, Rabie Ben Atitallah and Wissem Chouchene visited Michael Huebner, Professor and Chair for Embedded Systems in Information Technique (ESIT) at the Ruhr-University of Bochum. The objective is to establish a new collaboration in the field of 3D FPGA next generation.

In October 2013, Andrei Arusoae visited the team of Prof. Grigore Roşu at the University of Illinois at Urbana Champaign, where he worked on implementing the symbolic domains used in our language-independent symbolic execution and verification tool. He benefitted from the guest team's expertise on symbolic domains.

ESPRESSO Project-Team

7. Partnerships and Cooperations

7.1. National Initiatives

7.1.1. ANR

Program: ANR

Project acronym: VeriSync

Project title: Vérification formelle d'un générateur de code pour un langage synchrone

Duration: Nov. 2010 - Oct. 2013

Coordinator: IRIT

Other partners: IRIT

URL: <http://www.irit.fr/Verisync/>

Abstract:

The VeriSync project aims at improving the safety and reliability assessment of code produced for embedded software using synchronous programming environments developed under the paradigm of Model Driven Engineering. This is achieved by formally proving the correctness of essential transformations that a source model undergoes during its compilation into executable code.

Our contribution to VeriSync consists of revisiting the seminal work of Pnueli et al. on translation validation and equip the Polychrony environment with updated verification techniques to scale it to possibly large, sequential or distributed, C programs generated from the Signal compiler. Our study covers the definition of simulation and bisimulation equivalence relations capable of assessing the correspondence between a source Signal specification and the sequential or concurrent code generated from it, as well as both specific abstract model-checking techniques allowing to accelerate verification and counter-example search techniques, to filter spurious verification failures obtained from excessive abstracted exploration.

7.1.2. Competitivity Clusters

Program: FUI

Project acronym: P

Project title: Project P

Duration: March 2011 - Sept. 2015

Coordinator: Continental Automotive France

Other partners: 19 partners (Airbus, Astrium, Rockwell Collins, Safran, Thales Alenia Space, Thales Avionics...)

URL: <http://www.open-do.org/projects/p/>

Abstract:

The aim of project P is 1/ to aid industrials to deploy model-driven engineering technology for the development of safety-critical embedded applications, 2/ to contribute on initiatives such as OPEES [23] and CESAR [22] to develop support for tools inter-operability, and 3/ to provide state-of-the-art automated code generation techniques from multiple, heterogeneous, system-levels models. The focus of project P is the development of a code generation toolchain starting from domain-specific modeling languages for embedded software design and to deliver the outcome of this development

as an open-source distribution, in the aim of gaining an impact similar to GCC for general-purpose programming, as well as a kit to aid with the qualification of that code generation toolchain.

The contribution of project-team ESPRESSO in project P is to bring the necessary open-source technology of the Polychrony environment to allow for the synthesis of symbolic schedulers for software architectures modeled with P in a manner ensuring global asynchronous deterministic execution..

7.1.3. CORAC

Program: CORAC

Project acronym: CORAIL

Project title: Composants pour l'Avionique Modulaire Étendue

Duration: July 2013 - May 2017

Coordinator: Thales Avionics

Other partners: Airbus, Dassault Aviation, Eurocopter, Sagem...

URL: <http://www.corac-ame.com/>

Abstract:

The CORAIL project aims at defining components for Extended Modular Avionics. The contribution of project-team ESPRESSO is to define a specification method and to provide a generator of multi-task applications.

7.2. International Initiatives

7.2.1. Inria Associate Teams

7.2.1.1. POLYCORE

Title: Models of computation for embedded software design of multi-core architectures

Inria principal investigator: Jean-Pierre Talpin

International Partner :

Virginia Tech Research Laboratories, Arlington (United States)

Embedded Systems Group, Technische Universität Kaiserslautern (Germany)

Duration: 2011 - 2013

See also: <http://www.irisa.fr/espresso/Polycore>

Anyone experienced with multi-threaded programming would recognize the difficulty of designing and implementing such software. Resolving concurrency, synchronization, and coordination issues, and tackling the non-determinism germane in multi-threaded software is extremely difficult. Ensuring correctness with respect to the specification and deterministic behavior is necessary for safe execution of such code. It is therefore desirable to synthesize multi-threaded code from formal specifications using a provably “correct-by-construction” approach. In Europe, it has been widely claimed that the embedded software for “fly-by-wire” was mostly automatically generated using French tools based on the synchronous programming models. Unfortunately, software generated in those contexts usually operate in a time-triggered execution model. Such models are simpler but less efficient than multi-threaded software on multi-core processors. Normally they run on multiple processors communicating over a time-triggered bus. Hence the execution is less efficient than it could be. While time-triggered programming model simplifies code generation, we feel that multi-rate event driven execution model is much more efficient. Code synthesis for such execution model must be thoroughly investigated. The multi-threaded software generation is inspired by a recent shift in the hardware design paradigms from single-core to multi-core processors. This shift has brought parallel and concurrent programming to the desktop and embedded arena. In the desktop market, most processors

now being sold are multi-core, and very soon this trend might conquer the embedded world as well. We plan to develop formal models, methods, algorithms and techniques for generating provably correct multi-threaded reactive real-time embedded software for mission-critical applications. For scalable modeling of larger embedded software systems, the specification formalism has to be compositional and hierarchical. Our proposed formalism entails a model of computation (MoC) based on a multi-rate synchronous dataflow paradigm: Polychrony.

7.2.2. Inria International Partners

7.2.2.1. The University of Hong Kong, Emerging Technologies Institute

Title: Virtual prototyping of embedded software architectures

Inria principal investigator: Jean-Pierre Talpin

International Partner :

The University of Hong Kong - Emerging Technologies Institute - John Koo

Embedded software architectures are modeling objects at the crossing of several design viewpoints: the physical environment, the embedded software and the hardware architecture. These viewpoints present different perceptions of time: continuous and discrete, event-based and clock-based. They are further represented by high-level models that significantly alter this perception: in the model of the environment, evolution over time is represented by differential equations whose resolution alters discrete simulation time; in the model of the embedded software, hardware/operating-system events are sampled by periodic reaction loops; in the model of the hardware, instruction clock time is usually approximated by coarser periods or transactions. Providing a mathematical framework, verification and synthesis tools, to understand, compose and orchestrate them would prove invaluable to system architects. The architect operates from design focus point around which all components of the system under design—software, middleware, hardware and environment—need to be analyzed, profiled, composed, simulated, validated. It is the aim of our project to propose a formal design methodology to that purpose.

7.2.2.2. Beihang University, Institute of Computer Architectures

Title: Certifiable development of a synchronous compiler for multi-core platforms

Inria principal investigator: Jean-Pierre Talpin

International Partner :

Beihang University, China - Institute of Computer Architectures - Kai Hu

The synchronous paradigm is a widely accepted approach for the design of safety-critical applications, such as digital circuits or embedded software. The well-defined notions of time and causality at specification-level provide a simple way to model, analyze and verify systems. The synchronous programming paradigm is made popular because of its role at the joint point of 1) computer science and language design, 2) control theory and reactive systems, and 3) microelectronic (synchronous) circuit design. It provides a sound semantic background with a notion of discrete instants and successive reactions, together with high-level structuring primitives which help defining subthreads whose activations (defined by signals or clocks) model over/sub-sampling. Exploiting the semantic independence of various computations to allow the generation of concurrent, potentially distributed code from synchronous and polychronous specifications is a notoriously difficult subject. It amounts to determining which part of the system-wide synchronization specific to the synchronous model can be removed while preserving the specified functionality. In this context, the objective of the proposed project consists in the design of a certifiable compiler from a synchronous language to a multicore platform. However, even if the compilation of endochronous systems to a sequential architecture has been widely studied for twenty years, targeting multicore architectures is more recent and exploiting weak endochrony has not yet been deeply explored. Three main points will be addressed: the architecture of a compiler of weakly-endochronous programs to a virtual parallel machine; the formal verification of some of these compilation steps as well as the formal modeling of the target; the study of multicore platforms, of their synchronization primitives and the implementation of the virtual machine on such a platform.

7.2.3. Participation In other International Programs

7.2.3.1. USAF Office for Scientific Grant FA8655-13-1-3049

Title: Co-Modeling of Safety-Critical Multi-threaded Embedded Software for Multi-Core Embedded Platforms

Inria principal investigator: Jean-Pierre Talpin

International Partner :

Virginia Tech Research Laboratories, Arlington (United States)

Embedded Systems Group, Technische Universität Kaiserslautern (Germany)

Duration: 2013 - 2016

See also: <http://www.irisa.fr/espresso/Polycore>

The aim of the USAF OSR Grant FA8655-13-1-3049 is to support collaborative research entitled “Co-Modeling of safety-critical multi-threaded embedded software for multi-core embedded platforms” between Inria project-team ESPRESSO, the VTRL Fermat Laboratory and the TUKL embedded system research group, under the program of the Polycore associate-project.

7.3. International Research Visitors

7.3.1. Visits to International Teams

- Jean-Pierre Talpin was awarded a visiting researcher grant by the Chinese Academy of Science. In this context, he visited the Shenzhen Institutes of Advanced Technology and the University of Hong Kong in January, July and August, and Beihang University in November and December.
- In the context of the associate project Polycore, Jean-Pierre Talpin visited Virginia Tech Research Laboratories, Arlington, in April and October.

FORMES Team

7. Partnerships and Cooperations

7.1. National Initiatives

7.1.1. Tsinghua Grant

contract: Tsinghua National Laboratory for Information Science and Technology, Cross-discipline Foundation grant 2011-9

title: An Intensional Logical Framework and Its Implementation

Participants: Jean-Pierre Jouannaud, Jianqi Li

duration: 2011 - 2012

Amount: 100,000 RMB

7.1.2. NSFC Grant

contract: National Science Foundation of China grant 61272002

title: The meta-theories of higher-order rewriting and their proof automation: toward the next generation theorem prover

PIs: Jean-Pierre Jouannaud, Jianqi Li

duration: 2013-2016

Amount: 600,000 RMB

7.2. International Initiatives

7.2.1. Inria International Partners

7.2.1.1. Declared Inria International Partners

The FORMES project has been held since the beginning at Tsinghua University, Beijing, China. Tsinghua University is a founding member of LIAMA laboratory.

7.2.1.2. Informal International Partners

The FORMES project has also collaborated with:

- Pr John Koo at Shenzhen Institute of Advanced Technology, until August 2013.
- the Institute of Software of the Chinese Academy of Science where Frédéric Blanqui has been kindly hosted between July 2012 and August 2013.

7.2.2. Inria International Labs

FORMES is one of the LIAMA projects.

7.2.3. Participation In other International Programs

LIAMA is a member of the AURA network: Association of Units of Research in Asia.

7.3. International Research Visitors

7.3.1. Visits of International Scientists

FORMES project member Jean-Pierre Jouannaud organized jointly with Pr Ming Gu the LIAMA-Tsinghua Software Day, where the following scientists reported on their research:

- Pr Edmund Clarke, from Carnegie Mellon.
- Erik Hagersten from University of Uppsala.
- Marc Pouzet from University Pierre et Marie Curie.

7.3.1.1. Internships

- *Jiaxiang Liu*
 - Subject: Diagramatic Confluence,
 - Date: from Jul 2013 to Dec 2013,
 - Institution: Ecole Polytechnique
- *Antoine Rouquette*
 - Subject: Upgrade of SimSoC simulator,
 - Date: from September 2012 to August 2013,
 - Institution: Shenzhen Institutes of Advanced Technology
- *Shenpeng Wang*
 - Subject: Approximately Timed Simulation of PowerPC e200z,
 - Date: from March 2012 to May 2013,
 - Institutions: Tsinghua University and Shenzhen Institutes of Advanced Technology

GALLIUM Project-Team

8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. ANR projects

8.1.1.1. BWare

Participants: Damien Doligez, Fabrice Le Fessant, Luca Saiu.

The “BWare” project (2012-2016) is coordinated by David Delahaye at Conservatoire National des Arts et Métiers and funded by the *Ingénierie Numérique et Sécurité* programme of *Agence Nationale de la Recherche*. BWare is an industrial research project that aims to provide a mechanized framework to support the automated verification of proof obligations coming from the development of industrial applications using the B method and requiring high guarantees of confidence.

8.1.1.2. Paral-ITP

Participant: Damien Doligez.

The “Paral-ITP” project (2011-2014) is coordinated by Burkhart Wolff at Université Paris Sud and funded by the *Ingénierie Numérique et Sécurité* programme of *Agence Nationale de la Recherche*. The objective of Paral-ITP is to investigate the parallelization of interactive theorem provers such as Coq and Isabelle.

8.1.1.3. Verasco

Participants: Jacques-Henri Jourdan, Xavier Leroy.

The “Verasco” project (2012-2015) is coordinated by Xavier Leroy and funded by the *Ingénierie Numérique et Sécurité* programme of *Agence Nationale de la Recherche*. The objective of this 4-year project is to develop and formally verify a static analyzer based on abstract interpretation, and interface it with the CompCert C verified compiler.

8.1.2. FSN BGLE projects

8.1.2.1. ADN4SE

Participants: Damien Doligez, Jael Kriener.

The “ADN4SE” project (2012-2016) is coordinated by the Sherpa Engineering company and funded by the *Briques Génériques du Logiciel Embarqué* programme of *Fonds national pour la Société Numérique*. The aim of this project is to develop a process and a set of tools to support the rapid development of embedded software with strong safety constraints. Gallium is involved in this project to provide tools and help for the formal verification in TLA+ of some important aspects of the PharOS real-time kernel, on which the whole project is based.

8.1.2.2. CEEC

Participants: Thomas Braibant, Xavier Leroy.

The “CEEC” project (2011-2014) is coordinated by the Prove & Run company and also involves Esterel Technologies and Trusted Labs. It is funded by the *Briques Génériques du Logiciel Embarqué* programme of *Fonds national pour la Société Numérique*. The CEEC project develops an environment for the development and certification of high-security software, centered on a new domain-specific language designed by Prove & Run. Our involvement in this project focuses on the formal verification of a C code generator for this domain-specific language, and its interface with the CompCert C verified compiler.

8.1.3. FUI projects

8.1.3.1. Richelieu (FUI)

Participants: Michael Laporte, Fabrice Le Fessant.

The “Richelieu” project (2012-2014) is funded by the *Fonds unique interministériel* (FUI). It involves Scilab Enterprises, U. Pierre et Marie Curie, Dassault Aviation, ArcelorMittal, CNES, Silkan, OCamlPro, and Inria. The objective of the project is to improve the performance of scientific programming languages such as Scilab’s through the use of VMKit and LLVM.

8.2. European Initiatives

8.2.1. FP7 Projects

8.2.1.1. DEEPSEA

Type: IDEAS

Instrument: ERC Starting Grant

Duration: June 2013 - May 2018

Coordinator: Umut Acar

Partner: Inria

Inria contact: Umut Acar

Abstract: the objective of project DEEPSEA is to develop abstractions, algorithms and languages for parallelism and dynamic parallelism, with applications to problems on large data sets.

8.3. International Initiatives

8.3.1. Inria International Labs

Fabrice Le Fessant visited CIRIC (Center of Excellence on TIC, created by Inria in Chile) during two weeks. He gave several lectures on OCaml: a presentation at StarTechConf’2013, a presentation at University Adolfo Ibañez, and a presentation and a lecture at University of Chile.

8.4. International Research Visitors

8.4.1. Visits of International Scientists

Olin Shivers, professor at Northeastern University (Boston), visited the Gallium team from July 2013 to December 2013. He worked on static analysis and intermediate representations for functional programming languages.

8.4.1.1. Internships

Robbert Krebbers

Subject: formal semantics for the C language

Date: from Jan 2013 until Mar 2013

Institution: Radboud University (Netherlands)

GEOMETRICA Project-Team

8. Partnerships and Cooperations

8.1. Technological Development Actions

8.1.1. ADT PH

Participants: Jean-Daniel Boissonnat, Frédéric Chazal, David Cohen-Steiner, Sonali Digambar Patil, Marc Glisse, Steve Oudot, Clément Maria, Mariette Yvinec.

- Title: Persistent Homology
- Coordinator: Mariette Yvinec (GEOMETRICA)
- Duration: 1 year renewable once, starting date December 2012.
- Others Partners: Inria team ABS, Gipsa Lab (UMR 5216, Grenoble, <http://www.gipsa-lab.inpg.fr/>)
- Abstract: Geometric Inference is a rapidly emerging field that aims to analyse the structural, geometric and topological, properties of point cloud data in high dimensional spaces. The goal of the ADT PH is to make available, a robust and comprehensive set of algorithmic tools resulting from recent advances in Geometric Inference. The software will include:
 - tools to extract from the data sets, families of simplicial complexes,
 - data structures to handle those simplicial complexes,
 - algorithmic modules to compute the persistent homology of those complexes,
 - applications to clustering, segmentation and analysis of scalar fields such as the energy landscape of macromolecular systems.

8.1.2. ADT OrbiCGAL

Participants: Mikhail Bogdanov, Aymeric Pellé, Monique Teillaud.

- Title: OrbiCGAL
- Coordinator: Monique Teillaud (GEOMETRICA)
- Duration: 1 year renewable once, starting date September 2013.
- Abstract: OrbiCGAL is a software project supported by Inria as a Technological Development Action (ADT). It is motivated by applications ranging from infinitely small (nano-structures) to infinitely large (astronomy), through material engineering, physics of condensed matter, solid chemistry, etc
- The project consists in developing or improving software packages to compute triangulations and meshes in several types of non-Euclidean spaces: sphere, 3D closed flat manifolds, hyperbolic plane.

8.2. Regional Initiatives

8.2.1. Digiteo project TOPERA

Participants: Frédéric Chazal, Marc Glisse, Anaïs Vergne.

TOPERA is a project that aims at developing methods from Topological Data Analysis to study covering properties and quality of cellular networks. It also involves L. Decreusefond and P. Martins from Telecom Paris.

- Starting date: December 2013
- Duration: 18 months

8.3. National Initiatives

8.3.1. ANR Présage

Participants: Olivier Devillers, Marc Glisse, Ross Hemsley, Monique Teillaud, Rémy Thomasse.

- Acronym: Presage.
- Type: ANR blanc.
- Title: *méthodes PRobabilistes pour l'Éfficacité des Structures et Algorithmes GÉométriques*.
- Coordinator: Xavier Goaoc.
- Duration: 31 december 2011 - 31 december 2015.
- Other partners: Inria VEGAS team, University of Rouen.
- Abstract: This project brings together computational and probabilistic geometers to tackle new probabilistic geometry problems arising from the design and analysis of geometric algorithms and data structures. We focus on properties of discrete structures induced by or underlying random continuous geometric objects. This raises questions such as:
 - What does a random geometric structure (convex hulls, tessellations, visibility regions...) look like?
 - How to analyze and optimize the behavior of classical geometric algorithms on *usual* inputs?
 - How can we generate randomly *interesting* discrete geometric structures?
- Year publications: [16], [31], [51].

8.3.2. ANR GIGA

Participants: Jean-Daniel Boissonnat, Frédéric Chazal, David Cohen-Steiner, Mariette Yvinec, Steve Oudot, Marc Glisse.

- Acronym : GIGA.
- Title : Geometric Inference and Geometric Approximation.
- Type: ANR blanc
- Coordinator: Frédéric Chazal (GEOMETRICA)
- Duration: 4 years starting October 2009.
- Others Partners: Inria team-project Titane, Inria team-project ABS, CNRS (Grenoble), Dassault Systèmes.
- Abstract: GIGA stands for Geometric Inference and Geometric Approximation. GIGA aims at designing mathematical models and algorithms for analyzing, representing and manipulating discretized versions of continuous shapes without losing their topological and geometric properties. By shapes, we mean sub-manifolds or compact subsets of, possibly high dimensional, Riemannian manifolds. This research project is divided into tasks which have Geometric Inference and Geometric Approximation as a common thread. Shapes can be represented in three ways: a physical representation (known only through measurements), a mathematical representation (abstract and continuous), and a computerized representation (inherently discrete). The GIGA project aims at studying the transitions from one type to the other, as well as the associated discrete data structures.

Some tasks are motivated by problems coming from data analysis, which can be found when studying data sets in high dimensional spaces. They are dedicated to the development of mathematically well-founded models and tools for the robust estimation of topological and geometric properties of data sets sampled around an unknown compact set in Euclidean spaces or around Riemannian manifolds.

Some tasks are motivated by problems coming from data generation, which can be found when studying data sets in lower dimensional spaces (Euclidean spaces of dimension 2 or 3). The proposed research activities aim at leveraging some concepts from computational geometry and harmonic forms to provide novel algorithms for generating discrete data structures either from mathematical representations (possibly deriving from an inference process) or from raw, unprocessed discrete data. We target both isotropic and anisotropic meshes, and simplicial as well as quadrangle and hexahedron meshes.

- See also: <http://www-sop.inria.fr/geometrica/collaborations/giga/>

8.3.3. ANR TOPDATA

Participants: Jean-Daniel Boissonnat, Frédéric Chazal, David Cohen-Steiner, Mariette Yvinec, Steve Oudot, Marc Glisse.

- Acronym : TopData.

- Title : Topological Data Analysis: Statistical Methods and Inference.

- Type : ANR blanc

- Coordinator : Frédéric Chazal (GEOMETRICA)

- Duration : 4 years starting October 2013.

- Others Partners: Département de Mathématiques (Université Paris Sud), Institut de Mathématiques (Université de Bourgogne), LPMA (Université Paris Diderot), LSTA (Université Pierre et Marie Curie)

- Abstract: TopData aims at designing new mathematical frameworks, models and algorithmic tools to infer and analyze the topological and geometric structure of data in different statistical settings. Its goal is to set up the mathematical and algorithmic foundations of Statistical Topological and Geometric Data Analysis and to provide robust and efficient tools to explore, infer and exploit the underlying geometric structure of various data.

Our conviction, at the root of this project, is that there is a real need to combine statistical and topological/geometric approaches in a common framework, in order to face the challenges raised by the inference and the study of topological and geometric properties of the wide variety of larger and larger available data. We are also convinced that these challenges need to be addressed both from the mathematical side and the algorithmic and application sides. Our project brings together in a unique way experts in Statistics, Geometric Inference and Computational Topology and Geometry. Our common objective is to design new theoretical frameworks and algorithmic tools and thus to contribute to the emergence of a new field at the crossroads of these domains. Beyond the purely scientific aspects we hope this project will help to give birth to an active interdisciplinary community. With these goals in mind we intend to promote, disseminate and make our tools available and useful for a broad audience, including people from other fields.

8.4. European Initiatives

8.4.1. FP7 Projects

8.4.1.1. CG-Learning

Type: COOPERATION

Defi: FET Open

Instrument: Specific Targeted Research Project

Objectif: FET-Open: Challenging Current Thinking

Duration: November 2010 - October 2013

Coordinator: Friedrich-Schiller-Universität Jena (Germany)

Others partners: National and Kapodistrian University of Athens (Greece), Technische Universität Dortmund (Germany), Tel Aviv University (Israel), Eidgenössische Technische Hochschule Zürich (Switzerland), Rijksuniversiteit Groningen (Netherlands), Freie Universität Berlin (Germany)

Inria contact: Mariette Yvinec

See also: <http://cgl.uni-jena.de/>

Abstract: The Computational Geometric Learning project aims at extending the success story of geometric algorithms with guarantees to high-dimensions. This is not a straightforward task. For many problems, no efficient algorithm exist that compute the exact solution in high dimensions. This behavior is commonly called the curse of dimensionality. We try to address the curse of dimensionality by focusing on inherent structure in the data like sparsity or low intrinsic dimension, and by resorting to fast approximation algorithms.

8.5. International Initiatives

8.5.1. Inria Associate Teams

8.5.1.1. COMET

Title: Computational methods for the analysis of high-dimensional data

Inria principal investigator: Steve Y. Oudot

International Partner (Institution - Laboratory - Researcher):

Stanford University (United States) - Computer Science - Leonidas Guibas

Ohio State University (United States) - Computer Science and Engineering - Yusu Wang

Duration: 2011 - 2013

See also: <http://geometrica.saclay.inria.fr/collaborations/CoMeT/index.html>

CoMeT is an associate team between the Geometrica group at Inria, the Geometric Computing group at Stanford University, and the Computational Geometry group at the Ohio State University. Its focus is on the design of computational methods for the analysis of high-dimensional data, using tools from metric geometry and algebraic topology. Our goal is to extract enough structure from the data, so we can get a higher-level informative understanding of these data and of the spaces they originate from. The main challenge is to be able to go beyond mere dimensionality reduction and topology inference, without the need for a costly explicit reconstruction. To validate our approach, we intend to set our methods against real-life data sets coming from a variety of applications, including (but not restricted to) clustering, image or shape segmentation, sensor field monitoring, shape classification and matching. The three research groups involved in this project have been active contributors in the field of Computational Topology in the recent years, and some of their members have had long-standing collaborations. We believe this associate team can help create new synergies between these groups.

8.6. International Research Visitors

Mirel Ben Chen (Technion - Israel Institute of Technology)

Benjamin Burton (University of Queensland)

Pedro Machado Manhães de Castro (Universidade Federal de Pernambuco)

Arijit Ghosh (Indian Statistical Institute)

Michael Hemmer (University of Technology Braunschweig)

Dmitriy Morozov (Berkeley)

Yusu Wang (Ohio State University)

Jian Sun (Tsinghua University - China)

Yuan Yao (Peiking University - China)

GRACE Project-Team

8. Partnerships and Cooperations

8.1. Regional Initiatives

- ISN-Privacy. From late 2012 through the year 2013, Daniel Augot was heavily involved in the preparation of the *Institut de la société du numérique* (Digital Society Institute) proposal within IDEX Paris-Saclay. Led by N. Boujemaa, this proposal aims to be a catalyst for interdisciplinary research (involving computer scientists and researchers from the humanities) on societal challenges inherent to eLife/life digitization. The proposal has initial funding from the IDEX, and will hopefully be self-funding within three years. Two kick-off projects were defined: joint human & machine interaction, and privacy and digital identity.

Daniel Augot engaged in monthly brainstorming meetings with researchers from Inria Paris–Rocquencourt (project-team SMIS), Université Jean Monnet’s ADIS and CERDI labs (Alain Rallet, Alexandra Bensamoun), and Télécom ParisTech (Claire Levallois-Barth). Topics under discussion include terms of service of various cloud storage providers, SMIS’s *TrustedCell* secure token initiative for holding private and secure personal data, privacy leaks, and measurements on smartphones.

A seminar will be held in Summer 2014. Within IDEX Paris-Saclay, the PAIP (Pour une Approche Interdisciplinaire de la Privacy) project was proposed and accepted in September 2013, with a small budget (30 keuros) for all the partners of the privacy group.

8.2. National Initiatives

8.2.1. ANR

- CATREL (accepted June 2012, Kickoff December 14, 2012, Starting January 1st, 2013): “Cribles: Améliorations Théoriques et Résolution Effective du Logarithme” (Sieve Algorithms: Theoretical Advances and Effective Resolution of the Discrete Logarithm Problem). This project aims to make effective “attacks” on reduced-size instances of the discrete logarithm problem (DLP). It is a key ingredient for the assessment of the security of cryptosystems relying on the hardness of the DLP in finite fields, and for deciding on relevant key sizes.

8.2.2. DGA

- DIFMAT: this two-year project aims to find matrices with good diffusion over small finite fields. These matrices are used in block ciphers and hash functions; coding theory helps to build and analyse them. Guillaume Quintin was hired as a postdoctoral researcher using this funding.
- Daniel Augot is co-advising Gwezheneg Robert with Pierre Loidreau (DGA, Rennes University).

8.2.3. PEPS ICQ (*Projet Exploratoire de Premier Soutien - Information et Communication Quantique*)

- ToCQ is a one-year project exploring the connections between algebraic topology, combinatorics, and Low Density Parity Check Quantum Codes. Alain Couvreur and Nicolas Delfosse are members of this project. The other partners are Inria Paris–Rocquencourt, Université Bordeaux I and Aix–Marseille Université.

8.3. European Initiatives

8.3.1. Collaborations in European Programs, except FP7

Program: COST

Project acronym: COST 4175/11

Project title: Random Network Coding and Designs over $GF(q)$ <http://www.network-coding.eu/index.html>

Duration: 04/2012 - 04/2016

Coordinator: Marcus Greferath

Other partners: Camilla Hollanti, Aalto University, Finland Simon R. Blackburn, Royal Holloway, University of London, UK Tuvi Etzion, Technion, Israel Ángeles Vázquez-Castro, Autonomous University of Barcelona, Spain Joachim Rosenthal, University of Zurich, Switzerland (Chairs of the five working groups).

Abstract: Random network coding emerged through an award-winning paper by R. Koetter and F. Kschischang in 2008 and has since then opened a major research area in communication technology with widespread applications for communication networks like the internet, wireless communication systems, and cloud computing. It allows transmitting information through a network by disregarding any of its topological features. Worldwide, there exists a larger number of workgroups focusing on this topic, which includes several groups located in Europe. This COST Action will set up a European research network and establish network coding as a European core area in communication technology. Its aim is to bring together experts from pure and applied mathematics, computer science, and electrical engineering, who are working in the areas of discrete mathematics, coding theory, information theory, and related fields.

8.4. International Initiatives

8.4.1. Inria International Partners

8.4.1.1. Informal International Partners

- Martin Bossert, Institute of Communications Engineering, Ulm Universität.
- Steven Galbraith, Department of Mathematics, University of Auckland.

8.5. International Research Visitors

8.5.1. Visits of International Scientists

8.5.1.1. Internships

- Charlotte Scribot is spending the period September 2013 - February 2014 as an intern with GRACE as part of her professional masters program (Paris 7). She is working with Benjamin Smith and François Morain on parameter selection for efficient elliptic curve cryptosystems.

Hycomes Team

6. Partnerships and Cooperations

6.1. Regional Initiatives

- Ayman Aljarbooh's PhD is partially funded by a ARED grant of the Brittany Regional Council.
- Benoît Caillaud is participating to the S3PM project of the CominLabs excellence laboratory ¹⁰. This project focuses on the computation of surgical procedural knowledge models from recordings of individual procedures, and their execution [7]. The objective is to develop an enabling technology for procedural knowledge based computer assistance of surgery. In this project, we demonstrate its potential added value in nurse and surgeon training.

6.2. National Initiatives

Program: « Briques génériques du logiciel embarqué » (Embedded Software Generic Building-Blocks)

Project acronym: Sys2soft

Project title: Physics Aware Software

Duration: June 2012 – April 2016

Coordinator: Dassault Systèmes (France)

Other partners: Thales TGS / TRT / TAS, Alstom Transport, Airbus, DPS, Obeo, Soyatec

Abstract: The Sys2soft project aims at developing methods and tools supporting the design of embedded software interacting with a complex physical environment. The project advocates a methodology where both physics and software are co-modeled and co-simulated early in the design process and embedded code is generated automatically from the joint physics and software models. Extensions of the Modelica language with synchronous programming features are being investigated, as a unified framework where interacting physical and software artifacts can be modeled.

6.3. European Initiatives

6.3.1. Collaborations in European Programs, except FP7

Program: ITEA2

Project acronym: Modrio

Project title: Model Driven Physical Systems Operation

Duration: September 2012 – November 2015

Coordinator: EDF (France)

Other partners: ABB (Sweden), Ampère Laboratory / CNRS (France), Bielefeld University (Germany), Dassault Systèmes (Sweden), Dassault Aviation (France), DLR (Germany), DPS (France), EADS (France), Equa Simulation (Sweden), IFP (France), ITI (Germany), Ilmenau University (Germany), Katholic University of Leuven (Belgium), Knorr-Bremse (Germany), LMS (France and Belgium), Linköping University (Sweden), MathCore (Sweden), Modelon (Sweden), Pöry (Finland), Qtronic (Germany), SICS (Sweden), Scania (Sweden), Semantum (Finland), Sherpa Engineering (France), Siemens (Germany and Sweden), Simpack (Germany), SKF (Sweden), Supmeca (France), Triphase (Belgium), University of Calabria (Italy), VTT (Finland), Vattenfall (Sweden), Wapice (Finland).

¹⁰<http://www.cominlabs.ueb.eu/projects/>

Abstract: Modelling and simulation are efficient and widely used tools for system design. But they are seldom used for systems operation. However, most functionalities for system design are beneficial for system operation, provided that they are enhanced to deal with real operating situations. Through open standards the benefits of sharing compatible information and data become obvious: improved cooperation between the design and the operation communities, easier adaptation of operation procedures wrt. design evolutions. Open standards also foster general purpose technology. The objective of the ITEA 2 MODRIO project is to extend modelling and simulation tools based on open standards from system design to system operation.

6.4. International Initiatives

6.4.1. Informal International Partners

Beyond the Modrio and Sys2soft collaborative projects, we have an informal but sustained collaboration with the Dassault Systèmes team developing the Dymola tool, located in Lund, Sweden, and with the DLR in Munich, Germany, which are both prominent actors of the Modelica association. This collaboration has allowed us to have an impact on the recent evolution of the Modelica language: Version 3.3 of the language integrates several of our contributions related to the introduction of language constructs inherited from synchronous programming languages ¹¹.

¹¹ See acknowledgements in section E.1.3, page 261 of <https://www.modelica.org/documents/ModelicaSpec33.pdf>

INDES Project-Team

7. Partnerships and Cooperations

7.1. National initiatives

7.1.1. ANR DEFIS PWD

The PWD project (for “Programmation du Web diffus”) has been funded by the ANR Défis programme for 4 years, starting November 2009. The partners of this project are the teams INDES (coordinator), LIP6 at University Pierre et Marie Curie and PPS at University Denis Diderot.

7.1.2. FUI X-Data

Broadly available big and open data open new perspectives in terms of use and applications. The X-Data project aims at validating this claim by using actual data sets for building realistic applications. The goal is to combine a large variety of data sets coming from different partners (Data Publica, Orange, EDF, La Poste, social networks, ...) to build innovative applications. The Indes team designs and implements new programming language constructs that help programming these applications.

7.1.3. MEALS

The MEALS project (Mobility between Europe and Argentina applying Logics to Systems), IRSES program, started October 1st (2011), and will end September 30th, 2015. The project goals cover three aspects of formal methods: specification (of both requirement properties and system behavior), verification, and synthesis. The Indes members are involved in the task of Security and Information Flow Properties (WP3). The partners in this task include University of Buenos Aires, University of Cordoba, Inria (together with Catuscia Palamidessi, Kostas Chatzikokolakis, Miguel Andrés) and University of Twente.

7.2. European initiatives

7.2.1. FP7 Projects

Program: RAPP

Title: Robot App Store

Collaborator: Inria Coprin

Abstract: RAPP is a 36 months pan-european FP7 project, started in December 2013. Hop is used in the development of prototypes of the Coprin Ang rollator transfer device, for mobility assistance and activity monitoring.

7.2.2. Collaborations in European Programs, except FP7

Program: ICT Cost Action IC1201

Program acronym: BETTY

Project title: Behavioural Types for Reliable Large-Scale Software Systems

Duration: October 2012 - October 2016

Coordinator: Simon Gay, University of Glasgow

Other partners: Several research groups, belonging to 22 european countries

Abstract: The aim of BETTY is to investigate and promote behavioural type theory as the basis for new foundations, programming languages, and software development methods for communication-intensive distributed systems. Behavioural type theory encompasses concepts such as interfaces, communication protocols, contracts, and choreography.

LFANT Project-Team

8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. ANRPeace – Parameter spaces for Efficient Arithmetic and Curve security Evaluation

Participants: Bill Allombert, Karim Belabas, Jean-Marc Couveignes, Andreas Enge, Nicolas Mascot, Enea Milio, Aurel Page, Damien Robert.

<http://chic2.gforge.inria.fr/>

The PEACE project is joint between the research teams of Institut de Recherche en Mathématiques de Rennes (IRMAR), LFANT and Institut Mathématiques de Luminy (IML).

The project aims at constituting a comprehensive and coherent approach towards a better understanding of theoretical and algorithmic aspects of the discrete logarithm problem on algebraic curves of small genus. On the theoretical side, this includes an effective description of moduli spaces of curves and of abelian varieties, the maps that link these spaces and the objects they classify. The effective manipulation of moduli objects will allow us to develop a better understanding of the algorithmic difficulty of the discrete logarithm problem on curves, which may have dramatic consequences on the security and efficiency of already deployed cryptographic devices.

One of the anticipated outcomes of this proposal is a new set of general criteria for selecting and validating cryptographically secure curves (or families of curves) suitable for use in cryptography. Instead of publishing fixed curves, as is done in most standards, we aim at proposing generating rationales along with explicit theoretical and algorithmic criteria for their validation.

Meetings:

- Paris: 11/04–12/04, talks and mini-courses;
- Rennes: 02/12–03/12, talks.

8.1.2. ANRSimpatic – SIM and PAiring Theory for Information and Communications security

Participant: Damien Robert.

The SIMPATIC project is an industrial research project, formed by academic research teams and industrial partners: Orange Labs, École Normale Supérieure, INVIA, Oberthur Technologies, ST-Ericsson France, Université de Bordeaux 1, Université de Caen Basse-Normandie, Université de Paris 8.

The aim of the SIMPATIC project is to provide the most efficient and secure hardware/software implementation of a bilinear pairing in a SIM card. This implementation will then be used to improve and develop new cryptographic algorithms and protocols in the context of mobile phones and SIM cards. The project will more precisely focus on e-ticketing and e-cash, on cloud storage and on the security of contactless and of remote payment systems.

As a participant, D. Robert will aim to bridge the gap between the theoretical results described in the pairing module and the practical realisation of pairing-based SIM cards in an industrial setting.

8.2. European Initiatives

8.2.1. FP7 Projects

8.2.1.1. ANTICS

Title: Algorithmic Number Theory in Cryptology

Type: IDEAS

Instrument: ERC Starting Grant

Duration: January 2012 - December 2016

Coordinator: Inria (France)

Abstract: Data security and privacy protection are major challenges in the digital world. Cryptology contributes to solutions, and one of the goals of ANTICS is to develop the next generation public key cryptosystem, based on algebraic curves and abelian varieties. Challenges to be tackled are the complexity of computations, certification of the computed results and parallelisation, addressed by introducing more informatics into algorithmic number theory.

8.3. International Initiatives

8.3.1. Inria International Labs

The *MACISA* project-team (Mathematics Applied to Cryptology and Information Security in Africa) is one of the new teams of LIRIMA. Researchers from Inria and the universities of Bamenda, Bordeaux, Dakar, Franceville, Maroua, Ngaoundéré, Rennes, Yaoundé cooperate in this team.

The project is concerned with public key cryptology and more specifically the role played by algebraic maps in this context. The team focus on two themes:

- Theme 1 : Rings, primality, factoring and discrete logarithms;
- Theme 2 : Elliptic and hyperelliptic curve cryptography.

The project is managed by a team of five permanent researchers: G. Nkiet, coordinator of the project, J.-M. Couveignes, vice coordinator, T. Ezome and D. Robert, responsible for each of the two scientific working areas, A. Enge, head of the LFANT project team. The managing team organises the cooperation, schedules meetings, prepares reports, controls expenses, reports to the LIRIMA managing team and administrative staff.

8.4. International Research Visitors

8.4.1. Visits of International Scientists

- Tony Ezome Mintsu, University of Franceville, Gabon, 02/2013 and 11–12/2013
- Loïc Grenie, University of Bergamo, 11–12/2013
- Matthias Waack, University of Leipzig, Germany, 10–11/2013
- Eduardo Friedman, University of Chile, 01–02/2013
- Francisco Diaz y Diaz, emeritus, 01–02/2013
- Bernadette Perrin-Riou, Université d'Orsay, 03/2013

8.4.1.1. Internships

- Fritz Hiesmayr, ÉNS Lyon, 06–07/2013
- Gregor Seiler, Technische Universität Berlin, Germany, 10/2013–03/2014

8.4.2. Visits to International Teams

D. Robert visited the cryptology team at Microsoft Research from August 06 to August 14.

MARELLE Project-Team

7. Partnerships and Cooperations

7.1. National Initiatives

7.1.1. ANR

- We participated in the ANR project TAMADI, which started in October 2010. Other participants are ARENAIRE-Inria Rhone-Alpes and the PEQUAN team from University of Paris VI Pierre and Marie Curie. The objective of the TAMADI project is to study the question of precision in floating-point arithmetic and to provide formal proofs on this topic. This project was completed in October 2013.

7.2. European Initiatives

7.2.1. FP7 Projects

7.2.1.1. FORMATH

Type: COOPERATION

Defi: Future and Emerging Technologies

Instrument: Specific Targeted Research Project

Objectif: FET-Open: Challenging Current Thinking

Duration: March 2010 - August 2013

Coordinator: University of Göteborg (Sweden)

Partners: Radboud University Nijmegen, (the Netherlands), University of La Rioja, (Spain).

Site: <http://wiki.portal.chalmers.se/cse/pmwiki.php/ForMath/ForMath>

Inria contact: Y. Bertot

Abstract: The objective of this project is to develop libraries of formalised mathematics concerning algebra, linear algebra, real number computation, and algebraic topology. The libraries that we plan to develop in this proposal are especially chosen to have long-term applications in areas where software interacts with the physical world. The main originality of the work is to structure these libraries as a software development, relying on a basis that has already shown its power in the formal proof of the four-colour theorem, and to address topics that were mostly left untouched by previous research in formal proof or formal methods.

7.3. International Initiatives

7.3.1. Informal International Partners

We interact regularly with the team of Prof. Thierry Coquand at University of Göteborg and Chalmers University in Sweden and the team of Prof. Julio Rubio at Universidad de La Rioja in Spain.

7.4. International Research Visitors

7.4.1. Visits of International Scientists

Amy Felty, professor at the University of Ottawa, Doug Howe, professor at Carleton University in Canada, are visiting from September 2013 to Summer 2014.

7.4.1.1. Internships

- Florent Bréhard, student at École Normale Supérieure, worked from June to August 2013 on *homotopy type theory*. In particular, he produced a proof of equivalence between various presentations of spheres, at all dimensions.
- Antoine Gropellier, student at École Normale Supérieure, worked from June to August 2013 on integrating automatic proof tools for first order logic in the Coq system.

7.4.2. Visits to International Teams

- Yves Bertot spent three months From January 15th to April 15th, 2013 at Institute for Advanced Study, Princeton, where he was invited to participate to the special year on *Homotopy Type Theory*.

MEXICO Project-Team

7. Partnerships and Cooperations

7.1. Regional Initiatives

7.1.1. DIM/LSC TECSTES - 2011-052D

In this DIGITEO project (No. 6024), Hernán Ponce de León, Delphine Longuet (ParisSud) and Stefan Haar cooperate on the subject of conformance testing for concurrent systems, using Event Structures. The project started on September 1, 2011 and is scheduled to end on August 31, 2014.

7.1.2. LOCOREP

In the DIGITEO project LoCoReP (No. 2010-043D), Aiswarya Cyriac, Paul Gastin, and Benedikt Bollig worked on temporal logics for the specification and verification of concurrent recursive programs. The project started on September 1, 2010 and ended on August 31, 2013.

7.2. IRT

7.2.1. SystemX

Participants: Simon Theissing, Stefan Haar.

We participate in the project MIC on multi-modal transport systems with in the IRT *System X*, with academic partners UPMC, IFSTTAR and CEA, and several industrial partners including Alstom (project leader), COSMO and Renault.

7.3. National Initiatives

7.3.1. ANR project IMPRO

Participants: Thomas Chatain, Stefan Haar, Serge Haddad.

The Project ANR **ImpRo** ANR-2010-BLAN-0317 involves *IRCCyN* (Nantes), *IRISA* (Rennes), *LIP6*(Paris), *LSV* (Cachan), *LIAFA* (Paris) and *LIF* (Marseille). It addresses issues related to the practical implementation of formal models for the design of communication-enabled systems: such models abstract away from many complex features or limitations of the execution environment. The modeling of *time*, in particular, is usually idealized, with infinitely precise clocks, instantaneous tests or mode communications, etc. Our objective is thus to study to what extent the practical implementation of these models preserves their good properties. We aim at a generic mathematical framework to reason about and measure implementability, and then study the possibility to integrate implementability constraints in the models. A particular focus is on the combination of several sources of perturbation such as resource allocation, the distributed architecture of applications, etc. We also study implementability through control and diagnosis techniques, and apply the developed methods to a case study based on the AUTOSAR architecture, a standard in the automotive industry.

7.4. European Initiatives

7.4.1. FP7 Projects

7.4.1.1. Hycon2

Type: COOPERATION

Defi: Engineering of Networked Monitoring and Control Systems

Instrument: Network of Excellence

Objectif: Engineering of Networked Monitoring and Control systems

Duration: September 2010 - August 2014

Coordinator: CNRS

Partner: ETH Zürich, TU Berlin, TU Delft and many others.

Inria contact: C. Canudas de Wit

Abstract: Hycon2 aims at stimulating and establishing a long-term integration in the strategic field of control of complex, large-scale, and networked dynamical systems. It focuses in particular on the domains of ground and aerospace transportation, electrical power networks, process industries, and biological and medical systems.

7.4.1.2. UniverSelf: realizing autonomics for Future Networks

Type: COOPERATION

Defi: The Network of the Future

Instrument: Integrated Project

Objectif: The Network of the Future

Duration: September 2010 - August 2013

Coordinator: Alcatel Lucent (France)

Partner: UTwente, AL Ireland, AL Germany, VTT (Finland), U. of Piraeus, FT, Telecom Italia, NU of Athens, Fraunhofer, Interdic. Institutue for Broadband Technology, Telefonica, Thales, Nec Europe, U. of Surrey, UCL, IBBT (Belgium)

Inria contact: E. Fabre

Abstract: UniverSelf unites 17 partners with the aim of overcoming the growing management complexity of future networking systems, and to reduce the barriers that complexity and ossification pose to further growth.

7.5. International Initiatives

7.5.1. Inria International Partners

7.5.1.1. Informal International Partners

1. The CMI (Chennai Mathematical Institute) is a long-standing partner of our team. The project *Île de France/Inde* in the *ARCUS* program from 2008 to 2011 has allowed several exchange visits between Cachan and Chennai, organizations of ACTS workshops with french and indian researchers in Chennai, internships in Cachan, and two theses in *co-tutelle* (Akshay Sundararaman, defended in 2010) and Aiswarya Cyriac (thesis in progress).

Currently, Paul Gastin is co-head (with Madhavan Mukund) of the CNRS International Associated Laboratory (LIA) INFORMEL (INdo-French FORMal Methods Lab, <http://projects.lsv.ens-cachan.fr/informel/>). This LIA was created in January 2012 by an agreement between CNRS, ENS Cachan, University Bordeaux 1 on the french side and the Chennai Mathematical Institute, the Institute of Mathematical Sciences of Chennai, and the Indian Institute of Science of Bangalore on the Indian side.

2. We have been exchanging visits for several years between *MExICo* and the DISCO team (Lucia Pomello and Luca Bernardinello) at University Milano-Bicocca, Italy.
3. Exchanges are frequent with Rolf Hennicker from LMU and Javier Esparza at TUM, both in Munich, Germany.
4. With the computer science and electrical engineering departments at Newcastle University, UK

7.5.2. Participation In Other International Programs (non-Inria)

Benedikt Bollig, Aiswarya Cyriac, and Benjamin Monmege are participating in LeMon, a joint Procope project with LIAFA, (Paris) and the University of Lübeck, supported by EGIDE/DAAD. The aim of the project is to develop techniques for the inference of systems that deal with infinite data domains.

7.6. International Research Visitors

7.6.1. Visits of International Scientists

- Monika Heiner, Professor at University of Cottbus/Germany, visited *MExICo* from September 15 through October 15, 2013.
- Estibaliz Fraca, PhD student from Zaragossa, visited *MExICo* from november 2012 trough February 2013.
- From 7 to 19 January 2013, Paul Gastin and Aiswarya Cyriac (LSV) visit K. Narayan Kumar and Madhavan Mukund at CMI Chennai. They studied verification problems for concurrent and recursive multi-threaded programs.
- 13 May to 1 June 2013: Madhavan Mukund (CMI) visits LSV, IRISA.
- 8 to 29 June K. Narayan Kumar (CMI) visits LSV, LaBRI. The study verification problems for concurrent and recursive multi-threaded programs was pursued.
- 16 June to 30 June 2013: Saivasan Prakash (CMI) visits LSV and LIAFA. Discussions with Ahmed Bouajjani on Verification of networks of Communicating Recursive Processes. Joint work with M.F.Atig (Uppsala) and manuscript based on this work is under preparation.
- 25 May to 20 July 2013: Bharat Adsul (IIT Bombay) visits LSV and LaBRI to work on cascade products of asynchronous automata.

7.6.1.1. Internships

Gonzalo Amadio

Subject: Diagnosis of Stochastic Systems

Date: from Apr 2013 until Jul 2013

Institution: Universidad National de Rosario (Argentina)

Siddharth Krishna

Subject: Multiple Context Free Grammars

Date: from May 19, 2013 until June 15, 2013

Institution: Chennai Mathematical Institute, India

7.6.2. Visits to International Teams

- Thomas Chatain visited
 - Lucia Pomello and Luca Bernardinello at University of Milano-Bicocca for one week in February 2013,
 - Humboldt Universität Berlin for the KOSMOS-Workshop (November 28-30, 2013)
- 4 to 19 December 2013: Paul Gastin and Aiswarya Cyriac (LSV) visit CMI. With K. Narayan Kumar, they completed the study of verification problems via split-width for concurrent recursive multi-threaded programs (a paper is in preparation). With Madhavan Mukund, they started working on statistical analysis of asynchronous systems.

- Stefan Haar visited
 1. Technische Universität Berlin in for five days in March 2013 and three days in November 2013 for seminar talks and technical cooperation,
 2. Humboldt Universität Berlin for the KOSMOS-Workshop (Nov. 28-30)
 3. University of Newcastle (UK) June 10-12 and Sep.16-20,
 4. Bucarest Polytechnic (RO) May 29 to June 1, giving a course on verification within the *CAN'TI* summer school, and
 5. University of Cordoba (Argentina) as an invited professor, from Oct 27 to Nov 1.
- Serge Haddad
- Hernán Ponce de León visited University of Cordoba (Argentina) for two weeks in October/November.
- César Rodríguez visited Victor Khomenko at the University of Newcastle for one week in May.
- Stefan Schwon visited the group of Javier Esparza at the Technical University of Munich for two weeks in February.

MUTANT Project-Team

8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. ANR

8.1.1.1. INEDIT

Title: Interactivity in the Authoring of Time and Interactions

Project acronym: INEDIT

Type: ANR Contenu et Interaction 2012 (CONTINT)

Instrument: ANR Grant

Duration: September 2012 - September 2015

Coordinator: IRCAM (France)

Other partners: **Grame** (Lyon, France), **LaBRI** (Bordeaux, France).

Abstract: The INEDIT project aims to provide a scientific view of the interoperability between common tools for music and audio productions, in order to open new creative dimensions coupling *authoring of time* and *authoring of interaction*. This coupling allows the development of novel dimensions in interacting with new media. Our approach lies within a formal language paradigm: An interactive piece can be seen as a virtual interpreter articulating locally synchronous temporal flows (audio signals) within globally asynchronous event sequence (discrete timed actions in interactive composition). Process evaluation is then to respond reactively to signals and events from an environment with heterogeneous actions coordinated in time and space by the interpreter. This coordination is specified by the composer who should be able to express and visualize time constraints and complex interactive scenarios between mediums. To achieve this, the project focuses on the development of novel technologies: dedicated multimedia schedulers, runtime compilation, innovative visualization and tangible interfaces based on augmented paper, allowing the specification and realtime control of authored processes. Among posed scientific challenges within the INEDIT project is the formalization of temporal relations within a musical context, and in particular the development of a GALS (Globally Asynchronous, Locally Synchronous) approach to computing that would bridge in the gap between synchronous and asynchronous constraints with multiple scales of time, a common challenge to existing multimedia frameworks.

8.1.2. Other National Initiatives

The team participated to the CLASYCO network on DSL for simulation, supported by the RNSC (réseau national des systèmes complexes).

Jean-Louis Giavitto participates to the **SynBioTIC** ANR Blanc project (with IBISC, University of Evry, LAC University of Paris-Est, ISC - Ecole Polytechnique).

8.2. International Initiatives

8.2.1. Inria International Partners

8.2.1.1. Informal International Partners

Miller Puckette (UCSD), David Wessel (UC Berkeley), Edward Lee (UC Berkeley), Shlomo Dubnov (UCSD).

8.3. International Research Visitors

Dr. Roger Dannenberg (Carnegie Mellon University) was invited by MuTant in May 2013, where he took part in Arshia Cont's HDR defense, José Echeveste's mid-term PhD defense, and gave a public seminar in the [MuTant Seminars in Real-time Multimedia Computing](#) series.

Dr. Shlomo Dubnoc (University of California San Diego) was invited by MuTant in August 2013 for ongoing collaborative work and to take part in the [International Conference on Geometric Science of Information 2013](#), Special Session on *Audio and Music* organized by MuTant member Arshia Cont.

Masahiko Sakai visited MuTant for two weeks in August 2013. He is a professor at the University of Nagoya and director of the Sakabe/Sakai computer science laboratory of the department of computer science and mathematical informatics of Nagoya University.

Dr. Edward Lee and Dr. David Wessel (UC Berkeley) visited MuTant for discussions on future collaborations with MuTant around Cyber-Physical Systems.

PAREO Project-Team

7. Partnerships and Cooperations

7.1. Regional Initiatives

We participate at the LORIA project entitled “Combining deduction engines into SMT”.

7.2. National Initiatives

We participate in the “Logic and Complexity” part of the GDR–IM (CNRS Research Group on Mathematical Computer Science), in the projects “Logic, Algebra and Computation” (mixing algebraic and logical systems) and “Geometry of Computation” (using geometrical and topological methods in computer science).

7.3. International Research Visitors

7.3.1. Internships

Anisia Maria Magdalena Tudorescu

Subject: Integrating SMT solvers into Spike

Date: from Mar 2013 until May 2013

Institution: West Timisoara University (Romania)

Cosay Gurkay Topaktas

Subject: Property Based Testing

Date: from Feb 2013 until Jun 2013

Institution: Erasmus Mundus MSc in Dependable Software Systems

Fellype Vedovato Martins

Subject: Generation of Terms

Date: from Jun 2013 until Sept 2013

Institution: Mines-Nancy, 2nd year student

PARKAS Project-Team

8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. ANR

ANR WMC project (program “jeunes chercheuses, jeunes chercheurs”), 2012–2016, 200 Keuros. F. Zappa Nardelli is the main investigator.

ANR Boole project (program “action blanche”), 2009-2014.

ANR Partout (program “defis”), 2009-2012. Louis Mandel and Marc Pouzet.

ANR CAFEIN, 2013-2015. Marc Pouzet.

Action d’envergure Synchronics, 2008-2012. The action was driven by Alain Girault (Inria, PopArt, Grenoble) and Marc Pouzet (Inria, Parkas, Paris-Rocquencourt), to focus on “langages for embedded systems”. This has been instrumental in driving our new research on hybrid system modelers.

8.1.2. Competitvity Clusters

FUI project OpenGPU, 2008–2012.

8.1.3. Investissements d’avenir

Sys2Soft contract (Briques Génériques du Logiciel Embarqué). Partenaire principal: Dassault-Systèmes, etc. Inria contacts are Benoit Caillaud (HYCOMES, Rennes) and Marc Pouzet (PARKAS, Paris).

ManycoreLabs contract (Briques Génériques du Logiciel Embarqué). Partenaire principal: Kalray. Inria contacts are Albert Cohen (PARKAS, Paris) and Alain Darté (COMPSYS, Lyon).

8.1.4. Others

Marc Pouzet is scientific advisor for the Esterel-Technologies/ANSYS company.

8.2. European Initiatives

8.2.1. FP7 Projects

8.2.1.1. TETRACOM

Type: CAPACITIES

Defi: Alternative Paths to Components and Systems

Instrument: Coordination and Support Action

Objectif: Advanced Computing, embedded and Control systems

Duration: September 2013 – August 2016

Coordinator: Rainer Leupers

Partner: RWTH Aachen (Germany)

Inria contact: Albert Cohen

Abstract: coordination action to support bilateral technology transfer partnerships (TTPs); prototype of future H2020 transfer instruments.

8.2.1.2. COPCAMS

Type: ARTEMIS

Defi: Alternative Paths to Components and Systems

Instrument: ASP

Objectif: NC

Duration: April 2013 – March 2016

Coordinator: Christian Fabre

Partner: CEA Leti (Grenoble)

Inria contact: Albert Cohen

Abstract: cognitive/smart cameras enabled by hardware accelerators, including manycore processors (STHORM platform of ST) and GPUs.

8.2.2. Collaborations in European Programs, except FP7

8.2.2.1. MODRIO

Duration: December 2012 - December 2014

Coordinator: EDF

Partner: Dassault-Systèmes, EDF, Institut Francais du Pétrole, DLR (Munich, Germany), LMS-Imagine, Inria.

Inria contact: Benoit Caillaud (HYCOMES, Rennes); Marc Pouzet (PARKAS, Paris)

8.3. International Initiatives

8.3.1. Inria Associate Teams

8.3.1.1. POLYFLOW

Title: Polyhedral Compilation for Data-Flow Programming Languages

Inria principal investigator: Albert Cohen

International Partner (Institution - Laboratory - Researcher):

IISc Bangalore (India) - Department of Computer Science and Automation - Albert Cohen

Duration: 2013 - 2016

See also: <http://polyflow.gforge.inria.fr>

Polyhedral techniques for program transformation are now used in several proprietary and open source compilers. However, most of the research on polyhedral compilation has focused on imperative languages such as C, where computation is specified in terms of statements with zero or more nested loops and other control structures around them. Graphical data-flow languages, where there is no notion of statements or a schedule specifying their relative execution order, have so far not been studied using a powerful transformation or optimization approach. These languages are extremely popular in system analysis, modeling and design, in embedded reactive control. They also underline the construction of many domain-specific languages and compiler intermediate representations. The copy and execution semantics of data-flow languages impose a different set of challenges. We plan to bridge this gap by studying techniques that could enable extraction of a polyhedral representation from data-flow programs, transform them, and synthesize them from their equivalent polyhedral representation.

8.4. International Research Visitors

8.4.1. Visits of International Scientists

We have regular invited professors in the PARKAS team:

- In 2012, one month (June/July), Prof. Stephen Edwards (Columbia Univ., New York, USA).
- In 2013, one month (June), Prof. Mary Sheeran from (Chalmers Univ., Sweden).

8.4.1.1. Internships

Pankaj Prateek, Anirudh Kumar, and Pankaj More, students at IIT Kanpur, India, worked in the Parkas team under the supervision of Francesco Zappa Nardelli from 4th May, 2013 to 23 July, 2013.

Guillaume Chelfi, student at Telecom Paris and the MPRI program, under the supervision of Francesco Zappa Nardelli and Marc Pouzet, from 1st of March, 2013, to 31st July, 2013. Guillaume Chelfi worked on the formal verification of the translation of synchronous programs to sequential code.

Louis Mandel supervised the 5-months MPRI Internship of Louis Jachiet from April to August. Louis Jachiet worked on the static scheduling of ReactiveML programs.

Albert Cohen supervised the 3-months Internship of Vincent Thiberville, 3rd year student at École Polytechnique, from April to June. Vincent conducted experimental studies and proposed enhanced methods to support array-based computations in the Heptagon synchronous language.

8.4.2. Visits to International Teams

October, Louis Mandel spent 2 weeks in the team of Vijay Saraswat at IBM T.J. Watson. He worked on the type system of the X10 language.

PARSIFAL Project-Team

7. Partnerships and Cooperations

7.1. European Initiatives

7.1.1. FP7 Projects

7.1.1.1. Proofcert

Participants: Hichem Chihani, Quentin Heath, Dale Miller [correspondant], Fabien Renaud.

Title: ProofCert: Broad Spectrum Proof Certificates

Duration: January 2012 - December 2016

Type: IDEAS

Instrument: ERC Advanced Grant

Coordinator: Dale Miller

Abstract: There is little hope that the world will know secure software if we cannot make greater strides in the practice of formal methods: hardware and software devices with errors are routinely turned against their users. The ProofCert proposal aims at building a foundation that will allow a broad spectrum of formal methods—ranging from automatic model checkers to interactive theorem provers—to work together to establish formal properties of computer systems. This project starts with a wonderful gift to us from decades of work by logicians and proof theorist: their efforts on logic and proof has given us a *universally accepted* means of communicating proofs between people and computer systems. Logic can be used to state desirable security and correctness properties of software and hardware systems and proofs are uncontroversial evidence that statements are, in fact, true. The current state-of-the-art of formal methods used in academics and industry shows, however, that the notion of logic and proof is severely fractured: there is little or no communication between any two such systems. Thus any efforts on computer system correctness is needlessly repeated many time in the many different systems: sometimes this work is even redone when a given prover is upgraded. In ProofCert, we will build on the bedrock of decades of research into logic and proof theory the notion of *proof certificates*. Such certificates will allow for a complete reshaping of the way that formal methods are employed. Given the infrastructure and tools envisioned in this proposal, the world of formal methods will become as dynamic and responsive as the world of computer viruses and hackers has become.

7.1.2. Collaborations in European Programs, except FP7

7.1.2.1. STRUCTURAL: ANR blanc International

Participants: Kaustuv Chaudhuri, Nicolas Guenot, Willem Heijltjes, Stefan Hetzl, Novak Novakovic, François Lamarche, Dale Miller, Lutz Straßburger.

Title: Structural and computational proof theory

Duration: 01/01/2011 – 31/12/2013

Partners:

University Paris VII, PPS (PI: Michel Parigot)

Inria Saclay-IdF, EPI Parsifal (PI: Lutz Straßburger)

University of Innsbruck, Computational Logic Group (PI: Georg Moser)

Vienna University of Technology, Theory and Logic Group (PI: Matthias Baaz)

Total funding by the ANR: 242 390,00 EUR (including 12 000 EUR pôle de compétitivité: SYSTEMIC Paris région)

This project is a consortium of four partners, two French and two Austrian, who are all internationally recognized for their work on structural proof theory, but each coming from a different tradition. One of the objective of the project is build a bridge between these traditions and develop new proof-theoretic tools and techniques of structural proof theory having a strong potential of applications in computer science, in particular at the level of the models of computation and the extraction of programs and effective bounds from proofs.

On one side, there is the tradition coming from mathematics, which is mainly concerned with first-order logic, and studies, e.g., Herbrand's theorem, Hilbert's epsilon-calculus, and Goedel's Dialectica interpretation. On the other side, there is the tradition coming from computer science, which is mainly concerned with propositional systems, and studies, e.g., Curry-Howard isomorphism, algebraic semantics, linear logic, proof nets, and deep inference. A common ground of both traditions is the paramount role played by analytic proofs and the notion of cut elimination. We will study the inter-connections of these different traditions, in particular we focus on different aspects and developments in deep inference, the Curry-Howard correspondence, term-rewriting, and Hilbert's epsilon calculus. As a byproduct this project will yield a mutual exchange between the two communities starting from this common ground, and investigate, for example, the relationship between Herbrand expansions and the computational interpretations of proofs, or the impact of the epsilon calculus on proof complexity.

Besides the old, but not fully exploited, tools of proof theory, like the epsilon-calculus or Dialectica interpretation, the main tool for our research will be deep inference. Deep inference means that inference rules are allowed to modify formulas deep inside an arbitrary context. This change in the application of inference rules has drastic effects on the most basic proof theoretical properties of the systems, like cut elimination. Thus, much of the early research on deep inference went into reestablishing these fundamental results of logical systems. Now, deep inference is a mature paradigm, and enough theoretical tools are available to think to applications. Deep inference provides new properties, not available in shallow deduction systems, namely full symmetry and atomicity, which open new possibilities at the computing level that we intend to investigate in this project. We intend to investigate the precise relation between deep inference and term rewriting, and hope to develop a general theory of analytic calculi in deep inference. In this way, this project is a natural continuation of the ANR project INFER which ended in May 2010.

7.2. International Initiatives

7.2.1. Inria Associate Teams

7.2.1.1. RAPT

Participants: Kaustuv Chaudhuri [correspondant], Dale Miller, Yuting Wang, Olivier Savary-Bélanger.

Title: Applying Recent Advances in Proof Theory for Specification and Reasoning

Inria principal investigator: Kaustuv Chaudhuri

International Partner:

Institution: McGill University (Canada)

Laboratory: School of Computer Science

Researcher: Prof. Brigitte Pientka

International Partner:

Institution: University of Minnesota (United States)

Laboratory: Department of Computer Science and Engineering

Researcher: Prof. Gopalan Nadathur

International Partner:

Institution: Carnegie Mellon University (United States)

Laboratory: Department of Computer Science

Researcher: Prof. Frank Pfenning

Duration: 2011 - 2013

See also: <http://www.lix.polytechnique.fr/~kaustuv/rapt/>

Many aspects of computation systems, ranging from operational semantics, interaction, and various forms of static analysis, are commonly specified using inference rules, which themselves are formalized as theories in a logical framework. While such a use of logic can yield sophisticated, compact, and elegant specifications, formal reasoning about these logic specifications presents a number of difficulties. The RAPT project will address the problem of reasoning about logic specifications by bringing together three different research teams, combining their backgrounds in type theory, proof theory, and the building of computational logic systems. We plan to develop new methods for specifying computation that allow for a range of specification logics (eg, intuitionistic, linear, ordered) as well as new means to reason inductively and co-inductively with such specifications. New implementations of reasoning systems are planned that use interactive techniques for deep meta-theoretic reasoning and fully automated procedures for a range of useful theorems.

7.2.2. Inria International Partners

7.2.2.1. PHC Procopé: From Proofs to Counterexamples for Programming

Participants: Kaustuv Chaudhuri, Nicolas Guenot, Willem Heijltjes, Lutz Straßburger.

Title: From Proofs to Counterexamples for Programming

Duration: 01/01/2012 – 31/12/2013

German Partner: University of Bonn, Institute for Computer Science (Department III)

Finding counterexamples is an endeavor which is as important as proving theorems. But while the latter has seen a huge amount of research effort—we have nowadays a large quantity of tools for automated and interactive theorem proving—the former has mainly been neglected by proof theorists. One of the reasons is that finding counterexamples or countermodels has been considered a model theoretical activity, rather than a proof theoretical one. Only recently, researchers have begun to explore the well-known duality between "proof search" and "search for countermodels" in a purely proof theoretical way. The main objective of this collaboration is to develop the necessary proof theory for automatically generating such counterexamples in a more general setting.

7.3. International Research Visitors

7.3.1. Visits of International Scientists

Chuck Liang (Professor from Hofstra University, NY, USA) visited for three weeks in May and June and another week in December.

Gopalan Nadathur (Professor from the University of Minnesota) visited for two weeks in May and June.

Elaine Pimentel (Associate Professor, UFRN, Brazil) for four weeks in June and July.

7.3.2. Internships

Olivier Savary-Bélanger (Masters, McGill University, Canada), supervised by Kaustuv Chaudhuri

7.3.3. Visits to International Teams

Fabien Renaud visited Gopalan Nadathur in Minneapolis for two weeks in February.

Dale Miller visited Alwen Tiu at the Australian National University in Canberra, Australia for one week in May 2013.

Dale Miller visited Christof Benz Müller for one week in February.

PI.R2 Project-Team

6. Partnerships and Cooperations

6.1. National Initiatives

Pierre-Louis Curien (coordinator), Yves Guiraud and Philippe Malbos are members of the three-years Focal project of the IDEX Sorbonne-Paris-Cité, started in June 2013. This project, giving the support for the PhD grant of Cyrille Chenavier, concerns the interactions between higher-dimensional rewriting and combinatorial algebra with researchers from LAGA (Univ. Paris 13)

Pierre-Louis Curien (coordinator), Yves Guiraud and Philippe Malbos are members of the four-years Cathre ANR project, accepted in 2013, to begin in January 2014. This project will investigate the general theory of higher-dimensional rewriting, the development of a general-purpose library for higher-dimensional rewriting, and applications in the fields of combinatorial algebra, combinatorial group theory and theoretical computer science.

Matthieu Sozeau, Hugo Herbelin, Lourdes del Carmen González Huesca and Yann Régis-Gianas are members of the ANR Paral-ITP started November 2011. Paral-ITP is about preparing the Coq and Isabelle interactive theorem provers to a new generation of user interfaces thanks to massive parallelism and incremental type-checking.

Hugo Herbelin is the coordinator of the PPS site for the ANR Récré accepted in 2011, which started in January 2012. Récré is about realisability and rewriting, with applications to proving with side-effects and concurrency.

Matthieu Sozeau is member of the ANR Typex project (Types and certification for XML) and is coordinator of one of the tasks of the project on formalisation and certification of XML tools. The project kicked-off on January 8th, 2012 and is a joint project with LRI, PPS and Inria Grenoble.

6.2. European Initiatives

6.2.1. FP7 Projects

Yann Régis-Gianas is a participant of the EU-FP7 Certified Complexity project (CerCo). This European project started in February 2010 as a collaboration between Bologna university (Asperti, Sacerdoti Coen), Edinburgh university (Pollack) and Paris Diderot university (Amadio, Régis-Gianas). The CerCo project aims at the construction of a formally verified complexity preserving compiler from a large subset of the C programming language to some typical micro-controller assembly language, of the kind traditionally used in embedded systems.

6.2.2. Collaborations in European Programs, except FP7

Pierre-Louis Curien, Yves Guiraud and Philippe Malbos are collaborators of the Applied and Computational Algebraic Topology (ACAT) networking programme of the European Science Foundation.

6.3. International Initiatives

6.3.1. Inria Associate Teams

Title: Proof theory and functional programming languages (SEMACODE)

Inria principal investigator: Alexis SAURIN

International Partner:

Institution: University of Oregon (United States)

Laboratory: Computer and Information Science Department

Researcher: Zena ARIOLA

International Partner:

Institution: University of Novi Sad

Laboratory: Faculty of Engineering

Researcher: Silvia GHILEZAN

Duration: 2011 - 2013

See: <http://www.pps.univ-paris-diderot.fr/~saurin/EA-SEMACODE>

6.3.2. Inria International Partners

We are setting up a partnership with the University of Wrocław (our interlocutors are D. Biernacki and M. Biernacka).

6.3.3. Participation In other International Programs

Pierre-Louis Curien participates to the ANR International French-Chinese project LOCALI (coordinated by Gilles Dowek), and to a MathAmSud project in algebraic operads with the university of Talca (Chile).

6.3.4. Other international cooperations

MIT (Adam Chlipala, Jason Gross).

6.4. International Research Visitors

6.4.1. Visits of International Scientists

Beta Ziliani (MPI, Saarbrücken) visited πr^2 and PPS for a week in January to collaborate with Yann Régis-Gianas and Matthieu Sozeau.

Zena Ariola visited πr^2 and PPS for the whole academic year 2012-2013 with SEMACODE associate team to collaborate with Pierre-Louis Curien, Hugo Herbelin and Alexis Saurin. Her two PhD students joined for shorter terms (Paul Downen from November 2012 to July 2013 and Luke Maurer, being funded by the INTERNSHIP program – see below – from March 2013 to July 2013).

Marco Gaboardi visited πr^2 and PPS in for 10 days in may and again in december 2013 to collaborate with Alexis Saurin.

Olivier Danvy visited πr^2 and PPS in the fall 2013.

Fernando Ferreira (Univ. of Lisbon) and Ulrich Kohlenbach visited πr^2 , hosted by Jaime Gaspar.

6.4.2. Internships

Participant: Luke Maurer.

Subject: Foundation for lazy languages

Date: from Mar 2013 until Jul 2013

Institution: University of Oregon (United States)

6.4.3. Visits to International Teams

Pierre Boutillier visited MSP group at the university of Strathclyde for a month in March 2013.

Hugo Herbelin visited Thomas Streicher at the University of Darmstadt in May 2013.

Hugo Herbelin visited the Institute of Cybernetics in Tallinn, Estonia in September and October 2013.

Pierre-Louis Curien visited IAS for 3 weeks in March, towards the end of the Special Year on Univalent Foundations. Matthieu Sozeau visited Vladimir Voevodsky at the IAS in Princeton for 15 days in May 2013.

POLSYS Project-Team

8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. ANR

- **ANR Jeunes Chercheurs CAC Computer Algebra and Cryptography (2009-2013).** The contract CAC “Computer Algebra and Cryptography started in October 2009 for a period of 4 years. This project investigates the areas of cryptography and computer algebra, and their influence on the security and integrity of digital data. In CAC, we plan to use basic tools of computer algebra to evaluate the security of cryptographic schemes. CAC will focus on three new challenging applications of algebraic techniques in cryptography; namely block ciphers, hash functions, and factorization with known bits. To this hand, we will use Gröbner bases techniques but also lattice tools. In this proposal, we will explore non-conventional approaches in the algebraic cryptanalysis of these problems (Participants: L. Perret [contact], J.-C. Faugère, G. Renault).
- **ANR Grant (international program) EXACTA (2010-2013): Exact/Certified Algorithms with Algebraic Systems.**
The main objective of this project is to study and compute the solutions of nonlinear algebraic systems and their structures and properties with selected target applications using exact or certified computation. The project consists of one main task of basic research on the design and implementation of fundamental algorithms and four tasks of applied research on computational geometry, algebraic cryptanalysis, global optimization, and algebraic biology. It will last for three years (2010-2013) with 300 person-months of workforce. Its consortium is composed of strong research teams from France and China (KLMM, SKLOIS, and LMIB) in the area of solving algebraic systems with applications.
- **ANR Grant HPAC: High Performance Algebraic Computing (2012-2016).** The pervasive ubiquity of parallel architectures and memory hierarchy has led to a new quest for parallel mathematical algorithms and software capable of exploiting the various levels of parallelism: from hardware acceleration technologies (multi-core and multi-processor system on chip, GPGPU, FPGA) to cluster and global computing platforms. For giving a greater scope to symbolic and algebraic computing, beyond the optimization of the application itself, the effective use of a large number of resources (memory and specialized computing units) is expected to enhance the performance multi-criteria objectives: time, resource usage, reliability, even energy consumption. The design and the implementation of mathematical algorithms with provable, adaptive and sustainable performance is a major challenge. In this context, this project is devoted to fundamental and practical research specifically in exact linear algebra and system solving that are two essential "dwarfs" (or "killer kernels") in scientific and algebraic computing. The project should lead to progress in matrix algorithms and challenge solving in cryptology, and should provide new insights into high performance programming and library design problems (J.-C. Faugère [contact], L. Perret, G. Renault, M. Safey El Din).
- **ANR Grant GeoLMI: Geometry of Linear Matrix Inequalities (2011-2015).** The GeoLMI project aims at developing an algebraic and geometric study of linear matrix inequalities (LMI) for systems control theory. It is an interdisciplinary project at the border between information sciences (systems control), pure mathematics (algebraic geometry) and applied mathematics (optimisation). The project focuses on the geometry of determinantal varieties, on decision problems involving positive polynomials, on computational algorithms for algebraic geometry, on computational algorithms for semi-definite programming, and on applications of algebraic geometry techniques in systems control theory, namely for robust control of linear systems and polynomial optimal control (Participants: J.-C. Faugère, M. Safey El Din [contact], E. Tsigaridas).

8.2. European Initiatives

8.2.1. FP7 Projects

8.2.1.1. A3

Type: PEOPLE

Defi:

Instrument: Career Integration Grant

Objectif: NC

Duration: May 2013 - April 2017

Coordinator: Jean-Charles Faugère

Partner: Institut National de Recherche en Informatique et en Automatique (Inria), France

Inria contact: Elias Tsigaridas

Abstract: The project Algebraic Algorithms and Applications (A3) is an interdisciplinary and multidisciplinary project, with strong international synergy. It consists of four work packages. The first (Algebraic Algorithms) focuses on fundamental problems of computational (real) algebraic geometry: effective zero bounds, that is estimations for the minimum distance of the roots of a polynomial system from zero, algorithms for solving polynomials and polynomial systems, derivation of non-asymptotic bounds for basic algorithms of real algebraic geometry and application of polynomial system solving techniques in optimization. We propose a novel approach that exploits structure and symmetry, combinatorial properties of high dimensional polytopes and tools from mathematical physics. Despite the great potential of the modern tools from algebraic algorithms, their use requires a combined effort to transfer this technology to specific problems. In the second package (Stochastic Games) we aim to derive optimal algorithms for computing the values of stochastic games, using techniques from real algebraic geometry, and to introduce a whole new arsenal of algebraic tools to computational game theory. The third work package (Non-linear Computational Geometry), we focus on exact computations with implicitly defined plane and space curves. These are challenging problems that commonly arise in geometric modeling and computer aided design, but they also have applications in polynomial optimization. The final work package (Efficient Implementations) describes our plans for complete, robust and efficient implementations of algebraic algorithms.

8.3. International Initiatives

8.3.1. Inria Associate Teams

The POLSYS Team and ARIC at ENS Lyon are part of the QOLAPS (Quantifier Elimination, Optimization, Linear Algebra and Polynomial Systems) Associate Team with the Symbolic Computation Group at North Carolina State University. Activities of this associate team are described at the following url:

<http://www-polsys.lip6.fr/QOLAPS/index.html>

8.3.1.1. Informal International Partners

- Crypto team at Royal Holloway, University of London, UK.
- Prof. Victor Y. Pan, Department of Mathematics and Computer Science Lehman College, City University of New York, USA.

8.3.2. Inria International Labs

The POLSYS Team is involved in the ECCA (Exact Certified Computation with Algebraic Systems) at LIAMA in China.

8.4. International Research Visitors

8.4.1. Visits of International Scientists

Prof. K. Yokoyama (Japan) visited the POLSYS team during January 2013.

Prof. C. Yap (Courant Institute, New-York, USA) was an Inria invited professor and visited the POLSYS team during June and July 2013.

Prof. B. Sturmfels (Univ. Berkeley, USA) visited the POLSYS team during July 2013.

Prof. I. Bomze (Univ. of Vienna, Austria) visited the POLSYS team during October 2013.

Prof. J. Gutierrez (Univ. Santander, Spain) visited the POLSYS team during November 2013.

Prof. J. Hauenstein (North Carolina State Univ., USA) visited the POLSYS team during November 2013.

J. Rohal (North Carolina State Univ., USA) visited the POLSYS team during November 2013.

8.4.1.1. Internships

- T. Verron (Internship M2 and ENS Paris): Computation of Gröbner bases for quasi-homogeneous systems.

PRIVATICS Team

7. Partnerships and Cooperations

7.1. Regional Initiatives

7.1.1. *Privamov'*

Title: Privamov'

Type: Labex IMU.

Duration: September 2013 - 2015.

Coordinator: LIRIS.

Others partners: EVS-ITUS, Inria Urbanets.

Abstract: The objective of this project is to provide researchers the IMU community traces of urban mobility allowing further their research and validate their assumptions and models. Indeed , many communities need to know the modes of urban transport : sociologists, philosophers , geographers, planners or computer scientists. If these traces are an important feature for researchers or industrial, they are more for users who have helped to build: attacks jeopardize the privacy of users. Anonymization techniques developed within the project will make available to the greatest number of these traces, while ensuring that the entire process (from collection to data analysis) will be made in respect of the privacy of users involved.

7.1.2. *SCCyPhy*

Title: SCCyPhy

Type: Labex Persyval.

Duration: September 2013 - 2015.

Coordinator: Institut Fourier.

Others partners: Inria MOAIS, Verimag, CEA/LETI, LIG, GIPSA-Lab, TIMA.

Abstract: A main motivation of this action-team is to provide a structure to the Grenoble community in computer security and cryptography in the spirit of the PERSYVAL-lab Labex. Our emphasize, within the PCS workpackage, is around complementary areas of research with high impact for science and technology, with the following target applications: embedded systems (including smartphones and sensors network), at both software and hardware levels, distributed architectures (including "cloud" and "sky"), privacy and protection of information systems against cyberattacks of various origins.

7.2. National Initiatives

7.2.1. *ANR*

7.2.1.1. *BIOPRIV*

Title: Application of privacy by design to biometric access control.

Type: ANR.

Duration: April 2013 - March 2017.

Coordinator: Morpho (France).

Others partners: Morpho (France), Inria (France), Trusted Labs (France).

See also: <http://planete.inrialpes.fr/biopriv/>.

Abstract: The objective of BIOPRIV is the definition of a framework for privacy by design suitable for the use of biometric technologies. The case study of the project is biometric access control. The project will follow a multidisciplinary approach considering the theoretical and technical aspects of privacy by design but also the legal framework for the use of biometrics and the evaluation of the privacy of the solutions.

7.2.1.2. BLOC

Title: Analysis of block ciphers dedicated to constrained environments.

Type: ANR.

Duration: October 2013 - September 2015.

Coordinator: INSA-Lyon (France).

Others partners: CITI Laboratory XLIM Laboratory, University of Limoges, Inria Secret, CryptoExperts (PME).

See also: <http://bloc.project.citi-lab.fr/>.

Abstract: BLOC aims at studying the design and analysis of block ciphers dedicated to constrained environments. The four milestones of BLOC are: security models and proofs, cryptanalysis, design and security arguments and performance analyzes and implementations of lightweight block ciphers. The aims of the project are the following ones: Security models and proofs Cryptanalysis Design C library of lightweight block ciphers We also aim at providing at the end of the project a lightweight block cipher proposal.

7.2.1.3. pFlower

Title: Parallel Flow Recognition with Multi-Core Processor.

Type: ANR.

Duration: March 2011 - September 2014.

Coordinator: LISTIC Université de Savoie.

Others partners: ICT-CAS Insitute of Computing Technology (China), LISTIC Université de Savoie.

Abstract: The main objective of this project is to take advantage of powerful parallelism of multi-thread, multi-core processors, to explore the parallel architecture of pipelined-based flow recognition, parallel signature matching algorithms.

7.2.2. Other

7.2.2.1. MOBILITICS

Title: MOBILITICS

Type: joint project.

Duration: January 2012 - Ongoing.

Coordinator: CNIL.

Others partners: CNIL.

Abstract: Platform for mobile devices privacy evaluation. This project strives to deploy an experimental mobile platform for studying and analyzing the weaknesses of current online (smartphone) applications and operating systems and the privacy implications for end-users. For instance, one of the objectives is to understand trends and patterns collected when they are aimed at obtaining general knowledge that does not pertain to any specific individual. Examples of such tasks include learning of commuting patterns, inference of recommendation rules, and creation of advertising segments.

7.2.2.2. MOBILITICS

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Type: joint project.

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Coordinator: CNIL.

Others partners: CNIL.

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Inria Mobilitics (2011-2012): as a joint national project with CNIL (the French national committee of Information freedom).

Collaborative Action CAPRIS (2011-2014): the Collaborative Action on the Protection of Privacy Rights in the Information Society (CAPRIS), is an Inria national project, which goal is to tackle privacy-related challenges and provide solutions to enhance the privacy protection in the Information Society. His main tasks are the identification of existing and future threats to privacy, and the design of appropriate measures to assess and quantify privacy.

7.3. European Initiatives

7.3.1. FP7 Projects

7.3.1.1. PRIPARE

Title: Preparing industry to privacy-by-design by supporting its application in research.

Type: COOPERATION (ICT).

Instrument: Support Action (SA).

Duration: October 2013 - September 2015.

Coordinator: Trialog (France).

Others partners: American University of Paris (France), Atos (Spain), Fraunhofer SIT (Germany), Galician Research and Development Center in Advanced Telecommunications (Spain), Inria (France), KU Leuven (Belgium), Trialog (France), Trilateral Research (UK), Universidad Politecnica de Madrid (Spain), University of Ulm (Netherlands), Waterford Institute of Technology (UK).

Abstract: the general goal of PRIPARE is to facilitate the application of privacy by design. To this aim, PRIPARE will support the practice of privacy by design by the ICT research community (to prepare for industry practice) and foster risk management culture through educational material targeted to a diversity of stakeholders. The project will specify a privacy by design software and systems engineering methodology combining a multidisciplinary expertise involving legal, engineering and business viewpoints. The project will also provide best practices material and educational material focusing on risk management of privacy for different target audiences (general public, policy makers, users, ICT students and professional). The project will also pave the way for future research by identifying gaps and providing recommendations for a research agenda for privacy by design.

7.3.1.2. PARIS

Title: Privacy preserving infrastructure for surveillance.

Type: COOPERATION (ICT).

Instrument: Specific Targeted Research Project (STREP).

Duration: January 2013 - December 2015.

Coordinator: Trialog (France).

Others partners: AIT (Austria), Inria (France), KU Leuven (Belgium), Trialog (France), Universidad de Malaga (Spain), Université de Namur (Belgium), Thales (France), Visual Tools (Spain).

See also: <http://www.paris-project.org/>.

Abstract: PARIS will define and demonstrate a methodological approach for the development of surveillance infrastructure which enforces the right of citizens for privacy, justice and freedom and takes into account the evolving nature of such rights (e.g. aspects that are acceptable today might not be acceptable in the future), and the social and ethical nature of such rights (e.g. perception of such rights varies). The methodological approach will be based on two pillars, first a theoretical framework for balancing surveillance and data protection which fully integrates the concept of accountability, and secondly an associated process for the design of surveillance systems which takes from the start privacy (i.e. Privacy by Design) and accountability (i.e. Accountability by Design).

7.3.2. Collaborations in European Programs, except FP7

7.3.2.1. FI-WARE

Title: Future Internet Ware.

Type: COOPERATION (ICT).

Defi: PPP FI: Technology Foundation: Future Internet Core Platform.

Instrument: Integrated Project (IP).

Duration: May 2011 - April 2014.

Coordinator: Telefonica. (Spain)

Others partners: SAP (Germany), IBM (Israel, Switzerland), Inria (France), Thales Communications (France), Telecom Italia (Italy), France Telecom (France), Nokia Siemens Networks (Germany, Hungary, Finland), Deutsche Telekom (Germany), Technicolor (France), Ericsson (Sweden), Atos Origin (Spain), Ingeneria Informatica (Italy), Alcatel-Lucent (Italy, Germany), Siemens (Germany), Intel (Ireland), NEC (United Kingdom), Fraunhofer Institute (Germany), University of Madrid (Spain), University of Duisburg (Germany), University of Roma La Sapienza (Italy), University of Surrey (United Kingdom).

See also: <http://www.fi-ware.eu/>.

Abstract: The goal of the FI-WARE project is to advance the global competitiveness of the EU economy by introducing an innovative infrastructure for cost-effective creation and delivery of services, providing high QoS and security guarantees. FI-WARE is designed to meet the demands of key market stakeholders across many different sectors, e.g., healthcare, telecommunications, and environmental services. The project unites major European industrial actors in an unique effort never seen before. The key deliverables of FI-WARE will deliver an open architecture and implementation of a novel service infrastructure, building upon generic and reusable building blocks developed in earlier research projects. This infrastructure will support emerging Future Internet (FI) services in multiple Usage Areas, and will exhibit significant and quantifiable improvements in the productivity, reliability and cost of service development and delivery - building a true foundation for the Future Internet.

7.4. International Initiatives

7.4.1. Inria International Labs

Title: Secure and Private Distributed Data Storage and Publication in the Future Internet

Inria principal investigator: Claude Castelluccia

International Partners (Institution - Laboratory - Researcher):

University of California Berkeley (United States) - Electrical Engineering and Computer Science Department - Edward Lee

University of California Irvine (United States) - Donald Bren School of Information and Computer Sciences - Gene Tsudik

Duration: 2012 - 2014

See also: <http://planete.inrialpes.fr/cloudy-associated-team/>

Cloud computing is a form of computing where general purpose clients (typically equipped with a web browser) are used to access resources and applications managed and stored on a remote server. Cloud applications are increasingly relied upon to provide basic services like e-mail clients, instant messaging and office applications. The customers of cloud applications benefit from outsourcing the management of their computing infrastructure to a third-party cloud provider. However, this places the customers in a situation of blind trust towards the cloud provider. The customer has to assume that the "cloud" always remains confidential, available, fault-tolerant, well managed, properly backed-up and protected from natural accidents as well as intentional attacks. An inherent reason for today's limitations of commercial cloud solutions is that end users cannot verify that servers in the cloud and the network in between are hosting and disseminating tasks and content without deleting, disclosing or modifying any content. This project seeks to develop novel technical solutions to allow customers to verify that cloud providers guarantee the confidentiality, availability and fault-tolerance of the stored data and infrastructure.

7.5. International Research Visitors

7.5.1. Visits to International Teams

Mohamed Ali Kaafar, spending a sabbatical at NICTA Australia in Sydney (since February 2012)

Subject: Online Privacy Enhancing Technologies: measuring the risks and designing countermeasures

PROSECCO Project-Team

8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. ANR

8.1.1.1. ProSe

Title: ProSe: Security protocols : formal model, computational model, and implementations (ANR VERSO 2010.)

Other partners: Inria/Cascade, ENS Cachan-Inria/Secsi, LORIA-Inria/Cassis, Verimag.

Duration: December 2010 - December 2014.

Coordinator: Bruno Blanchet, Inria (France)

Abstract: The goal of the project is to increase the confidence in security protocols, and in order to reach this goal, provide security proofs at three levels: the symbolic level, in which messages are terms; the computational level, in which messages are bitstrings; the implementation level: the program itself.

8.1.2. FUI

8.1.2.1. Pisco

Title: PISCO

Partners: Bull, Cassidian, CEA, CS, Saferiver, Serpikom, Telecom Paristech

Duration: January 2013 - December 2014.

Coordinator: Liliana Calabanti, Bull (France)

Abstract: The goal of the project is to develop a prototype of a new secure appliance based on a virtual machine architecture accessing an HSM. The role of PROSECCO is to contribute to the analysis of security <http://www.systematic-paris-region.org/en/projets/pisco>

8.2. European Initiatives

8.2.1. FP7 Projects

8.2.1.1. CRYSP

Title: CRYSP: A Novel Framework for Collaboratively Building Cryptographically Secure Programs and their Proofs

Type: IDEAS ()

Instrument: ERC Starting Grant (Starting)

Duration: November 2010 - October 2015

Coordinator: Karthikeyan Bhargavan, Inria (France)

Abstract: The goal of this grant is to develop a collaborative specification framework and to build incremental, modular, scalable verification techniques that enable a group of collaborating programmers to build an application and its security proof side-by-side. We propose to validate this framework by developing the first large-scale web application and full-featured cryptographic protocol libraries with formal proofs of security.

8.3. International Initiatives

8.3.1. Inria International Partners

8.3.1.1. Informal International Partners

- K. Bhargavan, A. Pironti, and A. Delignat-Lavaud work closely with Microsoft Research in Cambridge, Redmond, Silicon Valley, and Bangalore (C. Fournet, N. Swamy, M. Abadi, P. Naldurg)
- G. Steel and R. Bardou work closely with University of Venice, Italy (R. Foccardi).
- G. Bana works closely with Keio University Japan
- E-I. Bartzia works closely with IMDEA Madrid (P-Y. Strub)

8.4. International Research Visitors

8.4.1. Visits of International Scientists

- Pierre-Malo Denielou (Lecturer, Royal Holloway, University of London) visited us for two months as professeur invité.
- Sergio Maffeis (Imperial College, London) visited us as part of an ongoing collaboration.
- Cédric Fournet (Researcher, Microsoft Researcher) visited us as part of an ongoing collaboration.

8.4.2. Visits to International Teams

- Alfredo Pironti visited Microsoft Research Cambridge (UK) several times, as part of a long-term collaboration
- Gergely Bana visited Keio University (Japan), ICT Lisbok (Portugal), and Queen Mary University of London in Nov 2013
- Benjamin Smyth visited Toshiba, Japan and Univesity of Birmingham (UK)

SECRET Project-Team**7. Partnerships and Cooperations****7.1. National Initiatives****7.1.1. ANR**

- **ANR SAPHIR-2** (03/09 → 03/13)
Security and Analysis of Primitives of Hashing Innovatory and Recent 2
<http://www.saphir2.fr/>
ANR program: VERSO (Reseaux du Futur et Services)
Partners: France Telecom, Gemalto, Cryptolog international, EADS SN, Sagem Securite, ENS/LIENS, UVSQ/PRISM, Inria (project-team SECRET), ANSSI
153 kEuros
This industrial research project aims at participating to the NIST competition (cryptanalysis, implementations, optimizations, etc.), and in supporting the SHA-3 candidates proposed by its partners.
- **ANR BLOC** (10/11 → 09/15)
Conception et analyse de chiffrements par blocs efficaces pour les environnements contraints
ANR program: Ingénierie numérique et sécurité
Partners: INSA Lyon, Inria (project-team SECRET), University of Limoges (XLIM), CryptoExperts
446 kEuros
The BLOC project aims at providing strong theoretical and practical results in the domain of cryptanalyses and design of block ciphers.
- **ANR KISS** (12/11 → 12/15)
Keep your personal Information Safe and Secure
ANR program: Ingénierie numérique et sécurité
Partners: Inria (project-teams SMIS and SECRET), LIRIS, Gemalto, UVSQ (Prism), Conseil Général des Yvelines
64 kEuros
The KISS project builds upon the emergence of new portable and secure devices known as Secure Portable Tokens (e.g., mass storage SIM cards, secure USB sticks, smart sensors) combining the security of smart cards and the storage capacity of NAND Flash chips. The idea promoted in KISS is to embed, in such devices, software components capable of acquiring, storing and managing securely personal data.
- **ANR CLE** (10/13 → 10/17)
Cryptography from learning with errors
ANR program: Jeunes Chercheurs, SIMI2
Coordinator: Vadim Lyubashevsky (Inria, EPI Cascade)
The aim of this project is to combine algorithmic and algebraic techniques coming from asymmetric and symmetric cryptology in order to improve some attacks and to design some symmetric primitives which have a good resistance to side-channel attacks.

7.1.2. Others

- **French Ministry of Defense** (01/11 → 12/13)
Funding for the supervision of Marion Bellard's PhD.
30 kEuros.
- **French Ministry of Defense** (10/12 → 09/15)
Funding for the supervision of Audrey Tixier's PhD.
30 kEuros.

- **DGA-MI** (12/11 → 02/13)
Analysis of binary streams.
20 kEuros.
- **PEPS IQC 2013** (04/13 → 03/14)
Topology and quantum codes
coordinated by G. Zémor, Institut de Mathématiques de Bordeaux.
<http://www.cnrs.fr/mi/spip.php?article301>
- **PEPS IQC 2013** (04/13 → 03/14)
Quantum Cryptography and distributed computing
coordinated by Frédéric Grosshans, Laboratoire Aimé Cotton.
<http://www.cnrs.fr/mi/spip.php?article301>

7.2. European Initiatives

7.2.1. Collaborations in European Programs, except FP7

Program: COST

Project acronym: ICT COST Action IC1306

Project title: Cryptography for Secure Digital Interaction

Duration: January 2014 - November 2017

Coordinator: Claudio Orlandi, Aarhus University, Denmark

Other partners: see http://www.cost.eu/domains_actions/ict/Actions/IC1306

Abstract: The aim of this COST action is to stimulate interaction between the different national efforts in order to develop new cryptographic solutions and to evaluate the security of deployed algorithms with applications to the secure digital interactions between citizens, companies and governments.

7.3. International Initiatives

7.3.1. Inria International Partners

7.3.1.1. Informal International Partners

- Otto-von-Guericke Universität Magdeburg, Institut für Algebra und Geometrie (Germany):
Study of Boolean functions for cryptographic applications
- DTU - Danmarks Tekniske Universitet, Department of Mathematics:
Lightweight symmetric cryptography and code-based cryptography
- Indian Statistical Institute, Kolkata, India:
Symmetric cryptography

7.4. International Research Visitors

7.4.1. Visits of International Scientists

- Grigory Kabatianskiy, Institute for Problems of Information Transmission, Moscow, Russia, November 23-30
- Paulo Barreto, University of Sao Paulo, Brazil, November 22-30
- Dimitrios Simos, SBA Research, Vienna, Austria, June 30-July 6
- Bimal Roy, Indian Statistical Institute, Kolkata, India, June 15-23

7.4.2. Visits to International Teams

- University of Sherbrooke, Canada, July 14-21 (J.P. Tillich)
- Newton Institute for Mathematical Sciences, Cambridge, United Kingdom, November 6-8, invitation to the *Mathematical Challenges in Quantum Information* Program, (A. Leverrier)
- CWI, Amsterdam, Netherlands, November 26-27, collaboration with Christian Schaffner, (A. Leverrier)
- FHNW, Windisch, Switzerland, May 27-31, visiting Willi Meier (M. Naya-Plasencia)

SECSI Project-Team

7. Partnerships and Cooperations

7.1. National Initiatives

7.1.1. ANR

- ANR programme blanc CPP (“Confidence, Probability, and Proofs”), 2009-April 2013. Partners: LSV (scientific leader), CEA LIST (co-leader), Inria (Comète, Parsifal), Ecole Supérieure d’Electricité (L2S, SSE). External partners: Safran, Dassault Systèmes.

In the context of proofs of safety properties for critical software, The CPP project proposes to study the joint use of probabilistic and formal (deterministic) semantics and analysis methods, in a way to improve the applicability and precision of static analysis methods on numerical programs. See <http://www.lix.polytechnique.fr/~bouissou/cpp/index.php>.

- ANR VERSO program ProSe (“Proofs of Security”), 2010-2014. Partners: Inria (Cascade, leader; Cassis), LSV, Verimag.

The goal of the ProSe project is to increase the confidence in security protocols, and in order to reach this goal, provide security proofs at three levels: the *symbolic* level, in which messages are terms; the *computational* level, in which messages are bitstrings; and the *implementation* level: the program itself. This project is a continuation of the FormaCrypt project. See <https://crypto.di.ens.fr/projects:prose:main>.

- ANR JCJC project VIP, 2012-2015. Awarded to Stéphanie Delaune.

The aim of this project is to formally analyze modern applications in which privacy plays an important role. Many applications having an important societal impact are concerned by privacy, e.g. electronic voting, electronic auction protocols, RFID tags, safety critical application in vehicular ad hoc networks, routing protocols in mobile ad hoc networks, etc. Moreover, each application comes with its own specificities. E.g. e-voting protocols often rely on complex cryptographic primitives, some routing protocols rely on recursive tests, and so on. In mobile ad hoc networks, taking into account mobility issues is also an important challenge.

Because security protocols are notoriously difficult to design and analyse, formal verification techniques are extremely important. However, nearly all studies focus on trace-based security properties, and thus to not allow one to analyse privacy-type properties that play an important role in many modern applications. Moreover, the envisioned applications have some specificities that prevent them to be modelled in an accurate way with existing verification tools.

The goal of this project is to design verification algorithms to analyse privacy-type properties on several applications having an important societal impact. The project is accompanied by an effort in case studies and application domains which will allow at the end of the project an assessment of the pragmatic potential both in terms of modelling and effective analysis. More details are available on the web page of the project: <http://www.lsv.ens-cachan.fr/Projects/anr-vip/>.

- Inria-DGA contract, on evaluation of the Orchids tool. This is a 3-year contract, starting in April 2013, on the evaluation and improvement of the Orchids intrusion detection tool. The actual contents of the contract is not public.

7.2. International Initiatives

7.2.1. Inria International Partners

7.2.1.1. Informal International Partners

- Mark D. Ryan, U. Birmingham
- Alwen Tiu, Australian National University
- Achim Jung, U. Birmingham
- Frédéric Mynard, Georgia Southern University
- Roberto Segala, U. Verona
- Dominique Unruh, U. Tallinn

7.2.2. Participation In other International Programs

- Inria Project Lab CAPPRIS (Collaborative Action on the Protection of Privacy Rights in the Information Society). Member: Stéphanie Delaune.

The goal of CAPPRIS is to provide solutions to enhance the privacy protection in the Information Society. The targeted applications are Online Social Networks, Location Based Services, and Electronic Health Record Systems.

7.3. International Research Visitors

7.3.1. Visits of International Scientists

- Dominique Unruh, Tallinn, 1 month, January 2013.
- Mark Ryan, Birmingham, 2 weeks, July 2013.
- Achim Jung, Birmingham, 1 month, April-May 2013.

7.3.1.1. Internships

Stéphanie Delaune et David Baelde co-supervised the following master student:

- Lucca Hirschi, ENS Lyon, “Réduction d’ordre partiel pour les propriétés d’équivalence”, 2013.

Jean Goubault-Larrecq supervised the following L2 student:

- Jean-Philippe Lachance, U. Laval, Québec, “Evaluation automatique de la complexité de détection des signatures Orchids”, 2013.

SPADES Team

8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. ANR Projects

8.1.1.1. PiCoq (ANR project)

Participants: Barbara Petit, Jean-Bernard Stefani.

The goal of the PiCoq project is to develop an environment for the formal verification of properties of distributed, component-based programs. The project's approach lies at the interface between two research areas: concurrency theory and proof assistants. Achieving this goal relies on three scientific advances, which the project intends to address:

- Finding mathematical frameworks that ease modular reasoning about concurrent and distributed systems: due to their large size and complex interactions, distributed systems cannot be analysed in a global way. They have to be decomposed into modular components, whose individual behaviour can be understood.
- Improving existing proof techniques for distributed/modular systems: while behavioural theories of first-order concurrent languages are well understood, this is not the case for higher-order ones. We also need to generalise well-known modular techniques that have been developed for first-order languages to facilitate formalisation in a proof assistant, where source code redundancies should be avoided.
- Defining core calculi that both reflect concrete practice in distributed component programming and enjoy nice properties *w.r.t.* behavioural equivalences.

The project partners include Inria (CELIQUE and SPADES teams), LIP (PLUME team), and Université de Savoie. The project runs from November 2010 to October 2014.

8.1.1.2. REVER (ANR project)

Participants: Barbara Petit, Jean-Bernard Stefani.

The REVER project aims to develop semantically well-founded and composable abstractions for dependable distributed computing on the basis of a reversible programming model, where reversibility means the ability to undo any program execution and to revert it to a state consistent with the past execution. The critical assumption behind REVER is that by combining reversibility with notions of compensation and modularity, one can develop systematic and composable abstractions for dependable programming.

The REVER work program is articulated around three major objectives:

- To investigate the semantics of reversible concurrent processes.
- To study the combination of reversibility with notions of compensation, isolation and modularity in a concurrent and distributed setting.
- To investigate how to support these features in a practical (typically, object-oriented and functional) programming language design.

The project partners are Inria (FOCUS and SPADES teams), Université de Paris VII (PPS laboratory), and CEA (List laboratory). The project runs from December 2011 to November 2015.

8.2. International Initiatives

8.2.1. Inria Associate Teams

8.2.1.1. RIPPES

Title: RIGorous Programming of Predictable Embedded Systems

Inria principal investigator: Alain Girault

International Partner (Institution - Laboratory - Researcher):

University of California Berkeley (USA) – EECS Department, PTOLEMY group – Prof. Edward Lee.

University of Auckland (New Zealand) – ECE Department – Prof. Partha Roop.

Duration: January 2013 – December 2015

See also: https://wiki.inria.fr/rippes/Main_Page

The RIPPES associated team gathers the SPADES team from Inria Grenoble, the Ptolemy group from UC Berkeley (EECS Department), and the Embedded Systems Research group from U. of Auckland (ECE Department). The planned research seeks to reconcile two contradictory objectives of embedded systems, more predictability and more adaptivity. We propose to address these issues by exploring two complementary research directions: (1) by starting from a classical concurrent C or Java programming language and enhancing it to provide more predictability, and (2) by starting from a very predictable model of computation (SDF) and enhancing it to provide more adaptivity.

8.3. International Research Visitors

8.3.1. Visits of International Scientists

- January and February 2013: Ismail Assayad (Ass. Prof. U. Casablanca) visited Inria Grenoble to work on multi-criteria optimisation and scheduling for embedded system.
- March 2013: Eugene Yip (PhD student, U. Auckland) visited Inria Grenoble to work on the semantics of the FOREC PRET programming language (RIPPES associated team).
- March 2013: Hokeun Kim (PhD student, UC Berkeley) visited Inria Grenoble to work on the RIPPES associated team.
- March 2013: Partha Roop (Senior Lecturer, U. Auckland) visited Inria Grenoble to work on the FOREC PRET programming language (RIPPES associated team).
- July 2013: Eugene Yip (PhD student, U. Auckland) visited Inria Grenoble to work on the semantics of the FOREC PRET programming language (RIPPES associated team).
- July 2013: Matthew Kuo (PhD student, U. Auckland) visited Inria Grenoble to work on tickpad memories for PRET programs (RIPPES associated team).
- December 2013: Chris Shaver (PhD student, UC Berkeley) visited Inria Grenoble to work on parametric data-flow models of computation (RIPPES associated team).

8.3.2. Visits to International Teams

- Vagelis Bebelis visited the University of California Berkeley (USA) in October 2013 to work on a parametric dataflow models of computation and on its implementation within the Ptolemy II framework.

8.3.3. Inria International Partners

8.3.3.1. Informal International Partners

We have a long lasting informal collaboration with Prof. Ivan Lanese (U. Bologna, Italy) on component programming and reversability. He visits the team regularly.

We have a long lasting informal collaboration with Prof. Ismail Assayad (U. Casablanca, Morocco) and Prof. Hamoudi Kalla (U. Batna, Algeria) on fault-tolerant embedded systems, multi-criteria optimization, reliability, and power consumption. They both visit the team regularly.

Specfun Team

8. Partnerships and Cooperations

8.1. Regional Initiatives

- Project *Coquelicot*, funded jointly by the Fondation de Coopération Scientifique “Campus Paris-Saclay” and Digiteo.
Goal: Create a new Coq library for real numbers of mathematics.
Leader: S. Boldo (INRIA Saclay, Toccata). Participant: A. Mahboubi.
Website: <http://coquelicot.saclay.inria.fr/>.

8.2. National Initiatives

8.2.1. ANR

- *Psi* (ANR-09-JCJC-0006).
Duration: 2009-2013. Goal: Proof-Search control in Interaction with domain-specific methods.
Coordinator: Stéphane Lengrand (CNRS, LIX).
Participant: A. Mahboubi.
Website: <http://www.lix.polytechnique.fr/~lengrand/PSI/>.
- *ParallITP* (ANR-11-INSE-001).
Goal: Improve the performances and the ergonomics of interactive provers by taking advantage of modern, parallel hardware.
Leader: B. Wolff (University of Orsay, Paris XI). Participants: A. Mahboubi, E. Tassi.

8.2.2. Other

- PEPS Grant *Holonomix*.
Goal: Asymptotics of special functions arising in physics, computer science, and number theory.
Leader: Cyril Banderier (CNRS, LIPN). Participant: A. Bostan, F. Chyzak.
Website: <http://www.cnrs.fr/ins2i/spip.php?article143>.

8.3. European Initiatives

8.3.1. FP7 Projects

- *Formalisation of Mathematics (ForMath)*, EU FP7 STREP FET-open project).
Partners: University of Gothenburg (Sweden); Radboud University Nijmegen (The Netherlands); Inria (France); Universidad de La Rioja (Spain).
Goal: Investigate how recent advances in the methodology and design of computer-checked libraries of formalized mathematics apply to so-far-unexplored areas of mathematics, like real analysis or certified efficient computations.
Leader: Th. Coquand (University of Gothenburg, Sweden). Participant: A. Mahboubi (work package leader for WP1).
Website: <http://wiki.portal.chalmers.se/cse/pmwiki.php/ForMath/ForMath>.

SUMO Team

8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. ANR

ANR VACSIM: Validation of critical control-command systems by coupling simulation and formal analysis, 2011-2014, [web site](#)

Partners: EDF R&D, Dassault Systèmes, LURPA, I3S, LaBRI, and Inria SUMO.

The project aims at developing both methodological and formal contributions for the simulation and validation of control-command systems. SUMO contributes to quantitative analysis and its application to testing, monitoring of timed systems, and verification of communicating timed automata.

ANR Ctrl-Green: Autonomic management of green data centers, 2011-2014

Partners: UJF/LIG, INPT/IRIT, Inria SUMO, EOLAS, Scalagent.

This project aims at developing techniques for the automatic optimal management of reconfigurable systems in the context of data centers using discrete controller synthesis methodology applied in the synchronous paradigm.

ANR ImpRo: Implementability and Robustness of Timed Systems, 2010-2014, [web site](#)

Partners: IRCCyN, LIP6, LSV, LIAFA, LIF, and Inria SUMO.

This project addresses the issues related to the practical implementation of formal models for the design of communicating embedded systems: such models abstract many complex features or limitations of the execution environment. The modeling of time, in particular, is usually ideal, with infinitely precise clocks, instantaneous tests or mode commutations, etc. Our objective is thus to study to what extent the practical implementation of these models preserves good properties that are satisfied by idealized models. Within IMPRO, members of SUMO mainly focus on robustness issues for timed models (timed automata, timed Petri nets,...), and diagnosis.

ANR STOCH-MC: Model-Checking of Stochastic Systems using approximated algorithms, 2014-2018.

Led by SUMO.

Partners: Inria Project Team CONTRAINTES (Rocquencourt), LaBRI (Bordeaux), and LIAFA (Paris).

The aim of STOCH-MC is to perform model-checking of large stochastic systems, using controlled approximations. Two formalisms will be considered: Dynamic Bayesian Networks, which represent compactly large Markov Chains; and Markov Decision Processes, allowing non deterministic choices on top of probabilities.

8.1.2. National informal collaborations

We collaborate with Yliès Falcone (VaSCO - LIG) on the enforcement of timed properties and Tristan Le Gall (CEA) on the control of distributed systems.

We collaborate with Arnaud Sangnier (LIAFA) on the parameterized verification of probabilistic systems.

8.2. European Initiatives

8.2.1. FP7 Projects

Participant: Éric Fabre.

Universef is a FP7 IP, with 19 partners, among which Alcatel-Lucent, Orange Labs, Thales Communications, Telefonica, Telecom Italia as industrial partners. It lasted from Sept. 2010 to Nov. 2013. See also <http://www.universef-project.eu/> Universef aimed at developing self-management methods for telecommunication networks, regardless of technological boundaries (wireless, wireline, services) and at providing tools for their integrability and acceptability. The focus was first on the development of network empowerment methods (NEM), that address specific needs in automating management functions, for example power tuning in SONs (Self-Organizing Networks), network and/or service diagnosis, vulnerability detection and correction, knowledge acquisition and elaboration, optimal resource usage and allocation, etc. A second set of results was on a methodology to deploy and coordinate such NEMs, through a Universal Management Framework (UMF).

8.3. International Initiatives

8.3.1. Inria Associate Teams

DISTOL ([web site](#)) is a joint project between the SUMO Team at Inria Rennes, the LogicA team at IRISA Rennes, the Chennai Mathematical Institute, the Institute of Mathematical Sciences at Chennai and the National University of Singapore.

The DISTOL project (Distributed systems, stochastic models and logics) aims at gathering researchers from Inria Rennes, two institutes in Chennai, India (CMI and IMSC) and National University of Singapore, working on formal modeling and verification of distributed systems. This project covers four main research directions. Each of these directions rely on specific and complementary competences:

- Robustness and time issues in distributed systems models (Members of SUMO consider this problem with the Chennai Mathematical Institute)
- Applications of formal models & techniques to Web Services (Members of SUMO consider this problem with the Chennai Mathematical Institute)
- Quantitative verification for distributed systems (Members of SUMO consider this problem with researchers at NUS)
- Unification of Control Theory of Distributed Systems (This part is mainly addressed by the LOGICA team in collaboration with the Institute of Mathematical Sciences)

8.3.2. Inria International Partners

8.3.2.1. Declared Inria International Partners

Éric Badouelis member of the team ALOCO (Architecture logicielle à Composants) of LIRIMA lab (Laboratoire international de recherche en informatique et mathématiques appliquées). LIRIMA is an african lab with headquarters in Yaoundé (Cameroun) partially funded by Inria. Within the team ALOCO, Éric collaborates on artifact-centric business process models.

8.3.2.2. Informal International Partners

We collaborate with Thomas Brihaye (UMONS, Brihaye) on the verification of stochastic timed systems.

We collaborated with Laurie Ricker (Mount Allison University, Canada) and Thierry Massart (ULB,Belgium) on the control of distributed systems.

8.3.3. Participation in other International Programs

Several researchers of the SUMO team are members of the LIA Informel. The Indo-French Formal Methods Lab is a CNRS International Associated Laboratory fostering the scientific collaboration between India and France in the domain of formal methods and applications to the verification of complex systems.

The research within LIA Informel focuses on theoretical foundations of games, automata, and logics, three important tools in formal methods. Members of Informel work on the verification of safety-critical systems, with an emphasis on quantitative aspects (time, cost, energy, etc.), concurrency, control, and security protocols.

8.4. International Research Visitors

8.4.1. Visits of International Scientists

S. Akshay from IIT Bombay visited the SUMO team one week in autumn.

Luca Bernardinello, professor at the University of Milano Bicocca (Italy).

Thomas Brihaye, professor at Mons University (Belgium), spent one month in SUMO team as ISTIC (University Rennes 1) invited professor.

Georges-Edouard Kouamou, junior professor at ENSP Yaoundé (Cameroun).

Madhavan Mukund, from the Chennai Mathematical Institute, visited SUMO in May 2013 and was part of Loïc Hélouët's habilitation jury. He also stayed one week in autumn.

Laurie Ricker (Mount Allison University) visited us during for 2 weeks in March 2013.

8.4.1.1. Internships

Shibashis Guha, PhD student at IIT Delhi, spent two months in SUMO team, supervised by Nathalie Bertrand.

Baptiste Lefebvre (L3 student, ENS Ulm), was an intern from June to Aug. 2013, on the experimental evaluation of an enhanced graceful shutdown method for the OSPF routing protocol, supervised by Éric Fabre.

Raphael Struk (L3 student, ENS Rennes), did an internship supervised by Blaise Genest and Loïc Hélouët.

TASC Project-Team

8. Partnerships and Cooperations

8.1. Regional Initiatives

- AGIRA project (LigéRO) *Teaching optimization project.*

8.2. National Initiatives

- Development of **IBEX** with **Jordan Ninin** and **Luc Jaulin** from **ENSTA Bretagne**, **Bertrand Neveu** from **ENPC PariTech**, and **Gilles Trombettoni** from **Lirmm**.
- Work on a conference and journal paper on optimization problems with **Mohamed Siala**, PhD student at **LAAS**, Toulouse.
- Collaboration with **F. Pachet** and **P. Roy**, **Sony music**, Paris.

8.3. International Initiatives

8.3.1. Inria Associate Teams

Inria Associated Team Bananas

- Partners: Inria-Lorraine, PUCV (Chili), UTFSM (Chili), Univ. Angers (LERIA), Univ. Nantes (TASC).
- Duration: 2012-2014.
- Topics: Autonomous constraint solving, SMT solvers.
- Budget: 15 KEuros per year for the project.

8.3.2. Inria International Partners

8.3.2.1. Informal International Partners

- **SICS**, Sweden: Work on the *global constraint catalog* and on *scalable constraints* with **Mats Carlsson**.
- **Uppsala University**, Sweden: Work on automata and dedicated filtering algorithms for some constraint patterns with the **ASTRA** group of **Pierre Flener**.
- **JFLI**, Japan: Work with **Philippe Codognet**.

8.4. International Research Visitors

8.4.1. Visits of International Scientists

Helmut Simonis (4C): work on model learning and work on learning constraints in the context of EDF, three months.

8.4.2. Visits to International Teams

- **N. Beldiceanu**, 4C Cork Ireland: work on *learning generic models* and work on *learning constraints in the context of EDF* with **H. Simonis**.
- **N. Beldiceanu**, **Uppsala University** and **SICS**: work on *automata and constraints* with **P. Flener** and **J. Pearson** and on *learning generic models* with **M. Carlsson**.
- **Eric Monfroy**, Univ. Austral de Chile, Valparaiso, Chile: work on autonomous search with **B. Crawford** and **R. Soto**.

TOCCATA Team

8. Partnerships and Cooperations

8.1. Regional Initiatives

8.1.1. *Coquelicot*

Participants: Sylvie Boldo [contact], Catherine Lelay, Guillaume Melquiond.

Coquelicot is a 3 years Digiteo project that started in September 2011. <http://coquelicot.saclay.inria.fr>. S. Boldo is the principal investigator of this project.

The Coquelicot project aims at creating a modern formalization of the real numbers in *Coq*, with a focus on practicality [100], [68][35], [45]. This is sorely needed to ease the verification of numerical applications, especially those involving advanced mathematics.

Partners: LIX (Palaiseau), University Paris 13

8.2. National Initiatives

8.2.1. *ANR BWare*

Participants: Sylvain Conchon, Évelyne Contejean, Jean-Christophe Filliâtre, Andrei Paskevich, Claude Marché.

This is a research project funded by the programme “Ingénierie Numérique & Sécurité” of the ANR. It is funded for a period of 4 years and started on September 1, 2012. <http://bware.lri.fr>.

It is an industrial research project that aims to provide a mechanized framework to support the automated verification of proof obligations coming from the development of industrial applications using the B method and requiring high guarantees of confidence. The methodology used in this project consists in building a generic platform of verification relying on different theorem provers, such as first-order provers and SMT solvers. The variety of these theorem provers aims at allowing a wide panel of proof obligations to be automatically verified by the platform. The major part of the verification tools used in BWare have already been involved in some experiments, which have consisted in verifying proof obligations or proof rules coming from industrial applications [107]. This therefore should be a driving factor to reduce the risks of the project, which can then focus on the design of several extensions of the verification tools to deal with a larger amount of proof obligations.

The partners are: Cedric laboratory at CNAM (CPR Team, project leader); Inria teams Gallium, Deducteam and Asap; Mitsubishi Electric R&D Centre Europe, the ClearSy company that develops and maintains *Atelier B* and the OCamlPro start-up.

8.2.2. *ANR Verasco*

Participants: Guillaume Melquiond [contact], Sylvie Boldo, Arthur Charguéraud, Claude Marché.

This is a research project funded by the programme “Ingénierie Numérique & Sécurité” of the ANR. It is funded for a period of 4 years and started on January 1st, 2012. <http://verasco.imag.fr>

The main goal of the project is to investigate the formal verification of static analyzers and of compilers, two families of tools that play a crucial role in the development and validation of critical embedded software. More precisely, the project aims at developing a generic static analyzer based on abstract interpretation for the C language, along with a number of advanced abstract domains and domain combination operators, and prove the soundness of this analyzer using the *Coq* proof assistant. Likewise, it will keep working on the CompCert C formally-verified compiler, the first realistic C compiler that has been mechanically proved to be free of miscompilation, and carry it to the point where it could be used in the critical software industry.

Partners: teams Gallium and Abstraction (Inria Paris-Rocquencourt), Airbus avionics and simulation (Toulouse), IRISA (Rennes), Verimag (Grenoble).

8.2.3. Systematic: Hi-Lite

Participants: Claude Marché [contact], Jean-Christophe Filliâtre, Sylvain Conchon, Évelyne Contejean, Andrei Paskevich, Alain Mebsout, Mohamed Iguernelala, Denis Cousineau.

The Hi-Lite project (<http://www.open-do.org/projects/hi-lite/>) is a project in the SYSTEMATIC Paris Region French cluster in complex systems design and management <http://www.systematic-paris-region.org>.

Hi-Lite is a project aiming at popularizing formal methods for the development of high-integrity software. It targets ease of adoption through a loose integration of formal proofs with testing and static analysis, that allows combining techniques around a common expression of specifications. Its technical focus is on modularity, that allows a divide-and-conquer approach to large software systems, as well as an early adoption by all programmers in the software life cycle.

Our involvements in that project include the use of the Alt-Ergo prover as back-end to already existing tools for SPARK/ADA, and the design of a verification chain for an extended SPARK/ADA language to verification conditions, via the Why3 VC generator.

The results of that project are the basis of SPARK2014, the next generation of the SPARK.

This project was funded by the French Ministry of industry (FUI), the Île-de-France region and the Essonne general council for 36 months from September 2010.

8.3. European Initiatives

8.3.1. FP7 Projects

Project acronym: ERC Deepsea

Project title: Parallel dynamic computations

Duration: Jun. 2013 - Jun. 2018

Coordinator: Umut A. Acar

Other partners: Carnegie Mellon University

Abstract:

The objective of this project is to develop abstractions, algorithms and languages for parallelism and dynamic parallelism with applications to problems on large data sets. Umut A. Acar (affiliated to Carnegie Mellon University and Inria) is the principal investigator of this ERC-funded project. The other researchers involved are Mike Rainey (Inria, Gallium team), who is full-time on the project, and Arthur Charguéraud (Inria, Toccata team), who works 40% of his time to the project. Project website: <http://deepsea.inria.fr/>.

8.3.2. Collaborations in European Programs, except FP7

Project acronym: JsCert

Project title: Certified JavaScript

Duration: Oct. 2011 - ...

Other partners: Imperial College and Inria Rennes – Bretagne Atlantique (Celtique project).

Abstract: This project aims at providing a formal semantics to the JavaScript language. It is joint work with Philippa Gardner, Sergio Maffeis, Gareth Smith, Daniele Filaretti and Daiva Naudziuniene from Imperial College, Alan Schmitt and Martin Bodin from Inria Rennes – Bretagne Atlantique, and Arthur Charguéraud from Inria Saclay –Île-de-France. Project website: <http://jscert.org>.

8.4. International Initiatives

8.4.1. Inria International Partners

8.4.1.1. Informal International Partners

- S. Conchon, A. Mebsout and F. Zaidi (VALS group, LRI) collaborate with S. Krstic and A. Goel (Intel Strategic Cad Labs in Hillsboro, OR, USA), in particular around the development of the SMT-based model checker Cubicle (see above). This collaboration is partly supported by an academic grant by Intel.

8.4.2. Participation In other International Programs

- C. Paulin is the representative of Univ. Paris-Sud for the education part of the EIT KIC ICT Labs. She contributed to the proposition of two master programs as well as the action on weaving Innovation and Entrepreneurship in Doctoral programs and the preparation of the Summer School “Imagine the future in ICT”.

TRIO Team

7. Partnerships and Cooperations

7.1. National Initiatives

7.1.1. BGLE DEPARTS

Participants: Liliana Cucu-Grosjean, Adriana Gogonel, Codé Lo, Cristian Maxim.

The project DEPARTS started on October 1st, 2012, but for administrative reasons the kick-off meeting was only on April, 2013. This project is funded by the national funding program BGLE. TRIO team proposes solutions for probabilistic component-based models and a PhD thesis will start early 2014. Such solution allows designers to unify in the same framework probabilistic scheduling techniques and compositional guarantees that have different levels of criticality. The schedulability analysis presented in [12], [6] are the bases of our future contributions.

7.2. European Initiatives

7.2.1. FP7 Projects

7.2.1.1. PROARTIS

Type: COOPERATION
Defi: Embedded Systems Design
Instrument: Specific Targeted Research Project
Objectif: Embedded Systems Design
Duration: February 2010 - July 2013
Coordinator: Barcelona Supercomputing Center (Spain)
Inria contact: L. Cucu-Grosjean

Participants: Liliana Cucu-Grosjean, Adriana Gogonel, Codé Lo, Dorin Maxim and Cristian Maxim.

TRIO team participates to PROARTIS which is a STREP project within the FP7 call and it started on February 2010. It has six partners: Barcelona Supercomputing, University of York, University of Padova, Inria and Airbus. The overarching objective of the PROARTIS project is to facilitate a probabilistic approach to timing analysis. The PROARTIS approach concentrates on proving that pathological timing cases can only arise with negligible probability, instead of struggling to eradicate them, which is arguably not possible and could severely degrade performance. This is a major turn from previous approaches that seek analyzability by predicting with cycle accuracy the state of hardware and software through analysis.

The PROARTIS project facilitates the production of analysable CRTE systems on advanced hardware platforms with features such as memory hierarchies and multi core processors.

This project ended July 2013.

7.2.1.2. PROXIMA

Type: COOPERATION
Defi: Mixed-Criticality Systems
Instrument: Integrated Project
Objectif: Development of probabilistic approaches for mixed-criticality systems on multi-core and many-core platforms
Duration: October 2013 - September 2016
Coordinator: Barcelona Supercomputing Center (Spain)
Inria contact: Liliana Cucu-Grosjean

Participants: Liliana Cucu-Grosjean, Adriana Gogonel, Codé Lo, Dorin Maxim and Cristian Maxim.

PROXIMA project started on October 1st, 2013 with a kick-off meeting in November 2013.

The PROXIMA hypothesis is that probabilistic analysis techniques can provide efficient (tractable) and effective (tight) analysis of the temporal behaviour of complex mixed-criticality applications on novel multicore and manycore platforms. Solid research results from the FP7 STREP PROARTIS project underpin this claim. The concept is based on using probabilistic analysis techniques to derive safe and tight bounds on the temporal behaviour of applications, reflecting requirements on failure rates commensurate with their criticality. PROXIMA defines architectural paradigms that break the causal dependence in the timing behaviour of execution components at hardware and software level that can give rise to pathological cases, and reduces that risk to quantifiable small levels. Only modest changes will be needed to this end in the hardware and software components beneath the application (processing cores, interconnects, memory hierarchies and controllers, real-time operating system, middleware, compilers).

7.2.2. Collaborations in European Programs, except FP7

7.2.2.1. European Network of Excellence (NOE) High Performance Embedded Architectures and Compilation (HiPEAC)

Participant: Olivier Zendra.

The TRIO team is involved in the HiPEAC 3 (High Performance Embedded Architecture and Compilation) European Network of Excellence (NoE). Olivier Zendra was initiator and leader in this context of a cluster of European Researchers "Architecture-aware compiler solutions for energy issues in embedded systems" from mid-2007 to mid-2009. A STREP proposal tentatively titled "RuSH2LEAP: Runtime Software-Hardware interactions to Lower Energy And Power" was written at the beginning of 2013, mostly in the context of this network of excellence, for submission in Call ICT 2013.10, challenge 3.4 Advanced computing, embedded and control systems. The proposal passed all thresholds, but failed to be funded.

7.3. International Research Visitors

7.3.1. Visits of International Scientists

Rob Davis (University of York) has continued to visit TRIO within the UK Seedcorn Grant that covers his visits in Nancy. This collaboration allowed to successfully apply for a FP7 IP project as well as an Inria International Chair that will start in 2014 within AOSTE (team that Liliana Cucu-Grosjean, Adriana Gogonel, Codé Lo and Cristian Maxim had joined before the end of 2013).

VEGAS Project-Team

6. Partnerships and Cooperations

6.1. National Initiatives

6.1.1. ANR PRESAGE

The white ANR grant PRESAGE brings together computational geometers (from the VEGAS and GEOMETRICA projects of Inria) and probabilistic geometers (from Universities of Rouen, Orléans and Poitiers) to tackle new probabilistic geometry problems arising from the design and analysis of geometric algorithms and data structures. We focus on properties of discrete structures induced by or underlying random continuous geometric objects.

This is a four year project, with a total budget of 400k€, that started on Dec. 31st, 2011. It is coordinated by Xavier Goaoc (VEGAS).

6.1.2. ANR SingCAST

The objective of the young-researcher ANR grant SingCAST is to intertwine further symbolic/numeric approaches to compute efficiently solution sets of polynomial systems with topological and geometrical guarantees in singular cases. We focus on two applications: the visualization of algebraic curves and surfaces and the mechanical design of robots.

After identifying classes of problems with restricted types of singularities, we plan to develop dedicated symbolic-numerical methods that take advantage of the structure of the associated polynomial systems that cannot be handled by purely symbolical or numerical methods. Thus we plan to extend the class of manipulators that can be analyzed, and the class of algebraic curves and surfaces that can be visualized with certification.

This is a 3.5 years project, with a total budget of 100k€, that will start on March 1st 2014, coordinated by Guillaume Moroz.

6.2. International Research Visitors

Nuno Gonçalves, University of Coimbra (Portugal), visited the VEGAS project for 1 week in January.

William J. Lenhart, Williams College (USA), visited the VEGAS project for 2 weeks in May..

6.2.1. Internships

Ioannis Psarros

Subject: Common tangents to ellipsoids in \mathbb{R}^3 .

Date: from Apr. 2013 until July 2013.

Institution: University of Athens, Greece.

Oswald Hounkounou

Subject: Study with computer algebra system of a conjecture relating the width of a convex polygon with the width of its inscribed triangles.

Date: from Apr. 2013 until Aug. 2013.

Institution: Telecom Nancy de l'université de Lorraine.

Judit Recknagel

Subject: Topology of planar singular curves resultant of two trivariate polynomials.

Date: from Apr. 2013 until Aug. 2013

Institution: Halle-Wittenberg university, Germany.

VERIDIS Project-Team

8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. Inria Development Action VeriT

Participants: Pablo Dobal, Pascal Fontaine.

Inria funds this project (started in 2011) to support the development of the SMT solver veriT (see section 5.1), including added expressiveness, improved efficiency and code stability, and interfaces with tools that embed veriT as a backend solver. The project is coordinated by Pascal Fontaine and also includes Inria Rennes (Celtique) and Sophia Antipolis (Marelle). Federico Dobal has been hired in 2012 on a position funded by this project and has in particular contributed to improvements in the code of the solver as well as of the testing platform that allows us to detect bugs and the impact of changes on the performance of the tool. He has also contributed to the maintenance of the deltaSMT tool, which has been used by several other teams of SMT developers for debugging SMT solvers.

8.2. European Initiatives

8.2.1. FP7 project MEALS

Type: PEOPLE

Instrument: International Research Staff Exchange Scheme

Objective: Exchange of scientists between Europe and Argentina

Duration: October 2011 - September 2015

Coordinator: Holger Hermanns, Universität des Saarlandes (Germany)

Partner: Universidad de Buenos Aires, Universidad Nacional de Córdoba, Universidad Nacional de Rio Cuarto, Instituto Tecnológico Buenos Aires

Inria contact: Castuscia Palamidessi

Abstract: The MEALS project funds exchanges between scientists in Europe (Saarland University, RWTH Aachen, TU Dresden, Inria, Imperial College, Univ. of Leicester, TU Eindhoven); it is structured in five work packages (Quantitative Analysis of Concurrent Program Behaviour, Reasoning Tasks for Specification and Verification, Security and Information Flow Properties, Synthesis in Model-based Systems Engineering, Foundations for the Elaboration and Analysis of Requirements Specifications). Our team mainly cooperates with the group led by Carlos Areces in Córdoba, as well with Diego Garbervetsky in Buenos Aires, within work package 2. In 2013, the project funded visits by Luciana Benotti, Rodrigo Castaño, Raúl Fervari, and Guillaume Hoffmann.

8.2.2. Cooperation with TU Wien, Austria

Participants: Pascal Fontaine, Stephan Merz.

This project – from January 2012 to December 2013 – fosters bilateral cooperation with the team headed by Prof. Alexander Leitsch at TU Vienna. It focuses on aspects of proof production and proof compression in automated reasoning. It is headed by Bruno Woltzenlogel Paleo of TU Wien, who was formerly a post-doctoral researcher in VeriDis until March 2011, and Pascal Fontaine. The project is funded by the Amadeus Programme of the Partenariat Hubert Curien and the Österreichischer Austausch Dienst.

The project funded the traveling costs for the participants for four one-week workshops in Vienna and Nancy. In particular, the third workshop was affiliated to Tableaux 2013 and was open to the participants of Tableaux; it attracted around 40 participants. The final workshop of the project took place in November 2013 in Vienna.

The discussions involved many aspects on proofs and allowed to improve some aspects of proof production in SMT, as well as several proof handling tools (e.g. Skeptik), developed among others at TU Wien. The [web page](#) gives more information on this project.

8.2.3. Cooperation with NUI Maynooth, Ireland

Participant: Dominique Méry.

The project *Building Reliable Systems: Software Refinement meets Software Verification* is a one-year project funded by PHC Ulysses. The academic Irish partner is Dr Rosemary Monahan of NUI Maynooth. The verification of software requires the specification of preconditions and postconditions as well as other properties of the code. These properties are expressed as annotations providing a detailed understanding of how the software is implemented. In program verification, the annotation process is often done *a posteriori*, with verification tools used to check that annotations are sound according to the semantics of the program. Determining the correct annotations to provide a complete specification is difficult, especially when specifying invariant properties of the code. *A priori* techniques for developing correct software are based on the correct-by-construction paradigm. The refinement-based approach is such a technique, providing for the construction of a correct program through the step-by-step refinement of an initial high-level model of the software. In this way, the program specification is developed alongside the code, discharging the conditions that need to be proved. We focus on combining these two software engineering techniques, to benefit from the strengths of both. We have proposed a framework [18] for integrating a representation of the *a posteriori* paradigm, namely Spec#, and a representation of the *a priori* paradigm, namely Event B. This integration induces a methodology which bridges the gap between software modeling and program verification in the software development life cycle.

8.3. International Initiatives

8.3.1. Participation In International Programs

8.3.1.1. Cooperation with Universidade Federal do Rio Grande de Norte, Brazil

Participants: David Déharbe, Pablo Dobal, Pascal Fontaine, Stephan Merz.

VeriDis has a close working relationship with a team at Universidade Federal do Rio Grande de Norte (UFRN), Brazil, and more specifically with Prof. David Déharbe. Pascal Fontaine visited Natal in early 2013. The project is centered around the development and applications of the veriT solver (section 5.1), of which David Déharbe and Pascal Fontaine are the main developers. Our cooperation was also supported by the Inria-CNPq project SMT-SAVeS from 2010 throughout early 2013.

A new STIC AmSud project has been approved that will start in 2014 and involves a team at the University of Córdoba in Argentina, the team at UFRN, and VeriDis. It is again centered on SMT, with a particular focus on quantifiers and modal logic [21].

8.4. International Research Visitors

8.4.1. Visits of International Scientists

David Déharbe from UFRN (Natal, Brazil) joined the VeriDis team in Nancy for a one-year sabbatical that started in August 2013.

Josef Widder from TU Vienna, Austria, spent 6 weeks in Nancy in October and November 2013 as an Inria invited researcher. Together with Stephan Merz, he worked on the formalization of parameterized model checking techniques for fault-tolerant distributed algorithms in a proof assistant.

Mike Poppleton from the University of Southampton and Hoang Thai Son from ETHZ spent a week in our group for developing techniques to integrate fairness in Event B models, on the basis of the work published at IFM 2013 [17].

8.4.1.1. Internships

Luis Esteban Campostrini

Subject: Formal Verification of Distributed Algorithms

Date: from May until October, 2013

Institution: Universidad Nacional de Rosario (Argentina)

Joint supervision with Martin Quinson (AlGorille team)

Anisia Maria Magdalena Tudorescu

Subject: Integrating SMT solvers into Spike

Date: from March 2013 until May 2013

Institution: West Timisoara University (Romania)

Joint supervision with Christophe Ringeissen (Cassis team) and Sorin Stratulat (Pareo team)

Paula Chocrón

Subject: Non-disjoint combination for SMT solvers: sharing a fragment of arithmetic

Date: from September 2013 until December 2013

Institution: University of Buenos Aires (Argentina)

Joint supervision with Christophe Ringeissen (Cassis team)

ALEA Project-Team

8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. ANR BNPSI: Bayesian NonParametric methods for Signal and Image processing

Statistical methods have become more and more popular in signal and image processing over the past decades. These methods have been able to tackle various applications such as speech recognition, object tracking, image segmentation or restoration, classification, clustering, etc. We propose here to investigate the use of Bayesian nonparametric methods in statistical signal and image processing. Similarly to Bayesian parametric methods, this set of methods is concerned with the elicitation of prior and computation of posterior distributions, but now on infinite-dimensional parameter spaces. Although these methods have become very popular in statistics and machine learning over the last 15 years, their potential is largely underexploited in signal and image processing. The aim of the overall project, which gathers researchers in applied probabilities, statistics, machine learning and signal and image processing, is to develop a new framework for the statistical signal and image processing communities. Based on results from statistics and machine learning we aim at defining new models, methods and algorithms for statistical signal and image processing. Applications to hyperspectral image analysis, image segmentation, GPS localization, image restoration or space-time tomographic reconstruction will allow various concrete illustrations of the theoretical advances and validation on real data coming from realistic contexts.

8.2. European Initiatives

8.2.1. FP7 Projects

8.2.1.1. ACOBSEC

Type: PEOPLE

Instrument: International Research Staff Exchange Scheme

Objectif: NC

Duration: November 2013 - October 2016

Coordinator: Pierrick Legrand

Partner:

Inria contact: Pierrick Legrand

Abstract: Over the last decade, Human-Computer Interaction (HCI) has grown and matured as a field. Gone are the days when only a mouse and keyboard could be used to interact with a computer. The most ambitious of such interfaces are Brain-Computer Interaction (BCI) systems. The goal in BCI is to allow a person to interact with an artificial system using only brain activity. The most common approach towards BCI is to analyse, categorize and interpret Electroencephalography (EEG) signals, in such a way that they alter the state of a computer. The objective of the present project is to study the development of computer systems for the automatic analysis and classification of mental states of vigilance; i.e., a person's state of alertness. Such a task is relevant to diverse domains, where a person is expected or required to be in a particular state. However, this problem is by no means a trivial one. In fact, EEG signals are known to be highly noisy, irregular and tend to vary significantly from person to person, making the development of general techniques a very difficult scientific endeavor.

List of Beneficiaries

- Beneficiary 1 (coordinator) Institut National de Recherche en Informatique et Automatique
Inria France
- Beneficiary 2 Universite Victor Segalen Bordeaux II UB2 France

- Beneficiary 3 Instituto de Engenharia de Sistemas e Computadores, Investigacao e Desenvolvimento em Lisboa INESC-ID Portugal
- Beneficiary 4 Universidad de Extremadura UNEX Spain
- Partner 5 Instituto Tecnologico de Tijuana ITT Mexico
- Partner 6 Centro de Investigacion Cientifica y educacion Superior de Ensenada, Baja California CICESE Mexico

8.3. International Initiatives

8.3.1. Inria International Partners

8.3.1.1. Declared Inria International Partners

- Institut Technologique de Tijuana. TREE-LAB: www.tree-lab.org Tijuana, BC, Mexico

8.4. International Research Visitors

8.4.1. Visits of International Scientists

The following researchers visited the Team ALEA during 2013: J. Blanchet (Colombia University), A. Doucet (Univ. Oxford), A. Greaven (Univ. Erlangen).

8.4.2. Visits to International Teams

Pierre Del Moral: new South Wales university, Sydney.

APICS Project-Team

8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. ANR

The ANR (Astrid) project COCORAM (Co-design et co-intégration de réseaux d'antennes actives multi-bandes pour systèmes de radionavigation par satellite) has been accepted and will officially start January 2014. We are associated in this project with three other teams from XLIM (Limoges University), specialized respectively on filters, antennas and amplifiers. The core idea of the project is to work on the co-integration of various microwave devices in the context of GPS satellite systems and in particular for us to work on matching problems (see Section 6.3.1).

8.2. European Initiatives

8.2.1. Collaborations with Major European Organizations

APICS is part of the European Research Network on System Identification (ERNSI) since 1992.

Subject: System identification concerns the construction, estimation and validation of mathematical models of dynamical physical or engineering phenomena from experimental data.

8.3. International Initiatives

8.3.1. Inria Associate Teams

8.3.1.1. IMPINGE

Title: Inverse Magnetization Problems IN GEosciences.

Inria principal investigator: Laurent Baratchart

International Partner (Institution - Laboratory - Researcher):

MIT - Department of Earth, Atmospheric and Planetary Sciences (United States) - Benjamin Weiss

Duration: 2013 - 2015

See details at : <http://www-sop.inria.fr/apics/IMPINGE/>

The purpose of the associate team IMPINGE is to develop efficient algorithms to recover the magnetization distribution of rock slabs from measurements of the magnetic field above the slab using a SQUID microscope (developed at MIT). The US team also involves a group at Vanderbilt Univ.

8.3.2. Inria International Partners

8.3.2.1. Declared Inria International Partners

NSF CMG collaborative research grant DMS/0934630, "Imaging magnetization distributions in geological samples", with Vanderbilt University and the MIT (USA).

Cyprus NF grant "Orthogonal polynomials in the complex plane: distribution of zeros, strong asymptotics and shape reconstruction".

PHC Utique CMCU (led by Fédération Denis Poisson, Univ. Orléans), "Harmonic analysis and applications".

8.3.2.2. *Informal International Partners*

As mentioned in Sections 5.6 and 6.1.1, a cooperation with the German firm BESA⁴ has started this year, which includes Athena Team (Inria Sophia-Antipolis-Méditerranée) and Centre de Mathématiques Appliquées of École des Mines de Paris. It is expected to be formalized soon, so as to include several developments of the software FindSources3D as well as a co-advised PhD.

8.4. International Research Visitors

8.4.1. *Visits of International Scientists*

- Douglas Hardin (Vanderbilt University, Nashville, USA, Jun 2013)
- Matteo Oldoni (Siae Microelettronica, Milano, Italy, Nov 2013)
- Vladimir Peller (Michigan University, East Lansing, from May until Jun 2013)
- Yannick Privat (CNRS, Univ. P. et M. Curie, Paris, Dec 2013).
- Tao Qian (University of Macau, Taipa, China, Jul 2013)
- Edward Saff (Vanderbilt University, Nashville, USA, from May until Jun 2013)
- Michael Stessin (New York state University at Albany, USA, Jun 2013)
- Nikos Stylianopoulos (Univ. of Cyprus).
- Ian Sloan (University of New South Wales, Sydney, Australia, Jun. 2013).
- Maxim Yattselev (Indiana University–Purdue University, Indianapolis, USA, Mar 2013)

8.4.1.1. *Internships*

- K. Bashtova, Master 2 Mathmods - UNSA (6 months), Inverse source problems for electromagnetic fields, with physical applications.

8.5. List of international and industrial partners

- Collaboration under contract with Thales Alenia Space (Toulouse, Cannes, and Paris), CNES (Toulouse), XLIM (Limoges), University of Bilbao (Universidad del País Vasco / Euskal Herriko Unibertsitatea, Spain).
- Regular contacts with research groups at UST (Villeneuve d'Ascq), Universities of Bordeaux-I (Talence), Orléans (MAPMO), Aix-Marseille (CMI-LATP), Nice Sophia Antipolis (Lab. JAD), Grenoble (IJF and LJK), Paris 6 (P. et M. Curie, Lab. JLL), Paris Diderot (LAREG-IGN), CWI (the Netherlands), MIT (Boston, USA), Vanderbilt University (Nashville USA), Steklov Institute (Moscow), Michigan State University (East-Lansing, USA), Texas A&M University (College Station USA), State University of New-York (Albany, USA), University of Oregon (Eugene, USA), Politecnico di Milano (Milan, Italy), University of Trieste (Italy), RMC (Kingston, Canada), University of Leeds (UK), of Maastricht (The Netherlands), of Cork (Ireland), Vrije Universiteit Brussel (Belgium), TU-Wien (Austria), TFH-Berlin (Germany), ENIT (Tunis), KTH (Stockholm), University of Cyprus (Nicosia, Cyprus), University of Macau (Macau, China), BESA company (Munich), SIAE Microelettronica (Milano).
- The project is involved in the GDR-project AFHP (CNRS), in the ANR (Astrid program) project COCORAM (with XLIM, Limoges, and DGA), in a EMS21-RTG NSF program (with MIT, Boston, and Vanderbilt University, Nashville, USA), in the Associate Inria Team IMPINGE (with MIT, Boston), and in a CSF program (with University of Cyprus).

⁴<http://www.besa.de/>

ASPI Project-Team

7. Partnerships and Cooperations

7.1. National initiatives

7.1.1. PDMP Inférence, Évolution, Contrôle et Ergodicité (PIECE) — ANR Jeunes Chercheuses et Jeunes Chercheurs

Participant: Florent Malrieu.

January 2013 to December 2016.

Piecewise deterministic markov processes (PDMP) are non-diffusive stochastic processes which naturally appear in many areas of applications as communication networks, neuron activities, biological populations or reliability of complex systems. Their mathematical study has been intensively carried out in the past two decades but many challenging problems remain completely open. This project aims at federating a group of experts with different backgrounds (probability, statistics, analysis, partial derivative equations, modelling) in order to pool everyone's knowledge and create new tools to study PDMPs. The main lines of the project relate to estimation, simulation and asymptotic behaviors (long time, large populations, multi-scale problems) in the various contexts of application.

7.2. International initiatives

7.2.1. Inria international partners

Arnaud Guyader collaborates with the group of Nicolas Hengartner at Los Alamos National Laboratories, on the development of fast algorithms to simulate rare events, and on iterative bias reduction techniques in nonparametric estimation. This collaboration has a long record of bilateral visits, and a successful co-direction of a PhD thesis.

7.3. International research visitors

7.3.1. Visits to international teams

Arnaud Guyader has been invited by Nicolas Hengartner to visit LANL (Los Alamos National Laboratories) in July 2013.

François Le Gland has been invited by Arunabha Bagchi to visit the department of applied mathematics of the University of Twente in Enschede, in October 2013.

BACCHUS Team

7. Partnerships and Cooperations

7.1. Regional Initiatives

Title: TIDES: Robust simulation tools for non-hydrostatic free surface flows

Type: Apple à Projets Recherche du Conseil de la Région Aquitaine

Grant: 55Keuros (co-funding PhD A. Filippini)

Coordinator: M. Ricchiuto

Other partners: UMR EPOC (P. Bonneton)

Abstract: This project proposes to combine modern high order adaptive finite elements techniques with state of the art nonlinear and non-hydrostatic models for free surface waves to provide an accurate tool for the simulation of near shore hydrodynamics, with application to the study and prediction of tidal bores. The Garonne river will be used as a case study.

7.2. National Initiatives

7.2.1. Inria Project Lab

7.2.1.1. C2S@Exa - Computer and Computational Sciences at Exascale

Participants: Olivier Aumage [RUNTIME project-team, Inria Bordeaux - Sud-Ouest], Jocelyne Erhel [SAGE project-team, Inria Rennes - Bretagne Atlantique], Philippe Helluy [TONUS project-team, Inria Nancy - Grand-Est], Laura Grigori [ALPINE project-team, Inria Saclay - Île-de-France], Jean-Yves L'Excellent [ROMA project-team, Inria Grenoble - Rhône-Alpes], Thierry Gautier [MOAIS project-team, Inria Grenoble - Rhône-Alpes], Luc Giraud [HIEPACS project-team, Inria Bordeaux - Sud-Ouest], Michel Kern [POMDAPI project-team, Inria Paris - Rocquencourt], Stéphane Lanteri [Coordinator of the project], François Pellegrini [BACCHUS project-team, Inria Bordeaux - Sud-Ouest], Christian Perez [AVALON project-team, Inria Grenoble - Rhône-Alpes], Frédéric Vivien [ROMA project-team, Inria Grenoble - Rhône-Alpes].

Since January 2013, the team is participating to the C2S@Exa http://www-sop.inria.fr/c2s_at_exa Inria Project Lab (IPL). This national initiative aims at the development of numerical modeling methodologies that fully exploit the processing capabilities of modern massively parallel architectures in the context of a number of selected applications related to important scientific and technological challenges for the quality and the security of life in our society. At the current state of the art in technologies and methodologies, a multidisciplinary approach is required to overcome the challenges raised by the development of highly scalable numerical simulation software that can exploit computing platforms offering several hundreds of thousands of cores. Hence, the main objective of C2S@Exa is the establishment of a continuum of expertise in the computer science and numerical mathematics domains, by gathering researchers from Inria project-teams whose research and development activities are tightly linked to high performance computing issues in these domains. More precisely, this collaborative effort involves computer scientists that are experts of programming models, environments and tools for harnessing massively parallel systems, algorithmists that propose algorithms and contribute to generic libraries and core solvers in order to take benefit from all the parallelism levels with the main goal of optimal scaling on very large numbers of computing entities and, numerical mathematicians that are studying numerical schemes and scalable solvers for systems of partial differential equations in view of the simulation of very large-scale problems.

7.2.1.2. ANR

Title: PETALH: Preconditioning scientific applications on pETascALe Heterogeneous machines

Type: ANR

Grant: Cosinus 2010

Duration: September 2011 - May 2013

Coordinator: GRIGORI Laura (Inria Saclay-Île de France)

Other partners: Inria Saclay-Île de France (leader of the project), Paris 6, IFP (Rueil-Malmaison), CEA Saclay.

See also: <http://petal.saclay.inria.fr/>

Abstract: In this collaborative effort, we propose to develop parallel preconditioning techniques for the emergent hierarchical models of clusters of multi-core processors, as used for example in future petascale machines. The preconditioning techniques are based on recent progress obtained in combining the well known incomplete LU (ILU) factorization with tangential filtering.

The track we are following in order to contribute to this goal is to investigate improved graph ordering techniques that would privilege the diagonal dominance of the matrices corresponding to the subdomains of the Schur complement. It amounts to integrating numerical values into the adjacency graph of the matrices, so that the importance of off-diagonal terms is taken into account when computing graph separators. The core of this work is planned to take place at the beginning of next year.

This project is a continuation of PETAL project that was funded by ANR Cosinus 2008 call.

7.2.1.3. FUI Rodin

Title: Robust structural Optimization for Design in Industry (Rodin)

Type: FUI

Duration: July 2012 - July 2015

Coordinator: ALBERTELLI Marc (Renault)

Abstract: From the research point of view, the RODIN project will focus on: (1) extending level set methods to nonlinear mechanical or multiphysics models and to complex geometrical constraints, (2) developing algorithms for moving meshes with a possible change of topology, (3) adapting in a level-set framework second-order optimization algorithms having the ability of handling a large number of design variables and constraints.

The project will last 3 years and will be supported by a consortium of 7 partners: (1) 2 significant end-users, Renault and EADS, who will provide use-cases reflecting industrial complexity; (2) 3 academics partners, CMAP, J.-L. Lions laboratory and Inria of Bordeaux, who will bring expertise in applied mathematics, structural optimization and mesh deformation; (3) A software editor, ESI Group, who will provide mechanical software package and will pave the way of an industrialization; (4) A SME, Eurodecision, specialized in large-scale optimization.

7.2.1.3.1. ANR MAIDESC

Title: Maillages adaptatifs pour les interfaces instationnaires avec deformations, etirements, courbures.

Type: ANR

Duration: 48 months

Starting date : 1st Oct 2013

Coordinator: Dervieux Alain (Inria Sophia)

Abstract: Mesh adaptive numerical methods allow computations which are otherwise impossible due to the computational resources required. We address in the proposed research several well identified main obstacles in order to maintain a high-order convergence for unsteady Computational Mechanics involving moving interfaces separating and coupling continuous media. A priori and a posteriori error analysis of Partial Differential Equations on static and moving meshes will be developed from interpolation error, goal-oriented error, and norm-oriented error. From the minimization of the chosen error, an optimal unsteady metric is defined. The optimal metric is then converted into a sequence of anisotropic unstructured adapted meshes by means of mesh regeneration, deformation, high stretching, and curvature. A particular effort will be devoted to build an accurate representation of physical phenomena involving curved boundaries and interfaces. In association with curved boundaries, a part of studies will address third-order accurate mesh adaption. Mesh optimality produces a nonlinear system coupling the physical fields (velocities, etc.) and the geometrical ones (unsteady metric, including mesh motion). Parallel solution algorithms for the implicit coupling of these different fields will be developed. Addressing efficiently these issues is a compulsory condition for the simulation of a number of challenging physical phenomena related to industrial unsolved or insufficiently solved problems. Non-trivial benchmark tests will be shared by consortium partners and by external attendees to workshops organized by the consortium. The various advances will be used by SME partners and proposed in software market.

7.2.1.3.2. ANR UFO

Title: Uncertainty quantification For compressible fluid dynamics and Optimisation.

Type: ANR

Duration: 36 months

Starting date : 1st June 2011

Coordinator: Remi Abgrall (Inria Bordeaux Sud-Ouest)

Abstract: This project deals with the simulation and the optimization of stochastic flows where the uncertainties can be both in the data and in the models. The focus will be on handling the uncertainties coming from the turbulence models or thermodynamics models in dense-gas flows. Since the thermodynamic models for dense-gas flows are not well-known, it is mandatory to compute the probability density functions of some quantities of interest by starting from the experimental data. Several methods have been developed for both reducing the global computational cost and increasing the accuracy in the statistics computation.

7.3. European Initiatives

7.3.1. FP7 Projects

7.3.1.1. IDIHOM

Title: Industrialisation of High-Order Methods

Type: COOPERATION (TRANSPORTS)

Instrument: Specific Targeted Research Project (STREP)

Duration: October 2010 - September 2013

Coordinator: Deutsches Zentrum für Luft und Raumfahrt (Germany)

Others partners: DLR (Germany), Dassault Aviation (France), EADS-Cassidian (Germany), Cenaero (Belgium), Numeca (Belgium), ARA (UK), FOI (Sweden), Inria (France), NLR (the Netherlands), ONERA (France), TSAGI (Russia), ENSAM (France), Imperial College (UK), Universities of Bergamo (Italy), Warsaw (Poland), Poznan (Poland), Linköping (Sweden), Université Catholique de Louvain (Belgium).

See also: http://www.dlr.de/as/en/desktopdefault.aspx/tabid-7027/11654_read-27492/

Abstract: The proposed IDIHOM project is motivated by the increasing demand of the European aerospace industries to advance their CFD-aided design procedure and analysis by using accurate and fast numerical methods, so-called high-order methods. They will be assessed and improved in a top-down approach by utilising industrially relevant complex test cases, so-called application challenges in the general area of turbulent steady and unsteady aerodynamic flows, covering external and internal aerodynamics as well as aeroelastic and aeroacoustic applications. Thus, the major aim is to support the European aeronautics industry with proven-track method(s) delivering an increased predictive accuracy for complex flows and (by same accuracy) an alleviation of computational costs which will secure their global leadership. An enhancement of the complete "high-order methods suite" is envisaged, including the most relevant methods, Discontinuous Galerkin and Continuous Residual-Based methods, in combination with underlying technologies as high-order grid generation and adaptation, visualisation, and parallelisation. The IDIHOM project is a key-enabler for meeting the ACARE goals, as higher-order methods offer the potential of more accurate prediction and at the same time faster simulations. Inria is involved in the design of Continuous Residual-Based methods for the simulation of steady turbulent flows.

7.3.1.2. *STORM*

Type: COOPERATION

Defi: NC

Instrument: Specific Targeted Research Project

Objectif: NC

Duration: October 2013 - September 2016

Coordinator: SNECMA (France)

Partner: SNECMA SA (FR), AEROTEX UK LLP (UK), AIRBUS OPERATIONS SL (ES), Airbus Operations Limites (UK), AIRCELLE SA (FR), ARTTIC (FR), CENTRO ITALIANO RICERCHE AEROSPAZIALI SCPA (IT), CRANFIELD UNIVERSITY (UK), DEUTSCHES ZENTRUM FUER LUFT - UND RAUMFAHRT EV (DE), EADS DEUTSCHLAND GMBH (DE), ONERA (FR), TECHSPACE AERO SA (BE)

Inria contact: Heloise Beaugendre

Abstract: During the different phases of a flight, aircraft face severe icing conditions. When this ice then breaks away, and is ingested through the remainder of the engine and nacelle it creates multiple damages which have a serious negative impact on the operations costs and may also generate some incident issues. To minimise ice accretion, propulsion systems (engine and nacelle) are equipped with Ice Protection Systems (IPS), which however have themselves performance issues. Design methodologies used to characterise icing conditions are based on empirical methods and past experience. Cautious design margins are used non-optimised designs solutions. In addition, engine and nacelle manufacturers are now limited in their future architectures solutions development because of lack of knowledge of icing behaviour within the next generation of propulsive systems solutions, and of new regulations adopted that require aero engine manufacturers to address an extended range of icing conditions.

In this context that STORM proposes to: characterise ice accretion and release through partial tests ; Model ice accretion, ice release and ice trajectories ; Develop validated tools for runback ; characterise ice phobic coatings ; select and develop innovative low cost and low energy anti-icing and de-icing systems. Thus, STORM will strengthen the predictability of the industrial design tools and reduce the number of tests needed. It will permit lower design margins of aircraft systems, and thus reduce the energy consumption as well as prevent incidents and break downs due to icing issues.

7.3.1.3. *ADDECCO*

Title: ADaptive schemes for DEterministic and stoChastiC Flow PrOblems (ADDECCO)

Type: IDEAS (AdG # 226316)

Instrument: ERC Advanced Grant (Advanced)

Duration: December 2008 - November 2013

Coordinator: Inria (France)

Others partners: none

See also: <http://www.math.u-bordeaux.fr/~rabgrall>

Abstract: The numerical simulation of complex compressible flow problem is still a challenge nowadays, even for the simplest physical model such as the Euler and Navier Stokes equations for perfect gases. Researchers in scientific computing need to understand how to obtain efficient, stable, very accurate schemes on complex 3D geometries that are easy to code and to maintain, with good scalability on massively parallel machines. Many people work on these topics, but our opinion is that new challenges have to be tackled in order to combine the outcomes of several branches of scientific computing to get simpler algorithms of better quality without sacrificing their efficiency properties. In this proposal, we will tackle several hard points to overcome for the success of this program. We first consider the problem of how to design methods that can handle easily mesh refinement, in particular near the boundary, the locations where the most interesting engineering quantities have to be evaluated. CAD tools enable to describe the geometry, then a mesh is generated which itself is used by a numerical scheme. Hence, any mesh refinement process is not directly connected with the CAD. This situation prevents the spread of mesh adaptation techniques in industry and we propose a method to overcome this even for steep problems. Second, we consider the problem of handling the extremely complex patterns that occur in a flow because of boundary layers: it is not always sufficient to only increase the number of degrees of freedom or the formal accuracy of the scheme. We propose to overcome this with class of very high order numerical schemes that can utilise solution dependant basis functions. Our third item is about handling unsteady uncertainties in the model, for example in the geometry or the boundary conditions. This need to be done efficiently: the amount of computation increases a priori linearly with the number of uncertain parameters. We propose a non-intrusive method that is able to deal with general probability density functions (pdf), and also able to handle pdfs that may evolve during the simulation via a stochastic optimisation algorithm, for example. This will be combined with the first two items of this proposal. Many random variables may be needed, the curse of dimensionality will be dealt thanks to multiresolution method combined with sparse grid methods. The aim of this proposal is to design, develop and evaluate solutions to each of these challenges. Currently, and up to our knowledge, none of these problems have been dealt with for compressible flows with steep patterns as in many moderns aerodynamics industrial problems. We propose a work program that will lead to significant breakthroughs for flow simulations with a clear impact on numerical schemes and industrial applications. Our solutions, though developed and evaluated on flow problems, have a wider potential and could be considered for any physical problem that are essentially hyperbolic.

7.3.2. TRP Contract with European Space Agency

- Contrat ESA AO /1-6938/11/NL/SFE) for uncertainty quantification in aerospace application.
- Starting Date : 1st June 2012
- Coordinator : Thierry Magin (VKI)
- Type : ESA (European Spatial Agency).
- Grant : 250.000 euros
- Abstract: this project deals with the development of uncertainty quantification methods for aerospace applications. This is the first project financed by ESA concerning uncertainty quantification. The approach that we propose to follow will be based on the quantification and reduction of all the uncertainties, thoroughly identified, in a balanced manner. A fundamental characteristic of this integrated simulation strategy must be also the ability to control the numerical errors present in the highly integrated computations.

7.4. International Initiatives

7.4.1. Inria Associate Teams

AQUARIUS associated team is a research project dealing with uncertainty quantification and numerical simulation of high Reynolds number flows. It represents a challenging study demanding accurate and efficient numerical methods. It involves the Inria team BACCHUS and the groups of Pr. Charbel Farhat from the Department of Aeronautics and Astronautics and Pr. G. Iaccarino from the Department of Mechanical Engineering at Stanford University. The first topic concerns the simulation of flows when only partial information about the physics or the simulation conditions (initial conditions, boundary conditions) is available. In particular we are interested in developing methods to be used in complex flows where the uncertainties represented as random variables can have arbitrary probability density functions. The second topic focuses on the accurate and efficient simulation of high Reynolds number flows. Two different approaches are developed (one relying on the XFEM technology, and one on the Discontinuous Enrichment Method (DEM), with the coupling based on Lagrange multipliers). The purpose of the proposed project is twofold : i) to conduct a critical comparison of the approaches of the two groups (Stanford and Inria) on each topic in order to create a synergy which will lead to improving the status of our individual research efforts in these areas ; ii) to apply improved methods to realistic problems in high Reynolds number flow.

A summary of research activities, publications, visits can be found on <http://www.stanford.edu/group/uq/aquarius/index3.html>

7.4.2. Inria International Partners

7.4.2.1. Informal International Partners

von Karman Institute for Fluid Dynamics (Belgium). With Pr. H. Deconinck we work on the design of high order methods, including goal oriented mesh adaptation strategies

Leeds University, School of Computing : Dr. M.E. Hubbard (as of January 2014 in University of Nottingham, Department of Mathematics). Collaboration on high order schemes for time dependent shallow water flows

Technical University of Crete, School of Production Engineering & Management : Pr. A.I. Delis. Collaboration on high order schemes for depth averaged free surface flow models, including robust code to code validation

LEGI, Grenoble : Collaboration with C. Corre, E. Goncalves and G. Balarac on uncertainty quantification methods, multiphase flows, cavitation and turbulence.

CWI, The Netherlands : Collaboration with J. Witteveen about the Simplex2 methods for robust design optimization.

University of Trieste : Collaboration with V. Pediroda and L. Parussini concerning robust optimization methods.

Politecnico di Milano, Aerospace Department (Italy) : Pr. A. Guardone. Collaboration on ALE for complex flows (compressible flows with complex equations of state, free surface flows with moving shorelines), and on robust optimization methods for morphing helicopter blades.

7.4.3. Inria International Labs

7.4.3.1. JLPC

In the context of the JLPC (Joint Laboratory for Petascale Computing), people involved in the development of graph partitioning algorithms in Scotch collaborate with several US partners (UIUC, Argonne) so as to improve partitioning run time and quality for large scale simulations. Sébastien Fourestier has been attending the Inria-UIUC meeting of last September and has delivered two talks, one regarding Scotch and the other regarding PaMPA.

7.4.3.2. Inria@SILICONVALLEY

People involved in the development of graph partitioning algorithms in Scotch have a loose collaboration with Sherry Li and her team at Berkeley, regarding sparse matrix reordering techniques.

7.4.4. Participation In other International Programs

7.4.4.1. Inria-CNPq

In the context of the HOSCAR project jointly funded by Inria and CNPq, coordinated by Stéphane LANTERI on the French side, François Pellegrini and Pierre Ramet have participated in a joint workshop in Petrópolis last September. A collaboration is envisioned regarding parallel graph partitioning algorithms for data placement in the context of big data applications.

7.5. International Research Visitors

7.5.1. Visits of International Scientists

- Kazuo AOKI, Kyoto University (Kyoto, Japan), from August 31st to September 9th ;
- Smadar KARNI, University of Michigan Ann Arbor (Ann Arbor, Michigan, USA), from January 15th to March 23rd ;
- Alexander KURGANOV, Tulane University (New-Orleans, USA), from July 8th to July 13th ;
- Dimitris VALOUGEORGIS, University of Thessaly (Grece), from June 24th to July 5th ;
- Federica VIGNATI, Politecnico di Milano (Italy), from May 6th to May 18th ;
- Bernhard MULLER, NTNU Trondheim (Norway), on sabbatical from October 2013 to May 2014.

We also received a large number of shorter visits (on/two days) from several internationally recognized scientists : M. Pelanti (ENSTA ParisTech, France), S. Takata (Kyoto University, Japan), E. Audit (CEA, France), E. Caron (Ecole Normale Supérieure Lyon, France), C. Corre (LEGI Grenoble, France), H. Deconinck (von Karman Institute, Belgium), B. Despres (Université Paris VI, France), M. Giles (Oxford University, UK), D. Lucor (Université Paris VI, France), H. Meyerhenke (KIT, Germany), C. Poloni (Università di Trieste, Italy), P. Sagaut (Université P. et M. Curie, France), P. Siarry (UPEC, France), and many others.

7.5.1.1. Internships

- Paola BACIGALUPPI. From April to October. Subject : Wave breaking modeling in a stabilized finite element code. University : Politecnico di Milano. Supervisor : M. Ricchiuto ;
- Sophie DALLET. From March to August. Subject : Approximation de modèles multiphase par méthodes aux résidus. Supervisor : R. Abgrall ;
- Marc DUVERNET. From March to June. Subject : Coupler un code numérique qui résout les équations du mélange liquide-vapeur avec un code pour la quantification des incertitudes basé sur un cadre bayésien. Supervisor : P. Congedo ;
- Simon ETTOUATI. From February to August. Subject : Déformation de maillage pour les maillages d'ordre élevé. Supervisor : C. Dobrzynski ;
- Andrea FILIPPINI. From January to April. Subject : Stabilized finite element modeling of non-hydrostatic wave propagation. University : Politecnico di Milano. Supervisor : M. Ricchiuto ;
- Adballa MANSOURI. From March to June. Subject : Génération d'un modèle thermodynamique complexe pour les gaz réels. Supervisor : P. Congedo ;
- Léo NOUVEAU. From February to August. Subject : Etude sur les méthodes de pénalisation adaptées aux maillages non-structurés fortement anisotropiques et utilisation de l'adaptation de maillage. Supervisor : H. Beaugendre ;
- Nassim RAZAALY. From February to July. Subject : Modifier un code de simulation numérique d'ordre élevé pour implémenter des modèles thermodynamiques précis. University : ENSEIRB-MATMECA. Supervisor : P. Congedo.

7.5.2. Visits to International Teams

- P.M. Congedo, Stanford University (USA), two weeks in May 2013.
- P.M. Congedo, University of Salento (Italy), two weeks in August 2013.
- G. Geraci, Stanford University, 1 month in August 2013.

BIPOP Project-Team

8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. ANR

- CHASLIM Chattering Free Sliding Mode Control: ANR BLAN 2011 BS03 007 01 (octobre 2011–octobre 2015), coordinator B. Brogliato.

8.2. International Research Visitors

- Valentina Sessa from the University of Benevento, Italy, DIS, a six-month internship as a PhD student under the supervision of V. Acary and B. Brogliato,.

8.2.1. Visits of International Scientists

Visit of Prof. Yury Starovetsky from Technion, Israel, four weeks in 2013.

CAD Team

7. Partnerships and Cooperations

7.1. Regional Initiatives

Our Join Inria Tsinghua Project is located from 2004 at Tsinghua University (Beijing – China). CAD is a LIAMA Project.

CAGIRE Team

7. Partnerships and Cooperations

7.1. Regional Initiatives

7.1.1. An experimental database for DNS assessment (6 months of post-doct funded by Communauté d'Agglomération Pau- Portes des Pyrénées)

The quality of our unsteady simulations have to be compared with high quality experimental data. Since the targeted baseline 1-jet in crossflow configuration is isothermal, the relevant comparisons will be made mainly on the velocity field for which detailed PIV measurements have to be carried out. In order to assess in depth the quality of our numerical simulations, it is important to generate experimental data that must give access to both the global flowfield statistics (one-point mean values and probability density functions) as well as the velocity field dynamics (spectra) and the most relevant related turbulence scales. In that framework, the objective of this one-year post-doc (co-funded by CNRS and UPPA) is to built-up a stereo-PIV based database giving access simultaneously to the three velocity components in the planes of measurement.

7.2. National Initiatives

7.2.1. GIS Success

We are presently participating in the CNRS GIS Success (Groupement d'Intérêt Scientifique) organised around the two major codes employed by the Safran group, namely AVBP and Yales 2. In the framework of mastering the Yales2 code, one team member has participated in October 2013 in a training session organised by Coria. Then, the yales2 code has been implemented locally and the evaluation of the code has started.

7.3. European Initiatives

7.3.1. FP7 Projects

Participants: Vincent Perrier [responsible of the team contribution], Pascal Bruel [substitute], Simon Delmas [PhD], Yann Moguen [Post-doc].

Program: Propulsion

Project acronym: IMPACT-AE

Project title: Intelligent Design Methodologies for Low Pollutant Combustors for Aero-Engines

Duration: 01/11/2011 - 31/10/2015

Coordinator: Roll Royce Deutschland

Other partners:

- France: Insa of Rouen, ONERA, Snecma, Turbomeca.
- Germany: Rolls-Royce Deutschland, MTU Aeo Engine Gmbh, DLR, Technology Institute of Karlsruhe, University of Bundeswehr (Munich)
- Italy: AVIOPROP SRL, AVIO S.P.A., University of Florence
- United Kingdom: Rolls Royce PLC, Cambridge University, Imperial College od Science, Technology and Medecine, Loughborough University.

Abstract: The environmental benefits of low emissions lean burn technology in reducing NO_x emissions up to 80% only be effective when these are deployed to a large range of new aero-engine applications. While integrating methodologies for advanced engine architectures and thermodynamic cycles. It will support European engine manufacturers to pick up and keep pace with the US competitors, being already able to exploit their new low emission combustion technology to various engine applications with short turn-around times. Key element of the project will be the development and validation of design methods for low emissions combustors to reduce NO_x and CO emissions by an optimization of the combustor aero-design process. Preliminary combustor design tools will be coupled with advanced parametrisation and automation tools. Improved heat transfer and NO_x models will increase the accuracy of the numerical prediction. The contribution of our team is to create with AeroSol a direct numerical simulations (DNS) database relevant to the configuration of film cooling for subsequent improvement of RANS based simulations of isothermal and non isothermal wall flows with discrete mass transfer.

7.4. International Research Visitors

7.4.1. Visits of International Scientists

June 2013 (4 days): Prof. E. Dick from Ghent University: improvement of pressure-velocity coupling for low Mach number flow simulation by introducing inertia terms in the flux scheme.

7.4.2. Visits to International Teams

P. Bruel spent a two-week stay at the Institute of Mathematics in Almaty (Kazakhstan) to set-up a joint project around the simulations of combustion of air and coal in a laboratory scale burner. A joint supervision of a Kazakh student was started at this occasion.

CALVI Project-Team

8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. ANR

- Takashi Hattori, Simon Labrunie and Jean Rodolphe Roche participate in the ANR project “CHROME” (Heating, Reflectometry and Waves for Magnetized Plasma), grouping researchers from Université Paris 6 (B. Després, M. Campos Pinto and others), the Inria project-team POEMS (E. Bécache, C. Hazard and P. Joly) and Université de Lorraine (S. Heuraux). Simon Labrunie is the head of the Lorraine team.

The CHROME project seeks to develop advanced mathematical and numerical tools for the simulation of electromagnetic waves in strongly magnetized plasmas (e.g., tokamak plasmas) in the context of reflectometry (a technique for probing the plasma by analysing the propagation of electromagnetic waves) and heating.

- GYPSI project (2010–2014), <https://sites.google.com/site/anrgypsi/>: coordinator Philippe Ghendrih (CEA Cadarache), other participants, University of Marseille, Universities of Strasbourg and Nancy (CALVI project-team). The aim is to understand the physics of turbulence in magnetically confined plasma using numerical simulation
- ANR project “PEPPSI” in Programme Blanc SIMI 9 – Sciences de l’ingénierie (Edition 2012) started in 2013. Participants : Giovanni Manfredi (coordinator), Edwin Chacon Golcher, Sever Hirstoaga.

8.1.2. Euratom-CEA projects

- Michel Mehrenberger and Philippe Helluy are local coordinators of the project FR FCM (CNRS Federation on Magnetic Confinement Fusion), within Euratom-CEA association, Title: "Numerical Methods for GYSELA", the goal is to help improving the numerical algorithms used by the GYSELA code developed at CEA Cadarache for the simulation of turbulence in magnetic fusion plasmas.
- Jean R. Roche is the coordinator of the FR FCM project with Euratom-CEA association, Title: "Full wave modeling of lower hybrid current drive in tokamaks". The goal of this project is to develop a full wave method to describe the dynamics of lower hybrid current drive problem in tokamaks.

8.2. International Research Visitors

8.2.1. Visits to International Teams

Michel Mehrenberger, since September 2013, Institut für Plasma Physics (IPP) Munich, Germany.

CLASSIC Project-Team

7. Partnerships and Cooperations

7.1. National Initiatives

- ANR project in the blank program: Calibration (2012–2015; involves Vincent Rivoirard, who is the coordinator; see <https://sites.google.com/site/anrcalibration/home>)
- ANR project in the blank program: Banhdits (2010–2013; involves Vincent Rivoirard; see <https://sites.google.com/site/anrcalibration/home>)
- PEPS Bio-Maths (“Estimation de graphes de dépendance entre neurones thalamiques et cortico-thalamiques via des modèles de Hawkes multivariés; 2012–2013; involves Vincent Rivoirard)

7.2. International Initiatives

We have one formal international collaboration, with

- Karine Bertin, University of Valparaiso, Chile (International cooperation CONICYT project, Andes Foundation project);

and other informal ones:

- Luc Devroye, McGill University, Canada;
- David Mason, Delaware University, USA;
- Shie Mannor, Technion, Israel.

COMMANDS Project-Team

7. Partnerships and Cooperations

7.1. National Initiatives

7.1.1. DGA

Participants: Olivier Bokanowski, Anna Désilles, Hasnaa Zidani.

This project is a collaboration in the framework of a 3-year (2012-2015) research program funded by DGA. The title of the project is “Problèmes de commande optimale pour des systèmes non-linéaires en présence d’incertitudes et sous contraintes de probabilité de succès”.

7.1.2. ANR HJNet

Participants: Olivier Bokanowski, Zhiping Rao, Hasnaa Zidani.

The team is part of the collaborative project HJNet funded by the French National Research Agency (ANR-12-BS01-0008-01). It started in January 2013 and will end in December 2013. Website: <http://hjnet.math.cnrs.fr>

7.2. European Initiatives

7.2.1. FP7 Projects

7.2.1.1. SADCO

Instrument: Initial Training Network

Duration: January 2011 - December 2014

Coordinator: Inria

Partner: Univ. of Louvain, Univ. Bayreuth, Univ. Porto, Univ. Rome - La Sapienza, ICL, Astrium-Eads, Astos solutions, Volkswagen, Univ. Padova, Univ. Pierre et Marie Curie.

Inria contact: Hasnaa Zidani

Abstract: Optimisation-based control systems concern the determination of control strategies for complex, dynamic systems, to optimise some measures of best performance. It has the potential for application to a wide range of fields, including aerospace, chemical processing, power systems control, transportation systems and resource economics. It is of special relevance today, because optimization provides a natural framework for determining control strategies, which are energy efficient and respect environmental constraints. The multi-partner initial training network SADCO aims at: Training young researchers and future scientific leaders in the field of control theory with emphasis on two major themes sensitivity of optimal strategies to changes in the optimal control problem specification, and deterministic controller design; Advancing the theory and developing new numerical methods; Conveying fundamental scientific contributions within European industrial sectors.

See: <http://itn-sadco.inria.fr>

7.3. International Initiatives

7.3.1. Inria Associate Teams

7.3.1.1. OCONET

Title: Optimization and control in network economics

Inria principal investigator: Frédéric Bonnans

International Partner (Institution - Laboratory - Researcher):

University of Chile (Chile) - Center for Mathematical Modeling - Joseph Frédéric Bonnans

Duration: 2012 - 2014

See also: http://www.cmm.uchile.cl/EA_OCONET

Limited resources in telecommunication, energy, gas and water supply networks, lead to multi-agent interactions that can be seen as games or economic equilibrium involving stochastic optimization and optimal control problems. Interaction occurs within a network, where decisions on what to produce, consume, trade or plan, are subject to constraints imposed by node and link capacities, risk, and uncertainty, e.g. the capacity of generators and transmission lines; capacity of pipeline in gas supply; switches and antennas in telecommunication. At the same time, nonlinear phenomena arise from price formation as a consequence of demand-supply equilibria or multi-unit auction processes in the case of energy and telecommunication. We will focus first in this project in electricity markets in which there are producers/consumers PCs, and an agent called ISO (Independent system operator) in charge of the management of the network. One major application we have in mind is the one of smart (electrical) grids, in view of the increased use of renewable energies, that is, a massive entry of wind, geothermal, solar in particular.

7.3.2. Inria International Labs

- The team is involved in the "Energy Optimization" group of the Inria research center in Chile (CIRIC). Several visits to Chile were conducted in relation with this project.

7.4. International Research Visitors

7.4.1. Visits of International Scientists

- Prof. B.S. Goh, Curtin University, Miri, Malaysia; two weeks in February.
- M.S. Aronna, Rosario University, Argentina; one month (February and November).

7.4.1.1. Internships

- Arthur Marly, second year student of ENS Lyon. Two months internship. Subject: optimal control of populations with state constraints. Supervisor: F. Bonnans.

CORIDA Project-Team

6. Partnerships and Cooperations

6.1. Regional Initiatives

In collaboration with B. Lévy (EPI ALICE), X. Antoine obtained a 25000 euros grant from Région Lorraine (projets émergents).

6.2. National Initiatives

6.2.1. ANR

Most of the members of our team are involved in at least one ANR program.

Thomas Chambrion has been responsible for the quantum control part of the ANR blanc project GCM from 2009 to December 2013.

Marius Tucnsak is local coordinator of ANR blan project Hamecmopsys. This ANR project will be active up to 2015.

Antoine Henrot is head of the ANR blanc project OPTIFORM since September 2012. This project is devoted to the Geometric Analysis of Optimal Shapes. It gathers scientist from Grenoble, Chambéry, Lyon, Rennes and Paris Dauphine. This ANR project will be active up to August 2016.

Xavier Antoine is coordinator for partner 2 of ANR blanc project BECASIM since September 2013. This ANR project will be active up to 2017.

6.3. International Initiatives

6.3.1. Inria International Partners

6.3.1.1. Informal International Partners

Most of the members of our team have regular collaborations with colleagues in abroad institutions.

Let us mention two new collaborations of Xavier Antoine with E. Lorin and A.D. Bandrauk (from Université de Carleton, Canada) and CRM, Montréal on one hand and with W. Bao (National University of Singapore) on the other hand. These two independent collaborations both deal with numerical computations in quantum mechanics (quantum chemistry and Bose-Einstein condensates).

6.4. International Research Visitors

6.4.1. Visits of International Scientists

George Weiss has been invited in our team for three months. This invitation was part of the “ Chercheur d’excellence” program of Région Lorraine.

Ademir Fernando Pazoto visited our team during March 2013.

Fernando José Henriquez Barraza visited our team from February to June 2013.

6.4.2. Visits to International Teams

Marius Tucnsak was invited in the University of Wuhan (one month).

CQFD Project-Team

8. Partnerships and Cooperations

8.1. Regional Initiatives

8.1.1. *PSI : Psychology and Sound Interactions*

The aim of this project was to develop a classifier to automatically determine the alertness state of humans from electroencephalographic (EEG) signals. Such a task is relevant to diverse domains, where a person is expected to be in a highly alert state. The goal was to contrast a Brain-Computer Interface (BCI) based on synthesized music to modify alertness state of a person. This Région Aquitaine grant (2010-2013) grant included the PHD-grant of Laurent Vezard.

8.1.2. *Chaire Inria-Astrium-EADS IW-Conseil régional d'Aquitaine*

The chaire is funding the PhD thesis of Christophe Nivot on the optimization of the assembly line of the future European launcher.

8.2. National Initiatives

8.2.1. *ANR FAUTOCOES*

The goal of the project "FAUTOCOES" (number ANR-09-SEGI-004) of the ARPEGE program of the French National Agency of Research (ANR) can be described as follows. Today, complex technological processes must maintain an acceptable behavior in the event of random structural perturbations, such as failures or component degradation. Aerospace engineering provides numerous examples of such situations: an aircraft has to pursue its mission even if some gyroscopes are out of order, a space shuttle has to succeed in its re-entry trip with a failed on-board computer. Failed or degraded operating modes are parts of an embedded system history and should therefore be accounted for during the control synthesis.

These few basic examples show that complex systems like embedded systems are inherently vulnerable to failure of components and their reliability has to be improved through fault-tolerant control. Embedded systems require mathematical representations which are in essence dynamic, multi-model and stochastic. This increasing complexity poses a genuine scientific challenge:

- to model explicitly and realistically the dynamical interactions existing between the physical state variables defining the system: pressure, temperature, flow rate, intensity, etc, and the functional and dysfunctional behavior of its components;
- to estimate the performance of the system through the evaluation of reliability indexes such as availability, quality, and safety;
- to optimize the control to prevent system failures, as well as to maintain the system function when a failure has occurred.

Our aim is to meet the previously mentioned challenge by using the framework of piecewise deterministic Markov processes (PDMP's in short) with an emphasis on probabilistic and deterministic numerical methods. More precisely, our objectives are

- to use the framework of piecewise deterministic Markov processes to model complex physical systems and phenomena;
- to compute expectations of functionals of the process in order to evaluate the performance of the system;
- to develop theoretical and numerical control tools for PDMP's to optimize the performance and/or to maintain system function when a failure has occurred.

More details are available at <http://fautocoes.bordeaux.inria.fr/>.

8.2.2. ANR ADAPTEAU

The ANR project ADAPTEAU has been obtained for the period 2012-2016 and will start in January 2012.

ADAPTEAU aims to contribute to the analysis and management of global change impacts and adaptation patterns in River-Estuarine Environments (REEs) by interpreting the scientific challenges associated with climate change in terms of: i) scale mismatches; ii) uncertainty and cognitive biases between social actors; iii) interdisciplinary dialogue on the "adaptation" concept; iv) critical insights on adaptive governance and actions, v) understanding the diversity of professional, social and economic practices vis-à-vis global change. The project aims to build an integrative and interdisciplinary framework involving biophysical and social sciences, as well as stakeholders and civil society partners. The main objective is to identify adaptive strategies able to face the stakes of global change in REEs, on the basis of what we call 'innovative adaptation options'.

We consider the adaptation of Social-Ecological Systems (SES) through the expected variations of the hydrological regimes (floods / low-flow) of the Garonne-Gironde REE—a salient issue in SW France, yet with a high potential for genericity. The ADAPTEAU project will be organised as follows:

- Achieve and confront socio-economic and environmental assessments of expected CC impacts on the Garonne-Gironde river-estuarine continuum (task 1);
- Identify the emerging 'innovative adaptation options' endorsed by various social, economic, political actors of the territory (depolderisation, 'room for rivers' strategies, changes in economic activities, agricultural systems or social practices), then test their environmental, economic and social robustness through a selected subset (task 2);
- Scientists, representatives from administrators and civil society collaborate to build adaptation scenarios, and discuss them in pluralistic arenas in order to evaluate their social and economic feasibility, as well as the most appropriate governance modes (task 3).
- Disseminate the adaptation strategies to academics and managers, as well as to the broader society (task 4).

The expected results are the definition and diffusion of new regional-scale reference frameworks for the discussion of adaptation scenarios in REE and other SESs, as well as action guidelines to better address climate change stakes.

The CQFD team work on tasks 1 and 3.

8.2.3. ANR Piece

ANR Piece (2013-2016) of the program *Jeunes chercheuses et jeunes chercheurs* of the French National Agency of Research (ANR), lead by F. Malrieu (Univ. Tours). The Piecewise Deterministic Markov Processes (PDMP) are non-diffusive stochastic processes which naturally appear in many areas of applications as communication networks, neuron activities, biological populations or reliability of complex systems. Their mathematical study has been intensively carried out in the past two decades but many challenging problems remain completely open. This project aims at federating a group of experts with different backgrounds (probability, statistics, analysis, partial derivative equations, modeling) in order to pool everyone's knowledge and create new tools to study PDMPs. The main lines of the project relate to estimation, simulation and asymptotic behaviors (long time, large populations, multi-scale problems) in the various contexts of application.

8.3. European Initiatives

8.3.1. Collaborations in European Programs, except FP7

Numerical methods for Markov decision processes (2013-2015) This project is funded by the Gobierno de Espana, Dercion Genral de Investigacion Cinetifica y Tecnica (reference number: MTM2012-31393) for three years to support the scientific collaboration between Tomas Prieto-Rumeau and François Dufour. This research project is concerned with numerical methods for Markov decision processes (MDPs). Namely, we are interested in approximating numerically the optimal value function and the optimal controls for different classes of constrained and unconstrained MDPs. Our methods are based on combining the linear programming formulation of an MDP with a discretization procedure —referred to as quantization— of a probability distribution, underlying the random transitions of the dynamic system. We are concerned with optimality criteria such as the total expected cost criterion (for finite horizon problems) and, on the other hand, the total expected discounted cost and the average cost optimality criteria (for infinite horizon problems).

8.4. International Initiatives

8.4.1. Participation In other International Programs

Control of Dynamic Systems Subject to Stochastic Jumps USP-COFECUB grant (2013-2016). The main goals of this joint cooperation will be to study the control of dynamic systems subject to stochastic jumps. Three topics will be considered throughout the next 3 years. In the first topic we will study the control problem of piecewise-deterministic Markov processes (PDMP's) considering constraints. In this case the main goal is to obtain a theoretical formulation for the equivalence between the original optimal control of PDMP's with constrains and an infinite dimensional static linear optimization problem over a space of occupation measures of the controlled process. F. Dufour at Inria and O. Costa in USP will mainly carry out this topic. In the second topic we will focus on numerical methods for solving control and filtering problems related to Markov jump linear systems (MJLS). This project will allow a first cooperation between B. de Saporta and E. Costa. The third research subject will be focused on quantum control by using Lyapunov-like stochastic methods and P. Rouchon and P. Pereira da Silva will conduct it.

8.5. International Research Visitors

8.5.1. Visits of International Scientists

Eduardo Costa (Univ. São Paulo), invited from July 22nd to August 1st 2013, USP-COFECUB grant.

8.5.2. Visits to International Teams

Benoîte de Saporta was invited one week (April 22-April 29) by Jian-Fang Yao at the University of Hong Kong. Benoîte de Saporta was invited three weeks (May 22-June 8) by Eduardo Costa at the University of São Paulo in São Carlos, Brazil (USP-COFECUB grant).

DEFI Project-Team

8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. ANR

- J.R. Li is the coordinator of the project Simulation du signal d'IRM diffusion dans des tissus biologiques (SIMUDMRI), funded 2010-2013 by the ANR Program COSINUS. Participants : Jing-Rebecca Li, Housseem Haddar, Dang Van Nguyen. Joint proposal between Inria-Saclay and CEA Neurospin. <http://www.cmap.polytechnique.fr/~jingrebeccali/grants/simudmri.html>
- H. Haddar is the DEFI coordinator of the ANR: Modelization and numerical simulation of wave propagation in metamaterials (METAMATH), program MN, 2011-2015. This is a joint ANR with POEMS, Inria Scalay Ile de France project team (Coordinator, S. Fliss), DMIA, Département de Mathématiques de l'ISAE and IMATH, Laboratoire de Mathématiques de l'Université de Toulon. <https://www.rocq.inria.fr/poems/metamath>
- J.R. Li is the coordinator of the Inria partner of the project "Computational Imaging of the Aging Cerebral Microvasculature", funded by ANR Program "US-French Collaboration". French Partners (Coordinating partner CEA Neurospin): CEA Neurospin (Coordinator Luisa Ciobanu), Inria Saclay (Coordinator Jing-Rebecca Li). US Partner: Univ of Illinois, bioengineering department (Coordinator Brad Sutton). Duration: Sept 2013- Sept 2016.

8.2. European Initiatives

8.2.1. Collaborations with Major European Organizations

Partner 1: University of Bremen, Department of Math. (Germany)

Joint PhD advising of T. Rienmuller, partly funded by French-German university. Correspondant: Armin Lechleiter.

Partner 2: University of Goettingen, Department of Math. (Germany)

Development of conformal mapping method to electrostatic inverse problems. Correspondant: Rainer Kress.

Partner 3: University of Genova, Department of Math. (Italy)

Development of qualitative methods in inverse scattering problems. Correspondant: Michele Piana.

8.3. International Initiatives

8.3.1. Inria Associate Teams

8.3.1.1. ISIP

Title: Inverse Scattering and Identification Problems

Inria principal investigator: Housseem HADDAR

International Partner (Institution - Laboratory - Researcher):

University of Delaware (United States) - Mathematical Department - Housseem HADDAR

Duration: 2008 - 2013

See also: <http://www.cmap.polytechnique.fr/~defi/ISIP/isip.html>

8.3.2. Inria International Partners

8.3.2.1. Declared Inria International Partners

- Mathematical department of the University of Delaware

8.3.3. Participation In other International Programs

- H. Haddar is member of the EPIC, an Inria team in the framework of LIRIMA.
- Olivier Pantz is in charge of the french side of the PHC (Hubert Curien Project) *Sur l'étude de quelques problèmes d'équations aux dérivées partielles issus de la physique* (with H. Zorgati of the University of Tunis in charge for the Tunisian side).

8.4. International Research Visitors

8.4.1. Visits of International Scientists

8.4.1.1. Sabbatical

- Yassine Boubendir, Department of Mathematical Sciences, New Jersey Institute of Technology (October-December 2013)

8.4.1.2. Internships

- Thi-Phong Nguyen (March-August 2013)
- Mohamed Lakhel (February-June 2013)
- Ahmed Aaddaj Eloudrhiri February 2013-June 2013
- Isaac Harris May 2013-July 2013
- Shixu Meng May 2013-August 2013
- Khieu Van NGUYEN, April-July 2013.

DISCO Project-Team

8. Partnerships and Cooperations

8.1. Regional Initiatives

- DIGITEO Project (DIM LSC) ALMA
Project title: Mathematical Analysis of Acute Myeloid Leukemia
Decembre 2010 - December 2013
Coordinator: Catherine Bonnet
Other partners: Inria Paris-Rocquencourt, France, L2S, France, INSERM, Cordeliers Research Center, France.
Abstract: this project studies a model of leukaemia based on previous works by M. Adimy and F. Crauste (Lyon), with theoretical model design adjustments and analysis in J. L. Avila Alonso's Ph D thesis and experimental parameter identification initiated by F. Merhi, postdoc of Bang (Dec. 2010-Nov. 2011), working at St. Antoine Hospital (Paris) on biological experiments on leukaemic cells.
- DIGITEO Project (DIM Cancéropôle) ALMA2
Project title: Mathematical Analysis of Acute Myeloid Leukemia - 2
October 2011 - March 2013
Coordinator: Jean Clairambault (Inria Paris-Rocquencourt)
Other partners: Inria Saclay-Île-de-France, France, L2S, France, INSERM, Cordeliers Research Center, France.
Abstract: This project has taken over the experimental identification part in St. Antoine Hospital, together with further model design with the postdoc of A. Ballesta (BANG). With this postdoc project have also been developed the theoretical and experimental - in leukaemic cell cultures - study of combined therapies by classical cytotoxics (anthracyclins, aracytin) and recently available targeted therapies (anti-Flt-3).
- DIGITEO Project (DIM LSC) MOISYR
Project title: Monotonie, observateur par intervalles et systèmes à retard.
Decembre 2011- December 2014
Coordinator: Frédéric Mazenc
Other partners: L2S, France, Mines-ParisTech, France
Abstract: MOISYR is concerned with the problem of extending the theory of monotone systems to the main families of continuous time systems with delay along with the application of this theory to the design of observers and interval observers. In particular, nonlinear systems with pointwise and distributed delays and stabilizable systems with delay in the input shall be considered. In a second step, we extend our result to discrete time systems and to a specific class of continuous/discrete systems called Networked Control Systems.

8.2. National Initiatives

8.2.1. ANR

An ANR Blanc SIMI 3 “Multidimensional Systems: Digression On Stabilities” (MSDOS) was submitted in 2013 and accepted. It will start in 2014 for a period of 4 years. Alban Quadrat is the local leader for Inria Saclay. For more details, see <http://www.lias-lab.fr/perso/nimayeganefer/doku.php>. Its main goal is to constructively study stabilities and stabilization problems of (nonlinear) multidimensional systems.

8.3. European Initiatives

8.3.1. Collaborations in European Programs, except FP7

Program: GDRI (European research network founded by CNRS)

Project acronym: DelSys

Project title: Delay Systems

Duration: 2011-2015

Coordinator: Silviu Iulian Niculescu

Other partners: GIPSA-Lab and LAAS France, Ancona University Italy, Czech Technical University in Prague Czech Republic, Kent University Great-Britain, KTH Stockholm Sweden and KU Leuven Belgium.

Abstract: the aim of this GDRI is to bring together the main European teams which work in the fields of Delay systems. This network meets once a year.

Program: PHC Aurora (Norway)

Project acronym: 28920SB

Project title: Connections between constrained control law synthesis and theory of positive dynamical systems

Duration: 2013

Coordinator: Sorin Olaru (French leader), Morten Hovd (Norwegian leader)

Other partners: NTNU Trondheim

Abstract: The project is constructed with two main scientific objectives: a) The (controlled) invariant set computation and their use in the stability analysis The main objective is the construction of invariant sets of reduced complexity in terms of generators (for example vertices in polyhedral/zonotopic sets). Such invariant sets are related to the positivity by the invariance of the positive orthant of a dual (comparison) state space. The existence of invariant sets will be subsequently linked through this comparison systems with the stability analysis of complex (large scale, interconnected, hybrid, delay-affected or nonlinear) dynamics. The results will be compared with the state of the art methods as for example those related to the feasible set description in Model Predictive Control related problems. b) Control design for constrained dynamical systems Once the invariance tools with manageable complexity are available, the respective set will be employed in the synthesis procedure as Lyapunov level sets. Practically this will lead to polyhedral Lyapunov functions type of constructions for which interpolation based techniques have recently been shown to be effective. Further, the robustness and the performance of the resulting closed-loop dynamics need to be adjusted in accordance with the choice of the interpolation factor. These control design degrees of freedom need to be adjusted with respect to positiveness or monotonicity requirements.

Program: PHC Pessoa (Portugal)

Project acronym: 28750QA

Project title: Robust Distributed Model Predictive Control of Medium- and Large- Scale Systems

Duration: 2013-2014

Coordinator: Cristina Stoica (French leader), Fernando Lobo Perreira (Portuguese leader)

Other partners: Sorin Olaru

Program: PHC Brancusi (Romania)

Project acronym: 28705PF

Project title: Adaptive and predictive control of bioprocesses (modelling, identification and control of interconnected bioprocesses)

Duration: 2013-2014

Coordinator: Sihem Tebbani (French leader), Dan Selisteanu (Romanian leader)

Other partners: Sorin Olaru

Program: PHC Parrot

Project acronym: CASCAC

Project title: Computer Algebra, Symbolic Computation, and Automatic Control

Duration: 2013 - 2014

Coordinator: Alban Quadrat (French leader), Maris Tõnso (Estonian leader)

Other partners: Institute of Cybernetics, University of Tallinn

Abstract: The CASCAC project is at the interfaces of control theory, computer algebra and software engineering. The goals of the project are: 1. Develop new theoretical results on nonlinear control systems defined by functional equations (e.g., ordinary differential equations, partial differential equations, differential time-delay equations, partial difference equations). 2. Implement them on dedicated softwares developed in the computer algebra system Mathematica. In particular, Mathematica versions of the OREMODULES and ORE MORPHISMS packages will be developed. 3. Develop an interface between the C library BLAD (<http://www.lifl.fr/~boulrier/pmwiki/pmwiki.php?n=Main.BLAD>) – dedicated to differential algebra techniques – and Mathematica. This interface will allow one to have access to differential elimination techniques in Mathematica and to use them in decision methods for nonlinear control theory. 4. Co-supervise the Master thesis of Kristina Halturina with Prof. Ülle Kotta on constructive aspects of differential flatness and its applications to control theory (e.g., tracking, motion planning).

Program: PHC Rila (Bulgaria)

Project acronym: 29401YJ

Project title: Robust Distributed Model Predictive Control of Medium- and Large- Scale Systems

Duration: 2013-2014

Coordinator: Sorin Olaru (French leader), Alexandra Grancharova (Bulgarian leader)

Other partners: Bulgarian Academy of Science

Abstract: The project intends to address the control design of large scale dynamical systems with an emphasis on distributed predictive control strategies. There are two points of view with respect to the control synthesis in this framework: a. avoid the use of a global prediction model in the receding horizon optimal control of the subsystems and privilege the use of a coordination level in the decision process; b. consider the distributed synthesis for a network of discrete-time constrained linear systems without central coordinator. In the present project we intend to contribute to both of these directions by: a. Prediction of the interactions in between subsystems in a decomposition-coordination scheme. This can be done by imposing a reduced set of constraints for the MPC problems at the lower levels. b. With respect to the MPC design in the absence of coordination one of the issues will be the definition of appropriate terminal sets, ensuring invariance properties or at least recursive feasibility for the global functioning. We will investigate the construction of terminal set for a stabilizing centralized MPC decomposable in the form of a cross product of sets in each subsystem state space. An interesting idea on this direction was presented recently by the participants in this project.

8.3.2. Collaborations with Major European Organizations

Partner 1: University of l'Aquila, Italy

Nonlinear delay systems interconnected with a differential-difference equation.

Partner 2: RWTH Aachen University, Germany

Mathematical systems theory, control theory, symbolic computation

Partner 3: Bilkent University, Turkey

Control of linear and nonlinear systems with delays, medical applications

Partner 4: Tel Aviv University, Israel

Stability analysis of nonlinear Partial Differential Equations

8.4. International Initiatives

8.4.1. Inria International Partners

8.4.1.1. Informal International Partners

- UNICAMP, Sao Paulo, Brazil
- Kyushu Institute of Technology, Iizuka, Fukuoka, Japan
- Louisiana State University, Baton Rouge, USA
- University of California, San Diego, CA, USA

8.5. International Research Visitors

8.5.1. Visits of International Scientists

Within the PHC Parrot (Inria Saclay - Institute of Cybernetics, University of Tallinn), Ülle Kotta, Maris Tõnso and Juri Belikov visited the DISCO project (twice for a week).

Within the invited Professor Program of DIGITEO, Prof. Georges BiTSORIS visited the DISCO project and Supélec from January-July 2013 and Emilia Fridman visited the DISCO project in September 2013.

8.5.2. Visits to International Teams

Alban Quadrat was invited by the Mathematics department of the Universidad Nacional de Colombia Bogotá (Colombia) for two weeks, and at the Tempere University of Technology (Finland).

DOLPHIN Project-Team

8. Partnerships and Cooperations

8.1. Regional Initiatives

- PPF (Bioinformatics): This national program within the University of Lille 1 deals with solving bioinformatics and computational biology problems using combinatorial optimization techniques, 2010-2013.
- PPF HPC (High performance computing), 2010-2013.
- CIA (Campus Intelligence Ambiante) project from CPER (Contrat Plan Etat Région): Transversal research action: “High performance computing”, 2010-2013.

8.2. National Initiatives

8.2.1. ANR

- ANR project Transports Terrestres Durable “RESPET - Gestion de réseaux de service porte-à-porte efficace pour le transport de marchandises”, in collaboration with LAAS (Toulouse), DHL, JASSP, LIA (Univ. Avignon) (2011-2014).
- ANR project Modèles Numériques “NumBBO - Analysis, Improvement and Evaluation of Numerical Blackbox Optimizers” (2012-2016) in collaboration with Inria Saclay, TAO team, Ecole des Mines de St. Etienne, CROCUS team, and TU Dortmund University, Germany (2012-2016).

8.3. European Initiatives

8.3.1. Collaborations in European Programs, except FP7

Program: COST

Project acronym: IC0804

Project title: Energy efficiency in large scale distributed systems

Duration: Jan 2009 - May 2013

Coordinator: J. M. Pierson

Other partners: More than 20 European countries.

Abstract: The COST Action IC0804 proposes realistic energy-efficient alternate solutions to share IT distributed resources. As large scale distributed systems gather and share more and more computing nodes and Storage resources, their energy consumption is exponentially increasing. While much effort is nowadays put into hardware specific solutions to lower energy consumptions, the need for a complementary approach is necessary at the distributed system level, i.e. middleware, network and applications. The Action characterizes the energy consumption and energy efficiencies of distributed applications.

8.3.2. Collaborations with Major European Organizations

University of Luxembourg: CSC, ILIAS (Luxembourg)

Design of parallel and hybrid metaheuristics to solve complex optimization problems

University of Malaga: ETSI Informatica (Spain)

Parallel metaheuristics for dynamic optimization

8.4. International Initiatives

8.4.1. Inria Associate Teams

8.4.1.1. STEM

Title: deciSion Tools for Energy Management (STEM)

Inria principal investigator: L. Brotcorne

International Partners (Institution - Laboratory - Researcher):

Polytechnic School of Montréal (Canada) - Département de mathématique et génie industriel

Université de Montréal (Canada) - Département d'informatique et recherche opérationnelle

Duration: 2012 - 2014

See also: <http://dolphin.lille.inria.fr/Dolphin/EA-DOLPHIN>

The economic rise of developing countries, together with the need to meet ever more stringent pollution reduction targets, will increase the stress on the global energy system. Within this framework, the goal of the current project is to develop decision tools for energy management in a context of market deregulation. We will focus on two issues, namely demand management and production planning.

The first problem is concerned with the efficient management of consumption. More precisely, the short or long term behaviour of customers can be influenced through signals sent by a utility (or several utilities) to the end-users. These signals can take the form of an "optimal" pricing scheme, or yet of devices (timers, automatic switches, etc.) designed to induce an "optimal" behaviour from the users.

The second issue is concerned with efficient management of sustainable energy production. Indeed the development of renewable energy introduces new parameters in the supply/demand global equilibrium process. The issue is to achieve the right trade-off between costs (production, security) and revenues when determining the daily hydro-electricity generation and storage within an environment where demand is stochastic.

The first problem is modeled as a bilevel program, the second one as a integer multi-objective stochastic program. Efficient and effective solution methods are developed and implemented to solve these problems.

8.4.2. Inria International Partners

- University of Sydney, Australia
- University of Montreal, Canada
- Ecole Polytechnique of Montreal, Canada

8.4.2.1. Declared Inria International Partners

- University of Luxembourg, Luxembourg

8.4.2.2. Informal International Partners

- University of Shinshu, Nagano, Japan: Evolutionary multi-objective optimization, landscape analysis, and search performance (JSPS project 2013-2016)
- Cooperation with Hernan Aguirre et Tanaka : Internship in Japan of A. Blot co-supervised by H. Aguirre, C. Dhaenens, L. Jourdan and Tanaka

8.4.3. Participation In other International Programs

- Inria STIC-Tunisie 2011-2013.
- CNRS PICS Luxembourg 2012-2014.

- Japanese Government Grant Program 2013.

8.5. International Research Visitors

8.5.1. Visits of International Scientists

- Dr. Hernan Aguirre, Shinshu University, Japan
- Prof. Kiyoshi Tanaka, Shinshu University, Japan
- Prof. Michel Gendreau, University of Montreal
- Prof. Pascal Bouvry, University of Luxembourg

8.5.1.1. Internships

- Martin Drozdik [PhD student, Shinshu University, Japan, from Nov 2013]

8.5.2. Visits to International Teams

- E-G. Talbi, June 2013, Univ. Colchester, Sussex, UK
- E-G. Talbi, April 2013, Univ. Murcia, Spain

GAMMA3 Project-Team

6. Partnerships and Cooperations

6.1. National Initiatives

6.1.1. ANR

F. Alauzet, N. Barral, V. Menier and A. Loseille are part of the MAIDESC ANR (2013-2015) on mesh adaptation for moving interfaces in CFD.

6.1.2. Autres sections...

P. Laug participated in the Inria collaboration program GEOFRAC: *Large-scale computation of flow in complex 3D geological fractured porous media*. Its coordinator is J. Erhel, SAGE team, Inria Rennes (January 2012 - June 2013). The teams involved are GAMMA3, POMDAPI, SAGE (Inria) and UMR Géosciences Rennes.

6.2. European Initiatives

6.2.1. FP7 Projects

F. Alauzet, N. Barral, V. Menier and A. Loseille are part of the UMRIDA FP7 program (2013-2017) devoted to the control of uncertainties in CFD.

GECO Project-Team

7. Partnerships and Cooperations

7.1. Regional Initiatives

- **Digitéo project CONGEO.** CONGEO (2009–2013) is financed by Digitéo in the framework of the DIM *Logiciels et systèmes complexes*. It focuses on the neurophysiology applications. U. Boscain, Y. Chitour (leader), F. Jean and P. Mason are part of the project.
- **Digitéo project 2012-061D SSyCoDyC.** SSyCoDyC (2013–2014) is financed by Digitéo in the framework of the DIM *Hybrid Systems and Sensing Systems*. It focuses on the application of techniques of hybrid systems to the analysis of retarded equations with time-varying delays. SSyCoDyC finances the post-doc fellowship of Ihab Haidar and is coordinated by Paolo Mason and Mario Sigalotti.

7.2. National Initiatives

- **ANR project GCM.** The project ANR GCM (*programme blanc*, 2009–13) involves the great majority of GECO's members (permanent and external). It focuses on various theoretical aspects of geometric control and on quantum control. It is coordinated by J.-P. Gauthier.

7.3. European Initiatives

7.3.1. FP7 Projects

Program: ERC Starting Grant

Project acronym: GeCoMethods

Project title: Geometric Control Methods for the Heat and Schroedinger Equations

Duration: 1/5/2010 - 1/5/2015

Coordinator: Ugo Boscain

Abstract: The aim of this project is to study certain PDEs for which geometric control techniques open new horizons. More precisely we plan to exploit the relation between the sub-Riemannian distance and the properties of the kernel of the corresponding hypoelliptic heat equation and to study controllability properties of the Schroedinger equation.

All subjects studied in this project are applications-driven: the problem of controllability of the Schroedinger equation has direct applications in Laser spectroscopy and in Nuclear Magnetic Resonance; the problem of nonisotropic diffusion has applications in cognitive neuroscience (in particular for models of human vision).

Participants. Main collaborator: Mario Sigalotti. Other members of the team: Andrei Agrachev, Riccardo Adami, Thomas Chambrion, Grégoire Charlot, Yacine Chitour, Jean-Paul Gauthier, Frédéric Jean.

7.4. International Initiatives

7.4.1. Inria International Partners

7.4.1.1. Informal International Partners

SISSA (Scuola Internazionale Superiore di Studi Avanzati), Trieste, Italy.

Sector of Functional Analysis and Applications, Geometric Control group. Coordinator: Andrei A. Agrachev.

We collaborate with the Geometric Control group at SISSA mainly on subjects related with sub-Riemannian geometry. Thanks partly to our collaboration, SISSA has established an official research partnership with École Polytechnique.

7.4.2. Participation In other International Programs

- Laboratoire Euro Maghrébin de Mathématiques et de leurs Interactions (LEM2I)
<http://www.lem2i.cnrs.fr/>
- GDRE Control of Partial Differential Equations (CONEDP)
<http://www.ceremade.dauphine.fr/~glass/GDRE/>

GEOSTAT Project-Team

7. Partnerships and Cooperations

7.1. National Initiatives

- ICARODE [2013-2016]. Participants : Hussein Yahia, Oriol Pont, Véronique Garçon, Joel Sudre, Antonio Turiel, Christine Provost [LOCEAN]. 4-year contract, CNES-NASA funding, started 2013. Title: *ICARODE: Integration and cascading for high resolution ocean dynamics*. Project leader: H. Yahia.
- IHU LIRYC and CRA DIAFIL project [2012-2014]. Post-doctoral fellow: B. Xu. Project leaders H. Yahia and O. Bernus.
- REGION AQUITAINE PROJECT "OPTAD". Participants : H. Yahia, S. Kumar Maji. Project leader: H. Yahia.

7.2. European Initiatives

7.2.1. Collaborations in European Programs, except FP7

Program: ESA (European Spatial Agency) Support to Science Element

Project acronym: OceanFlux

Project title: High resolution mapping of GHGs exchange fluxes.

Duration: 09/2011 - 09/2014

Coordinator: C. Garbe

Other partners: IWR (University of Heidelberg), LEGOS (CNRS DR-14), GEOSTAT (Inria), KIT (Karlsruher Institut für Technologie, Frankfurt), IRD, Université Paul Sabatier.

Abstract: The EBUS (Eastern Boundary Upwelling Systems) and OMZs (Oxygen Minimum Zone) contribute very significantly to the gas exchange between the ocean and the atmosphere, notably with respect to the greenhouse gases (hereafter GHG). Invasion or outgassing fluxes of radiatively-active gases at the air-sea interface result in coupled or decoupled sink and source configurations. From in-situ ocean measurements, the uncertainty of the net global ocean-atmosphere CO₂ fluxes is between 20 and 30%, and could be much higher in the EBUS-OMZ. Off Peru, very few in-situ data are available presently, which justifies alternative approaches for assessing the fluxes. GHG vertical column densities (VCD) can be extracted from satellite spectrometers. The accuracy of these VCDs need to be very high in order to make extraction of sources feasible. To achieve this accuracy is extremely challenging, particularly above water bodies, as water strongly absorbs infra-red (IR) radiation. To increase the amount of reflected light, specular reflections (sun glint) can be used on some instruments such as GOSAT. Also, denoising techniques from image processing may be used for improving the signal-to-noise ratio (SNR). GHG air-sea fluxes determination can be inferred from inverse modeling applied to VCDs, using state of the art modeling, at low spatial resolution. For accurately linking sources of GHGs to EBUS and OMZs, the resolution of the source regions needs to be increased. This task develops on new non-linear and multiscale processing methods for complex signals to infer a higher spatial resolution mapping of the fluxes and the associated sinks and sources between the atmosphere and the ocean. Such an inference takes into account the cascading properties of physical variables across the scales in complex signals. The use of coupled satellite data (e.g. SST and/or Ocean colour) that carry turbulence information associated to ocean dynamics is taken into account at unprecedented detail level to incorporate turbulence effects in the evaluation of the air-sea fluxes. We will present a framework as described above for determining sources and sinks of GHG from satellite remote sensing. The approach includes resolutions enhancements from nonlinear and multiscale processing methods. The applicability is validated against ground truth observations and numerical model studies.

7.3. International Initiatives

- Project "Profilage à partir des données hétérogènes du Web pour la cybersécurité" funded by the Canadian CRSNG (3 years) is in its last year. The partners in this project are: Univ of Sherbrooke, Concordia Univ, Sûreté du Québec, the company E-Profile and GEOSTAT. related publication: [23].
- The Volubilis project "Study of Upwelling in the Moroccan coast by satellite imaging" led by K. Daoudi is in its last year. The partners in this project are: Faculté des sciences de Rabat (FSR), Centre Royal de Télédétection Spatiale (CRTS), LEGOS-CNRS (Toulouse) and GEOSTAT.

7.3.1. Inria Associate Teams

A project of Associate Team with Indian Partner IIT Roorkee is submitted for 2014. This EA team project comes in conjunction with accepted IFCAM project (Indo-French Centre for Applied Mathematics) *Optimal inference in complex and turbulent data*.

7.3.2. Inria International Partners

7.3.2.1. Informal International Partners

IIT Roorkee: Indo-French Centre for Applied Mathematics (IFCAM) project [2014-2017] and submitted Associated Team project (2014).

7.3.3. Participation In other International Programs

- IFCAM (India): Indo-French Centre for Applied Mathematics (IFCAM) project [2014-2017]. Title: *Optimal inference in complex and turbulent data*. 3-year contract, IFCAM funding, started 2014. Partners: GEOSTAT and IIT ROORKEE (INDIA).

7.4. International Research Visitors

7.4.1. Visits of International Scientists

7.4.1.1. Internships

Safa Mrad

Subject: Nonlinear speech analysis for pathological voice detection.

Date: from April 2013 until September 2013.

Report: [41].

Institution: Ecole Nationale d'Ingénieurs de Tunis (Tunisia)

Nicolas Vinuesa

Subject: Matching pursuit for efficient speech coding.

Date: from October 2012 until Avril 2013.

Report: [44]

Institution: Facultad de Ciencias Exactas, Ingenieria y Agrimensura (FCEIA), UNR (Rosario, Argentina)

Blaise Bertrac

Subject: Matching pursuit for pathological voice classification.

Date: June and July 2013.

Report: [40].

Institution: Université de Bordeaux-1.

I4S Project-Team

7. Partnerships and Cooperations

7.1. National Initiatives

7.1.1. Collaboration with ADVITAM

Participants: Laurent Mevel, Dominique Siegert, Ivan Gueguen.

contract 6841.

I4S is related to the project FUI SIPRIS (Systèmes d'Instrumentation pour la prévention des risques), lead by Advitam. Dominique Siegert and Ivan Gueguin handled instrumentation of a portique structure in Nantes for testing in scilab, matlab and lab view of modal analysis algorithms. Link with PEGASE platform have been done, testing and damage simulation have been performed. Internal report has been produced.

7.1.2. Collaboration with STX

Participants: Dominique Siegert, Ivan Gueguen.

Collaboration happened with STX during Fondeol project for the monitoring of foundation of wind turbine.

7.1.3. Collaboration with ISAE

Participants: Laurent Mevel, Ahmed Jhinaoui.

Ahmed Jhinaoui is finishing his thesis on helicopter instability. This thesis is codirected by professor Morlier from ISAE, France. This thesis is funded by FP7-NMP Large Scale Integrated Project IRIS.

7.2. European Initiatives

7.2.1. FP7 Projects

7.2.1.1. FP7 ISMS

Participants: Laurent Mevel, Michael Doehler.

Type: PEOPLE

Instrument: Industry-Academia Partnerships and Pathway (IAPP)

Duration: September 2010 - August 2014

Coordinator: SVS (Structural Vibrations Solutions) (Denmark)

Others partners: University of British Columbia, Canada

In 2009, a proposal has been submitted with SVS, University of British Columbia and I4S to develop a framework for handling structural health monitoring methods. This proposal implies some long stay of the concerned people, Laurent Mevel and Michael Doehler for I4S abroad. Palle Andersen and one of its engineer from SVS are assumed to stay 9 months at Inria, for tighten integration of COSMAD and ARTEMIS software. The proposal has been rated 88/100 and ranked A in the final selection procedure. The project has been signed on August 1st 2010 and has been running from September 1st. Michael Doehler has been spending 5 months in 2010-2011 in Denmark. Laurent Mevel spent 2 months in 2012 in Denmark. Palle Andersen was in Rennes in 2013 for 3 months. The mid term project has been well reviewed by the EC.

7.2.1.2. MODRIO Project

Participant: Qinghua Zhang.

MODRIO: Model Driven Physical Systems Operation. This ITEA 2 (Information Technology for European Advancement) project is joined by partners from Austria, Belgium, Finland, France, Germany, Italy and Sweden. See the complete list of partners on the MODRIO page of the ITEA call website (<https://itea3.org/all-projects/call-14.html>).

To meet the evermore stringent safety and environmental regulations for power plants and transportation vehicles, system operators need new techniques to improve system diagnosis and operation. Open standards are necessary for different teams to cooperate by sharing compatible information and data. The objective of the MODRIO project is to extend modeling and simulation tools based on open standards from system design to system diagnosis and operation.

7.3. International Initiatives

7.3.1. Inria International Partners

7.3.1.1. SIMS, Canada

Participants: Michael Doehler, Laurent Mevel.

A new project called SIMS is currently ongoing on vibration analysis and monitoring in Canada. This project is funded by Ministry of Transport, British Columbia, Canada. It implies deep collaboration with University of British Columbia, Canada.

SVS and I4S are investigating how to link the modal analysis software ARTeMIS of SVS and COSMAD. Through an annual agreement, I4S gets a license of ARTeMIS in exchange to offer support for integrating our damage detection software into SVS software and offerings. I4S provides algorithms and expertise for integration within a damage detection structural health monitoring system and SVIBS does the implementation. This technology transfer has been funded by the ministry of transportation of British Columbia, Canada. The work is supervised by UBC, CA. The end product will be a web based structural health monitoring system for in operation bridges.

7.3.1.2. Collaboration on damage localization and monitoring with Boston University

This work is related to the thesis of Luciano Gallegos. The objective is the draft of an associated Inria team. Currently exchange of postdocs and joint PhD supervision have been done.

7.3.2. Participation In International Programs

7.3.2.1. Northeastern University

Participants: Laurent Mevel, Michael Doehler, Luciano Gallegos.

Program: International joint supervision of PhD agreement

Title: Design of fast statistical algorithms for monitoring of damage and uncertainties in civil and aeronautic structures

Inria principal investigator: Laurent MEVEL

Northeastern University (United States)

Duration: May 2011 - Apr 2014

This collaboration involves a PhD student, Luciano Gallegos, and is involving Professor Bernal from University of Boston, USA. The thesis has been defended in 2013.

7.4. International Research Visitors

7.4.1. Visits of International Scientists

Participants: Koen Tiels, Palle Andersen.

Palle Andersen was here for 3 months within ISMS project.

Koen Tiels from VUB in Bruxelles has visited us for 2 months in 2013.

IPSO Project-Team

6. Partnerships and Cooperations

6.1. National Initiatives

6.1.1. ANR Programme blanc GYPSI: 2010-2014

Participant: Nicolas Crouseilles.

Leader: Ph. Gendrih.

The full description is available at <https://sites.google.com/site/anrgypsi/>

6.1.2. ANR Programme blanc E2T2: 2010-2014

Participant: Nicolas Crouseilles.

Leader: P. Beyer

6.1.3. ANR Programme blanc STOSYMAP

Participant: Arnaud Debussche.

Leader: A. Shirikyan, The full description is available at <http://shirikyan.u-cergy.fr/stosymap.html>

6.2. European Initiatives

6.2.1. FP7 Projects

6.2.1.1. Geopardi

Title: Geometric Partial Differential Equations

Type: IDEAS ()

Instrument: ERC Starting Grant (Starting)

Duration: September 2011 - August 2016

Coordinator: Inria (France)

See also: <http://www.irisa.fr/ipso/perso/faou/geopardi.html>

Abstract: The goal is to develop new numerical methods for the approximation of evolution equations possessing strong geometric properties such as Hamiltonian systems or stochastic differential equations. Use intensive numerical simulations to discover and analyze new nonlinear phenomena.

6.2.2. Collaborations in European Programs, except FP7

ANR Programme blanc international (BLAN)

LODIQUAS 2012-2015

Low DIMensional QUANtum Systems

Leaders: N. Mauser (Univ. Vienna) and F. Castella (IPSO).

Participants: François Castella, Philippe Chartier, Florian Méhats, Mohammed Lemou.

Fundings for 4 postdocs (48 months) and one pre-doc (36 months).

The whole project involves the following researchers : Norbert Mauser (Vienna), Erich Gornik (Vienna), Mechthild Thalhammer (Innsbruck), Christoph Naegerl (Innsbruck), Jörg Schmiedmayer (Vienna), Hans-Peter Stimming (Vienna). François Castella (IPSO), Florian Méhats (IPSO), Francis Nier (Rennes), Raymond El Hajj (Rennes), Mohammed Lemou (IPSO), Claudia Negulescu (Toulouse), Fanny Delebecque (Toulouse), Stéphane Descombes (Nice), Philippe Chartier (IPSO), Christophe Besse (Lille).

Abstract: Quantum technology as the application of quantum effects in macroscopic devices has an increasing importance, not only for far future goals like the quantum computer, but already now or in the near future. The present project is mainly concerned with the mathematical and numerical analysis of these objects, in conjunction with experimental physicists. On the side of fermions quantum electronic structures like resonant tunnelling diodes show well studied non classical effects like a negative differential resistance that are exploited for novel devices. On the side of bosons the creation and manipulation of Bose Einstein Condensates (the first creation of BECs by Ketterle et al merited a Nobel prize) has become a standard technique that allows to study fundamental quantum concepts like matter-wave duality with increasingly large objects and advanced quantum effects like decoherence, thermalization, quantum chaos. In state-of-the-art experiments e.g. with ultracold atoms in optical lattices the bosonic or fermionic nature of quantum objects can change and it makes a lot of sense to treat the models in parallel in the development of mathematical methods. The experimental progress in these fields is spectacular, but the mathematical modelling and analysis as well as the numerical simulation are lagging behind. Low dimensional models are mostly introduced in a heuristic way and there is also a need for systematic derivations and comparison with the 3-d models. To close the gap is a main goal of this project that aims to deliver reliable tools and programme packages for the numerical simulation of different classes of quantum systems modelled by partial differential equation of NLS type. Virtually all participants have a strong track record of international collaboration, they grew up with the concept of the European Research Area where science knows no boundaries and scientists used to work in different countries, as it was the case in a pronounced way in mathematics and in quantum physics in the thirties of the last century. The Pre- and Post-Docs to be funded by this project will be trained in this spirit of mobility between scientific fields and between places.

6.3. International Initiatives

6.3.1. Participation In other International Programs

- PTDC/EMS-ENE FCT (Fundação para a Ciência e a Tecnologia, Portugal): 2013-2014;
Participant: N. Crouseilles;
Leader: M. Roger
- IFCAM (Institute France-India for Applied Mathematics, India): 2013;
Participant: N. Crouseilles and M. Lemou;
Leaders: R. Raghurama, M. Lemou

6.4. International Research Visitors

6.4.1. Visits of International Scientists

- A. Debussche invited Y. Bakhtin (Georgia Tech., USA) and F. Baudoin (Purdue, USA) for a one month visit.
- L. Einkemmer, University of Innsbrück, one week, july 2013.
- A. Ruhi, Indian Institute of Sciences, 2 months, september-october 2013.
- R. Raghurama, Indian Institute of Sciences, two weeks, october 2013.
- Yong Zhang, under contract in Vienna, has been invited for several periods in Rennes (4 months altogether).

6.4.2. Visits to International Teams

- G. Vilmart: EPF Lausanne (Switzerland), invitation by Assyr Abdulle in the chair of numerical analysis and computational mathematics, several 1-2 weeks visits (totalizing 2 months).
- G. Vilmart: Invited research and teaching position at the University of Geneva, Section of Mathematics, for the period 09/2013-08/2014.

- N. Crouseilles visited the group of E. Sonnendrücker (IPP Garching, Germany), one week (december 2012).
- N. Crouseilles and E. Faou visited the group of A. Ostermann (University of Innsbrück, Austria), one week (march 2013).
- N. Crouseilles visited the group of P. Coelho (Universitat tecnico de Lisboa, Portugal), one week (july 2013).
- N. Crouseilles and M. Lemou visited the group of R. Raghurama (Indian Institute of Sciences, Bangalore (India)), 2 weeks (december 2013).

MATHRISK Project-Team

8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. ANR

B. Jourdain is involved in the ANR Stab (2013/2016). Partners: Lyon1 and Paris-Dauphine.

8.1.2. Competitvity Clusters

Pôle Finance Innovation.

8.2. International Initiatives

8.2.1. Inria International Partners

8.2.1.1. Informal International Partners

- Center of Excellence program in Mathematics and Life Sciences at the Department of Mathematics, University of Oslo, Norway, (with B. Øksendal).
- Department of Mathematics, University of Manchester (with Tusheng Zhang, currently in charge of an EU-ITN program on BSDEs and Applications).
- Mannheim University (with Alexander Schied, Chair of Mathematics in Business and Economics, Department of Mathematics)
- Roma Tor Vergata University (Lucia Caramellino)
- Amsterdam University (Michel Velekoop)
- Delft University (Kees Oosterlee)
- Mexico University and CIMAT (Begonia Fernandez)
- Osaka and Ritsumeikan University (A. Kohatsu-Higa).
- Shandong University, China (Z. Chen)

8.3. International Research Visitors

8.3.1. Visits of International Scientists

- Alexander Schied, Mannheim University,
- Andreea Minca, Cornell University,
- Xin Guo, Berkeley University,
- Arturo Kohatsu Higa, Ritsumeikan University,
- Luis Ortiz Gracia, CWI - Centrum voor Wiskunde en Informatica, Amsterdam,
- Karel in 't Hout, University of Antwerpen,
- Lucia Caramellino, Tor Vergata University, Roma.

Maxplus Project-Team

8. Partnerships and Cooperations

8.1. Actions nationales/National Initiatives

8.1.1. ANR

- Projet ANR Arpège ASOPT (Analyse statique et Optimisation), responsable B. Jeannet. Partenaires: équipe-projet Popart (Inria Grenoble), équipe MeASI, EADS, et Maxplus. Ce projet a été labellisé par le pôle de compétitivité System@tic.
- Participation de Cormac Walsh au projet ANR FINSLER (Géométrie de Finsler et applications).
- Projet ANR CAFEIN (Combinaison d'approches formelles pour l'étude d'invariants numériques), responsable P.L. Garoche. Partenaires: ONERA, CEA LIST, ENSTA Paristech, Inria Saclay (Maxplus, Toccata, Parkas), Université de Perpignan, Prover, Rockwell Collins France.

8.1.2. Programme Gaspard Monge pour l'Optimisation

Projet intitulé "Méthodes tropicales pour l'optimisation", responsable X. Allamigeon, faisant intervenir M. Akian, P. Benchimol, S. Gaubert, R. Katz, et Z. Qu.

8.2. Actions internationales/International Initiatives

8.2.1. Inria International Partners

8.2.1.1. Informal International Partners

Collaborations régulières dans le cadre des programmes internationaux ci-dessous, ainsi qu'avec:

- Ricardo Katz (Conicet et Cifasis, Argentine);
- Alexander Guterman (Moscow State University);
- Françoise Tisseur (Université de Manchester) qui participe à l'encadrement de la thèse d'Andrea Marchesini.

8.2.2. Participation In other International Programs

- La thèse de Pascal Benchimol est financée par une bourse Monge/DGA prévoyant des visites régulières du doctorant dans l'équipe de Michael Joswig (TU-Darmstadt).
- La thèse de Zheng Qu est co-encadrée par Shanjian Tang de l'Université Fudan (Shanghai), dans l'équipe duquel la doctorante effectue une partie de son travail de recherche.
- Les membres de l'équipe sont partenaires du Grant RFBR–CNRF 11-01-93106 "Tropical Mathematics and Mathematical Physics", porté par l'équipe de Grigori Litvinov (Moscou independent University).

8.3. Accueils de chercheurs étrangers/International Research Visitors

8.3.1. Chercheurs étrangers/Visits of International Scientists

- Zur Izhakian, 2 jours en Février.
- Srinivas Sridharan (University of California San Diego), 1 semaine en Mai.
- Ricardo Katz (Conicet, Rosario, Argentine), 2 mois en mars-avril, financé par PGMO.
- Alexander Guterman (Université d'état de Moscou), 5 jours en Septembre.
- Françoise Tisseur (Univ. Manchester), 4 jours en Janvier.

- James Hook (Univ. Manchester), 4 jours en Janvier et 4 jours en Octobre.
- Visite d'un jour de Maurizio Falcone (autour de la thèse de Zheng Qu).
- Visites d'un jour d'Yves Bertot, Didier Henrion, Monique Laurent, Markus Schweighofer, et de 4 jours de Thomas Hales (autour de la thèse de Victor Magron).

8.3.2. Séjours à l'étranger/Visits to International Teams

- P. Benchimol, visite à TU Darmstadt, décembre 2013 (1 semaine).
- A. Marchesini, séjour à l'Université de Manchester, avril 2013 (5 jours).
- M. Akian, séjour à l'Université de Manchester, avril 2013 (2 jours).
- X. Allamigeon, visite à TU Berlin, décembre 2013 (2 jours).

MC2 Project-Team

8. Partnerships and Cooperations

8.1. Regional Initiatives

Angelo Iollo is belongs to the Aerospace Valley committee IGPC. He is monitoring the project ECOSEA for the fnrae <http://www.fnrae.org/>.

8.2. National Initiatives

8.2.1. ANR CARPEiNTER

Participants: Héloïse Beaugendre, Michel Bergmann, Charles-Henri Bruneau, Angelo Iollo [Leader Project], Lisl Weynans.

Cartesian grid, penalization method, complex flow. The P.I. is Angelo Iollo. See <http://www.math.u-bordeaux1.fr/CARPEINTEr/>

8.2.2. ANR CYCLOBULLE

Participants: Charles-Henri Bruneau, Yong Liang Xiang.

The formation and dynamics of long lived coherent structures in atmospheric flows can be mimicked by soap film experiments on an hemisphere heated at the equator. The aim of this work is to simulate such flows and to compare both to the experiments and to the known data of various tornados.

8.2.3. ANR INTCELL

Participants: Thierry Colin, Olivier Saut, Clair Poignard.

The members T.Colin, C.Poignard and O.Saut are involved in the consortium INTCELL directed by P.LEVEQUE (XLIM), and which begun in December 2010. This mutlidisciplinary project, composed of four partners (XLIM laboratory, Vectorology and Anticancer therapies team at the IGR, EDAM and MC2) aims at studying the electroporabilization by nanopulses at the subcellular level. The goal is to develop new electrical devices and accurate models to understand the electroporabilization of the cytoplasm constituents such as the nuclear envelop or the mitochondrial membrane, based on the experiments and on the simulations of molecular dynamics.

8.2.4. ANR MEMOVE

Participants: Mathieu Colin, Thierry Colin, Angelo Iollo, Clair Poignard, Olivier Saut, Lisl Weynans.

Part of the team (M.Colin, T.Colin, A.Iollo, C.Poignard, O.Saut and L. Weynans) are involved in the consortium MEMOVE coordinanted by MC2 (coordinator C. Poignard), and which begins at the beginning of 2012. This consortium is composed of four partners (the Vectorology and Anticancer therapies team at the IGR, the bioengineering laboratory AMPERE of Lyon and the Department of mathematics of Versailles). It aims at developing electroporabilization models from the cell scale to the tissue scale. This project focuses on quite long pulses (from micro- to milli-pulses) compared with the ANR consortium INTCELL that has begun in december 2010. The main goal is to provide multi-scale modelling of "classical" eletroporation, in order to obtain numerical tools that can help from one side the biologists to understand the electroporabilization process when "non standard" pulses are applied, and from the other side it eventually aims at providing tools for the physicians to optimize the pulse delivering when the electrochemotherapy is used.

8.2.5. *PEPS CaRaMel3d*

- Program: PEPS Idex-CNRS
- Project acronym: CaRaMel3d
- Project title: Calibration et Recalage sur l'Imagerie Médicale
- Duration: 07/2012-07/2013
- Coordinator: Olivier Saut
- Other partners: Institut Bergonié, CHU Pellegrin (Bordeaux),

8.2.6. *French-German cooperative consortium SmartOnline*

Participants: Angelo Iollo, Iraj Mortazavi.

- Program: ANR & BMBF
- Project acronym: SmartOnline
- Project title: Online security management toolkit for water distribution networks.
- Duration: 04/2012-04/2015
- Coordinator: Olivier Piller (IRSTEA)
- Other partners: Irstea, Veolia, ENGES, CU Strasbourg, BW Berlin, TZW Dresden, 3S Consult, Franhofer.
- Abstract: The main objective of the project SMaRT-OnlineWDN is the development of an online security management toolkit for water distribution networks that is based on sensor measurements of water quality as well as water quantity. Its field of application ranges from detection of deliberate contamination, including source identification and decision support for effective countermeasures, to improved operation and control of a WDN under normal and abnormal conditions (dual benefit).

8.2.7. *Plan Cancer, biologie des systemes*

Participant: Thierry Colin.

- Program: Modeling cancer biology and treatment
- Project acronym: METASTASIS
- Project title: Modeling the Interaction of the (Metastasis) Vascular/Tumor Niche Using a Systems Biology Approach
- Duration: 2013-2015
- Coordinator: A. Bikfalvi (Biologie, Université de Bordeaux)

8.3. European Initiatives

8.3.1. *FP7 Projects*

8.3.1.1. *FFAST*

Title: FUTURE FAST AEROELASTIC SIMULATION TECHNOLOGIES

Type: COOPERATION (TRANSPORTS)

Instrument: Specific Targeted Research Project (STREP)

Duration: January 2010 - December 2012

Coordinator: University of Bristol (Saint Pierre And Miquelon)

Other partners: University of Bristol, irias, TU Delft, Politecnico di Milano, Numeca, EADS, DLR, Airbus, University of Cap Town, csir, Optimad.

See also: <http://www.bris.ac.uk/aerodynamics-research/ffast/>

Abstract: The FFAST project aims to develop, implement and assess simulation technologies to accelerate future aircraft design. These technologies will demonstrate a step change in the efficiency and accuracy of the dynamic aeroelastic "loads process" using unique critical load identification methods and reduced order modeling. The outcome from the project will contribute to the industrial need to reduce the number of dynamic loads cases analyzed, whilst increasing the accuracy and reducing the cost/time for each unsteady aeroelastic analysis performed compared to the current approach. Unsteady loads calculations play an important part across much of the design and development of an aircraft, and have an impact upon the concept and detailed structural design, aerodynamic characteristics, weight.

8.4. International Initiatives

- Collaboration with Hassan Fathallah, Neuro-oncology and mathematics, University of Alabama at Birmingham. We work on numerical modeling of brain tumor.
- Collaborations with Luca Zannetti, Politecnico di Torino; Simone Camarri, Università di Pisa; Eyal Arian, Boeing Commercial Airplanes.
- PHC Sakura on cancer modeling with University of Osaka. (12Keur for 2 years) Collaboration with the University of Osaka on the modeling of the cell migration in cancer.
- Collaboration with John Ebos, Roswell Park Cancer Institute, Buffalo, NY, USA. Quantification of metastatic potential and differential effect of anti-angiogenic therapies on primary tumor and metastasis, in a preclinical setting.
- Collaboration with the Center of Cancer and Systems Biology at Tufts University, Boston, MA, USA. We work together on quantitative modeling of tumor-tumor interactions and their implications on global metastatic dynamics.
- Collaboration with Sinisa Krajnovic, Chalmers University, on the high fidelity simulation and control of ground vehicle flows.
- Collaboration with Spencer Sherwin and Denis Doorly (Imperial College London) on the novel flow diagnostics approaches.

MCTAO Project-Team

8. Partnerships and Cooperations

8.1. Regional Initiatives

The “région” *Provence Alpes Côte d’Azur* (PACA) partially supports Helen Heninger’s PhD . The other part comes from Thales Alenia space, see section 7.1 .

The “région” *Provence Alpes Côte d’Azur* (PACA) partially supports Jérémy Rouot’s PhD.

8.2. National Initiatives

8.2.1. *IMB - Université de Bourgogne, Dijon*

The team is officially a common team with University of Nice, but also has very strong links with Université de Bourgogne and IMB (Institute of Mathematics in Burgundy). Bernard Bonnard is currently on leave from Université de Bourgogne; Jean-Baptiste Caillau collaborates actively with us; there is also an active common seminar http://math.unice.fr/~rifford/publis/Journee_McTAO/J_McTAO.html .

A formal convention between Inria and Université de Bourgogne is planned for 2014. It will make the IMB control team a part of McTAO.

8.2.2. *GCM (ANR project)*

This is a four year project ending in 2013, on Geometric Control Methods, Sub-Riemannian Geometry and Applications. It is organized in four “poles” and gathers people from Université du Sud Toulon-Var, Université de Bourgogne (Dijon), École Polytechnique (Paris), Nancy-Université, Université Joseph Fourier (Grenoble 1), Université Paris Sud, ParisTech ENSTA and Université Nice Sophia-Antipolis. Bernard Bonnard, Jean-Baptiste Caillau and Ludovic Rifford (leader of one pole) are members of this project. More details on the site; <http://www-fourier.ujf-grenoble.fr/~charlot/GCM.html>.

8.2.3. *Others*

Bernard Bonnard and Ludovic Rifford participate in the GDR MOA, a CNRS network on Mathematics of Optimization and Applications. <http://gdrmoa.univ-perp.fr/>.

Jean-Baptiste Caillau is in the board of governors of the group SMAI-MODE (<http://smai.emath.fr/spip.php?article338>).

Jean-Baptiste Caillau is a member of the Centre de Compétences Techniques (CCT) Mécanique orbitale du CNES

Jean-Baptiste Caillau is the corresponding member in Dijon for the Labex AMIES (<http://www.agence-maths-entreprises.fr/>).

8.3. European Initiatives

8.3.1. *FP7 Projects*

Jean-Baptiste Caillau is a member of the SADCO network (FP7-PEOPLE-2010-ITN, grant no. 264735-SADCO), cf. <http://itn-sadco.inria.fr>.

8.3.2. Collaborations with Major European Organizations

Technische Universität München, Department of Chemistry (Germany).

The applications of optimal control to MNR (see sections 4.2) are conducted with the group of Prof. Steffen Glaser in Munich.

8.4. International Initiatives

University of Hawaii, Department of Mathematics (U. S. A.)

There is a long term collaboration on optimal control and control of quantum systems, see mostly section 6.1.1. Besides, Gautier Picot, a former Phd student from Dijon has a temporary position at the Math Department and collaborates with M. Chyba and G. Patterson (second Phd student from M. Chyba) in relation with the Laboratoire d'Astronomie de Paris, to apply the Hampath code to make rendez-vous with quasi-asteroids entering in the solar system near the L1-Lagrange point, in the continuation of the work developed by G. Picot and B. Daoud. This collaboration is very active and has to be emphasized.

University of Toronto, Department of Mathematics (Canada)

Optimal Transport. Alice Erlinger's PhD is co-supervised by Ludovic Rifford and John Mc Cann from University of Toronto. See section 6.4.

8.5. International Research Visitors

8.5.1. Visits of International Scientists

Alessio Figalli, from University of Texas at Austin, visited twice, for a total of slightly more than a month.

8.5.2. Visits to International Teams

There is a strong collaboration with the control group in the University of Hawaii around M. Chyba. B. Bonnard visited the group twice in 2012-2013 (a total of 3 months). The purpose of the collaboration is to study the aspects of the contrast problem in Nuclear Magnetic Resonance, see section 6.1.1.

Ludovic Rifford was invited to the program "Optimal Transport: Geometry and Dynamics" (<http://www.msri.org/programs/277>) from august to December at MSRI, Berkeley, USA.

Bernard Bonnard was invited to the Japanese forum "Math-for-Industry" 2013 on *The Impact of Applications on Mathematics*, November 4 to 8, 2013, Fukuoka. See <http://fmi2013.imi.kyushu-u.ac.jp/>.

MICMAC Project-Team

7. Partnerships and Cooperations

7.1. International Initiatives

T. Lelièvre, G. Stoltz and F. Legoll participate to the Laboratoire International Associé (LIA) CNRS / University of Illinois at Urbana-Champaign on complex biological systems and their simulation by high performance computers. This LIA involves on the french side research teams from Université Nancy, Université de Lyon and Inria Rennes.

7.2. International Research Visitors

7.2.1. Visits of International Scientists

We have invited the following researchers to visit our team:

- U. Hetmaniuk (University of Washington in Seattle), April 8-12, 2013, and Dec 16-20, 2013.

MISTIS Project-Team

7. Partnerships and Cooperations

7.1. Regional Initiatives

- MISTIS is involved in three regional initiatives: PEPS (funded by CNRS and the PRES of Grenoble), AGIR (funded by Université Grenoble 1 and Grenoble-INP) and the MOTU project (funded by UPMF). The first two projects focus on the modelling of the extreme risk and its application in social science. The partners include the LTHE (Laboratoire d'étude des Transferts en Hydrologie et Environnement) and the 3S-R lab (Sols, Solides, Structures - Risques). The third project focuses on the use of statistical techniques for transportation data analysis and involves the GAEL laboratory (Grenoble Applied Economics Laboratory).
- MISTIS participates in the weekly statistical seminar of Grenoble. Jean-Baptiste Durand is in charge of the organization and several lecturers have been invited in this context.
- S. Girard is at the head of the probability and statistics department of the LJK since september 2012.

7.2. National Initiatives

7.2.1. Competitvity Clusters

MISTIS was a partner in a three-year MINALOGIC project (I-VP for Intuitive Vision Programming) supported by the French Government. The project was led by VI Technology (<http://www.vitechnology.com>), a world leader in Automated Optical Inspection (AOI) of a broad range of electronic components. The other partners involved were the CMM (Centre de Morphologie Mathématiques) in Fontainebleau, and Pige Electronique in Bourg-Les-Valence. The overall goal was to exploit statistical and image processing techniques more intensively to improve defect detection capability and programming time based on existing AOI principles so as to eventually reach a reliable defect detection with virtually zero programming skills and efforts. The final review of this project was held in March 2013 with live demos of our tools at VIT.

7.2.2. Inria project HEROES

The 2-year Inria ARC project AINSI (2011-12) coordinated by F. Forbes (<http://thalie.ujf-grenoble.fr/ainsi>) was followed with the same partners by a project entitled HEROES. HEROES stands for "HEmodynamics-infoRmed atlas of brain functiOnal and vascular territoriES from multimodal MR images". The goal, based on ASL and BOLD fMRI and advanced models, is to 1) provide individual brain maps of hemodynamic characteristics useful as biomarkers and 2) extend the use of functional MRI (BOLD or ASL) in the clinic through an improved characterization of the impact of vascular alterations under pathological conditions. The partners involved are Visages and Panama teams from Inria in Rennes and Parietal in Saclay, the INSERM Unit U594 (Grenoble Institute of Neuroscience) and CEA NeuroSpin.

7.3. European Initiatives

7.3.1. FP7 Projects

7.3.1.1. HUMAVIPS

Title: Humanoids with audiovisual skills in populated spaces

Type: COOPERATION (ICT)

Defi: Cognitive Systems and Robotics

Instrument: Specific Targeted Research Project (STREP)

Duration: February 2010 - January 2013

Coordinator: Inria (France)

Others partners: CTU Prague (Czech Republic), University of Bielefeld (Germany), IDIAP (Switzerland), Aldebaran Robotics (France)

See also: <http://humavips.inrialpes.fr>

Abstract: Humanoids expected to collaborate with people should be able to interact with them in the most natural way. This involves significant perceptual and interactive skills, operating in a coordinated fashion. Consider a social gathering scenario where a humanoid is expected to possess certain social skills. It should be able to analyze a populated space, to localize people, and to determine whether they are looking at the robot and are speaking to it. Humans appear to solve these tasks routinely by integrating the often complementary information provided by multi-sensory data processing, from 3D object positioning and sound-source localization to gesture recognition. Understanding the world from unrestricted sensorial data, recognizing people's intentions and behaving like them are extremely challenging problems. The objective of HUMAVIPS has been to endow humanoid robots with audiovisual (AV) abilities: exploration, recognition, and interaction, such that they exhibit adequate behavior when dealing with a group of people. Developed research and technological developments have emphasized the role played by multimodal perception within principled models of human-robot interaction and of humanoid behavior. An adequate architecture has implemented auditory and visual skills onto a fully programmable humanoid robot (the consumer robot NAO). A free and open-source software platform has been developed to foster dissemination and to ensure exploitation of the outcomes of HUMAVIPS beyond its lifetime.

7.4. International Initiatives

7.4.1. Inria International Partners

7.4.1.1. Informal International Partners

The main international collaborations that we are currently trying to develop are with:

- Emma Holian and John Hinde from National University of Ireland, Galway, Ireland.
- K. Qin and D. Wraith from RMIT and Centre for Epidemiology and Biostatistics University in Melbourne, Australia.
- E. Deme and S. Sylla from Saint Louis university and IRD in Saint Louis, Senegal.
- Alexandre Nazin and Russian Academy of Science in Moscow, Russia.
- Alexis Roche and University Hospital Lausanne/Siemens Healthcare, Advanced Clinical Imaging Technology group, Lausanne, Switzerland.

7.5. International Research Visitors

7.5.1. Visits of International Scientists

- Alexander Nazin (Russian Academy of Sciences, Russia) has been an invited researcher in the MISTIS team to work with Stéphane Girard and Anatoli Ioudistki (Université Grenoble 1).
- El Hadji Deme (Université Gaston Berger, Sénégal) has been hosted by the MISTIS team for two months. His stay has been partially funded by the Ibni Oumar Mahamat Saleh price.

7.5.1.1. Internships

Jennifer Sloboda (Master, from May 2013 until Aug 2013)

Subject: Physiologically-inspired Bayesian analysis of BOLD and ASL fMRI data

Institution: University of Michigan, Ann Arbor (United States)

Aina Frau-Pascual (Master, from May 2013 until Aug 2013)

Subject: Hemodynamically informed parcellation of cerebral fMRI data

Institution: University Paris Sud

Pham Van Trung (Master, from Apr 2013 until Sep 2013)

Subject: Implémentation et paquetage d'un modèle statistique des valeurs extrêmes.

Institution: Hanoi, Vietnam.

Seydou-Nourou Sylla (PhD, from October 2013 to December 2013)

Subject: Classification for medical data

Institution: Université Gaston Berger (Sénégal)

MODAL Project-Team

8. Partnerships and Cooperations

8.1. Regional Initiatives

- Christophe Biernacki: Industrial studies, Arcelor-Mittal (C. Théry)
- Sophie Dabo-Niang:
 - Festival NEXT avec la ROSE DES VENTS : programme Cartes et Cartel du spectacle vivant – stratégies et fréquentation du festival NEXT en Nord Pas de Calais et Belgique (Tournai).
 - SIRIC (Site de Recherche Intégrée en Cancérologie) ONCOLILLE
- Guillemette Marot:
 - Institut Pasteur Lille, Équipe Etudes Transcriptomiques et Génomiques Appliquées, D. Hot
 - Institut Pasteur Lille, Équipe Peste et Yersinia pestis, F. Sebbane
 - Institut de Biologie de Lille, Unité d’approches fonctionnelle et structurale des cancers, O. Pluquet
 - Université Lille 2, Plate-forme de génomique fonctionnelle et Structurale, M. Figeac
 - CHRU Lille, Centre de Biologie Pathologie, Laboratoire d’Hématologie, C. Preudhomme

8.2. National events

- Alain Celisse belongs to the Statistics for Systems Biology group (SSB) in Paris.
- Julien JACQUES organized the first French Summer School in Astrostatistics (Annecy, October 2013).
- Christophe Biernacki co-organized with Gilles Celeux, Gérard Govaert and Florent Langrogné the 4th one-day meeting on Mixmod on September 2013 (~ 50 participants).
- Guillemette Marot belongs to the StatOmique working group <http://vim-iip.jouy.inra.fr:8080/statomique/>

8.3. International Research Visitors

8.3.1. Visits of International Scientists

Mahlet Tadesse (University of Georgetown), Mohamed Ben Alaya (INRS, Québec), Aliou Diop (University of Gaston Berger, Senegal), Papa Ngom (University UCAD, Senegal).

8.3.1.1. Internships

Every year the Modal team welcomes numerous internships from various areas: Master 2 (Applied mathematics in Lille 1, Besançon,...), École centrale Lille, École PolytechLille, IUT A,...Some of them are awarded by a grant and then become PhD students (Jérémy Kellner, Quentin Grimonprez, Julie Hamon, Mathieu Marbac-Lourdelle,...).

8.3.2. Visits to International Teams

Julien Jacques was invited to the Working-Group on Model-Based Clustering of Adrian Raftery (Univ. Washington).

MOKAPLAN Exploratory Action

7. Partnerships and Cooperations

7.1. National Initiatives

7.1.1. ANR

Jean-David Benamou is the coordinator of the ANR ISOTACE (Interacting Systems and Optimal Transportation, Applications to Computational Economics) ANR-12-MONU-0013 (2012-2016). The consortium explores new numerical methods in Optimal Transportation AND Mean Field Game theory with applications in Economics and congested crowd motion. Four extended seminars have been organized/co-organized by Mokaplan. Check <https://project.inria.fr/isotace/news>.

Christophe Duquesne (Aurigetech) is a software and mobility consultant hired on the ANR budget. He helps the consortium to develop its industrial partnerships.

7.2. International Initiatives

7.2.1. Informal International Partners

Mokaplan has strong links with several Canadian researchers (Oberman, Froese, Agueh, Pass). In July 2013, Oudet, Carlier, Agueh, Pass, Oberman, Froese and Benamou gathered in Banff for a "focussed research group" week :

<http://www.birs.ca/events/2013/focussed-research-groups/13frg167>. The meeting was productive and several new collaborations were started on the occasion which are listed in the objectives of this proposal.

7.3. International Research Visitors

7.3.1. Visits of International Scientists

- Brendan Pass (U. of Alberta).
- Brittany Froese (U. Texas at Austin).
- Giuseppe Buttazzo (U. Pisa).

7.3.1.1. Internships

- Nicolas Bonne extended the ALG2 used in the CFD approach to Optimal Mass Transportation to build a numerical method for Mean Field Games models.

NACHOS Project-Team

8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. Inria Project Lab

8.1.1.1. C2S@Exa - Computer and Computational Sciences at Exascale

Participants: Olivier Aumage [RUNTIME project-team, Inria Bordeaux - Sud-Ouest], Jocelyne Erhel [SAGE project-team, Inria Rennes - Bretagne Atlantique], Philippe Helluy [TONUS project-team, Inria Nancy - Grand-Est], Laura Grigori [ALPINE project-team, Inria Saclay - Île-de-France], Jean-Yves L'Excellent [ROMA project-team, Inria Grenoble - Rhône-Alpes], Thierry Gautier [MOAIS project-team, Inria Grenoble - Rhône-Alpes], Luc Giraud [HIEPACS project-team, Inria Bordeaux - Sud-Ouest], Michel Kern [POMDAPI project-team, Inria Paris - Rocquencourt], Stéphane Lanteri [Coordinator of the project], François Pellegrini [BACCHUS project-team, Inria Bordeaux - Sud-Ouest], Christian Perez [AVALON project-team, Inria Grenoble - Rhône-Alpes], Frédéric Vivien [ROMA project-team, Inria Grenoble - Rhône-Alpes].

Since January 2013, the team is coordinating the C2S@Exa http://www-sop.inria.fr/c2s_at_exa Inria Project Lab (IPL). This national initiative aims at the development of numerical modeling methodologies that fully exploit the processing capabilities of modern massively parallel architectures in the context of a number of selected applications related to important scientific and technological challenges for the quality and the security of life in our society. At the current state of the art in technologies and methodologies, a multidisciplinary approach is required to overcome the challenges raised by the development of highly scalable numerical simulation software that can exploit computing platforms offering several hundreds of thousands of cores. Hence, the main objective of C2S@Exa is the establishment of a continuum of expertise in the computer science and numerical mathematics domains, by gathering researchers from Inria project-teams whose research and development activities are tightly linked to high performance computing issues in these domains. More precisely, this collaborative effort involves computer scientists that are experts of programming models, environments and tools for harnessing massively parallel systems, algorithmists that propose algorithms and contribute to generic libraries and core solvers in order to take benefit from all the parallelism levels with the main goal of optimal scaling on very large numbers of computing entities and, numerical mathematicians that are studying numerical schemes and scalable solvers for systems of partial differential equations in view of the simulation of very large-scale problems.

8.2. European Initiatives

8.2.1. FP7 Projects

8.2.1.1. DEEP-ER

Type: COOPERATION

Defi: Exascale computing platforms, software and applications

Instrument: Integrated Project

Objectif: Dynamic Exascale Entry Platform - Extended Reach

Duration: October 2013 - September 2016

Coordinator: Forschungszentrum Juelich GmbH (Germany)

Partner: Intel GmbH (Germany), Bayerische Akademie der Wissenschaften (Germany), Ruprecht-Karls-Universität Heidelberg (Germany), Universität Regensburg (Germany), Fraunhofer-Gesellschaft zur Förderung der Angewandten Forschung E.V (Germany), Eurotech Spa (Italy), Consorzio Interuniversitario Cineca (Italy), Barcelona Supercomputing Center - Centro Nacional de Supercomputación (Spain), Xyratex Technology Limited (United Kingdom), Katholieke Universiteit Leuven (Belgium), Stichting Astronomisch Onderzoek in Nederland (The Netherlands) and Inria (France).

Inria contact: Stephane Lanteri

Abstract: the DEEP-ER project aims at extending the Cluster-Booster Architecture that has been developed within the DEEP project with a highly scalable, efficient, easy-to-use parallel I/O system and resiliency mechanisms. A Prototype will be constructed leveraging advances in hardware components and integrate new storage technologies. They will be the basis to develop a highly scalable, efficient and user-friendly parallel I/O system tailored to HPC applications. Building on this I/O functionality a unified user-level checkpointing system with reduced overhead will be developed, exploiting multiple levels of storage. The DEEP programming model will be extended to introduce easy-to-use annotations to control checkpointing, and to combine automatic re-execution of failed tasks and recovery of long-running tasks from multi-level checkpoint. The requirements of HPC codes with regards to I/O and resiliency will guide the design of the DEEP-ER hardware and software components. Seven applications will be optimised for the DEEP-ER Prototype to demonstrate and validate the benefits of the DEEP-ER extensions to the Cluster-Booster Architecture.

8.2.2. Collaborations with Major European Organizations

Prof. Martin Gander: University of Geneva, Mathematics section (Switzerland)

Domain decomposition methods (optimized Schwarz algorithms) for the solution of the frequency domain Maxwell equations

Dr. Maciej Klemm: University of Bristol, Communication Systems & Networks Laboratory, Centre for Communications Research (United Kingdom)

Numerical modeling of the propagation of electromagnetic waves at the nanoscale for biomedical applications

8.3. International Initiatives

8.3.1. Participation In other International Programs

8.3.1.1. CNPq-Inria HOSCAR project

Participants: Reza Akbarinia [ZENITH project-team, Inria Sophia Antipolis - Méditerranée], Rossana Andrade [CSD/UFC], Hélène Barucq [MAGIQUE3D project-team, Inria Bordeaux - Sud-Ouest], Alvaro Coutinho [COPPE/UFR], Juklien Diaz [MAGIQUE3D project-team, Inria Bordeaux - Sud-Ouest], Thierry Gautier [MOAIS project-team, Inria Grenoble - Rhone-Alpes], Antônio Tadeu Gomes [LNCC], Pedroedro Leite Da Silva Dias [LNCC, Coordinator of the project on the Brazilian side], Luc Giraud [HIEPACS project-team, Inria Bordeaux - Sud-Ouest], Stéphane Lanteri [Coordinator of the project on the French side], Alexandre Madureira [LNCC], Nicolas Maillard [INF/UFRG], Florent Maseglia [ZENITH project-team, Inria Sophia Antipolis - Méditerranée], Marta Mattoso [COPPE/UFR], Philippe Navaux [INF/UFRG], Esther Pacitti [ZENITH project-team, Inria Sophia Antipolis - Méditerranée], François Pellegrini [BACCHUS project-team, Inria Bordeaux - Sud-Ouest], Fabio Porto [LNCC], Bruno Raffin [MOAIS project-team, Inria Grenoble - Rhone-Alpes], Pierre Ramet [HIEPACS project-team, Inria Bordeaux - Sud-Ouest], Jean-Louis Roch [MOAIS project-team, Inria Grenoble - Rhone-Alpes], Patrick Valduriez [ZENITH project-team, Inria Sophia Antipolis - Méditerranée], Frédéric Valentin [LNCC].

Since July 2012, the team is coordinating the HOSCAR <http://www-sop.inria.fr/hoscar> Brazil-France collaborative project. The HOSCAR project is a CNPq - Inria collaborative project between Brazilian and French researchers, in the field of computational sciences. The project is also sponsored by the French Embassy in Brazil.

The general objective of the project is to setup a multidisciplinary Brazil-France collaborative effort for taking full benefits of future high-performance massively parallel architectures. The targets are the very large-scale datasets and numerical simulations relevant to a selected set of applications in natural sciences: (i) resource prospection, (ii) reservoir simulation, (iii) ecological modeling, (iv) astronomy data management, and (v) simulation data management. The project involves computer scientists and numerical mathematicians divided in 3 fundamental research groups: (i) numerical schemes for PDE models (Group 1), (ii) scientific data management (Group 2), and (iii) high-performance software systems (Group 3). Several Brazilian institutions are participating to the project among which: LNCC (Laboratório Nacional de Computação Científica), COPPE/UFRJ (Instituto Alberto Luiz Coimbra de Pós-Graduação e Pesquisa de Engenharia/Alberto Luiz Coimbra Institute for Graduate Studies and Research in Engineering, Universidade Federal do Rio de Janeiro), INF/UFRGS (Instituto de Informática, Universidade Federal do Rio Grande do Sul) and LIA/UFC (Laboratórios de Pesquisa em Ciência da Computação Departamento de Computação, Universidade Federal do Ceará). The French partners are research teams from several Inria research centers.

8.4. International Research Visitors

8.4.1. Visits of International Scientists

Prof. Kurt Busch, Theoretical Optics & Photonics, Humboldt-Universität zu Berlin, July 4-5

Prof. Martin Gander, University of Geneva, Switzerland, July 1-12

Prof. Jay Gopalakrishnan, Portland University, USA, July 15-19

Dr. Maciej Klemm, University of Bristol, UK, July 29-August 2

Dr. Antoine Moreau, Institut Pascal, Université Blaise Pascal, June 11-12

8.4.1.1. Internships

Anis Ben El Haj Midani Mohamed, ENIT-LAMSIN, Tunisia, April 30-July 31

Nicole Olivares, Mathematics Department, Portland University, Oregon, USA, June 11-August 21

8.4.2. Visits to International Teams

Stéphane Lanteri, School of Mathematical Sciences, Institute of Computational Sciences, University of Electronic Science and Technology of China Chengdu, June 2-7

Stéphane Lanteri, Laboratory for Computational Mathematics, Center of Mathematics, and Institute for Biomedical Imaging and Life Sciences, Coimbra University, Portugal, October 27-November 1

NANO-D Team

6. Partnerships and Cooperations

6.1. Regional Initiatives

- **ARC 2012:** This grant from the Rhone-Alpes region (<http://www.arc.rhonealpes.fr/>) has been provided to S. Redon, Jean-François Méhaut (LIG - Laboratoire d'Informatique de Grenoble) and Benjamin Bouvier (IBCP - Institut de Biologie et Chimie des Proteines) to develop adaptive, parallel algorithms for molecular simulation. The grants is for a PhD student.

6.2. National Initiatives

6.2.1. ANR

In 2013, NANO-D had funding from four ANR programs:

- **ANR Jeunes Chercheurs Jeunes Chercheuses (JCJC):** 340,000 Euros over three years (2011-2014). This grant has been provided to S. Redon by the French Research Agency for being a finalist in the ERC Starting Grant 2009 call, and is for two PhD students and an engineer.
- **ANR Modeles Numeriques (MN):** 180,000 Euros over four years (2011-2015). This project, coordinated by NANO-D (S. Grudinin), gathers biologists and computer scientists from three research groups: Dave Ritchie at LORIA, Valentin Gordeliy at IBS (total grant: 360,000 Euros).
- **ANR PIRIBio:** 25,000 Euros over four years (2010-2013). We are participating in this project coordinated by Michel Vivaudou at IBS, with Serge Cruzy at CEA/LCBM and Frank Fieschi at IBS.

6.2.2. PEPS

Sergei Grudinin participates in the Cryo-CA PEPS project. Cryo-CA (Computational algorithms for biomolecular structure determination by cryo-electron microscopy) is a 2-years project, supported by the Projets Exploratoires Pluridisciplinaires (PEPS) program in the panel Bio-Maths-Info provided by CNRS (French National Centre for Scientific Research). The project started on the 01/09/2012. Its main goal is to develop computational algorithms for cryo-electron microscopy (cryo-EM).

The partners of the Cryo-CA project are: Inria Nancy / Team Orpailleur (David Ritchie); Inria Grenoble / Team NANO-D (Sergei Grudinin); and INSERM IGBMC/ Team Integrated structural Biology (Annick Dejaegere, Patrick Schultz, and Benjamin Schwarz).

The main scientific aim of this cross-disciplinary project is to develop computational algorithms to help experimentalists and molecular modelers to solve more rapidly and accurately the structures of macromolecular complexes using cryo-electron microscopy (cryo-EM) and integrative structural biomolecular modeling techniques. More specifically, this PEPS initiative aims to address two important challenges in single particle cryo-EM, namely particle picking and multi-dimensional structure fitting. In the longer term, a further driving aim of this project is to develop strong collaborations amongst the participating teams to position ourselves for a larger project proposal to ANR or ERC.

6.3. European Initiatives

6.3.1. FP7 Projects

6.3.1.1. ADAPT

Type: IDEAS

Defi: NC

Instrument: ERC Starting Grant

Objectif: Theory and algorithms for adaptive particle simulation

Duration: September 2012 - August 2017

Coordinator: Stephane Redon

Inria contact: Stephane Redon

6.4. International Initiatives

6.4.1. Inria International Partners

6.4.1.1. Informal International Partners

NANO-D has an ongoing collaboration with the research group of Pr. Dr. Markus Reiher in ETH Zürich, to develop interactive quantum chemistry methods assisted with haptic feedback.

6.5. International Research Visitors

6.5.1. Visits of International Scientists

- Pr. Dr. Markus Reiher, from ETH Zürich, visited NANO-D in January 2013
- Pr. Eric Polizzi, from the University of Massachusetts Amherst, visited NANO-D in March 2013
- PhD students Moritz Haag and Arndt Finkelmann, from the Reiher group at ETH Zürich, visited NANO-D in October 2013

6.5.1.1. Internships

Astha Agarwal

Subject: Development of a Coarse-Grained Potential Function for Protein Folding and De Novo Design

Date: from May 2013 until Jul 2013

Institution: IIT Bombay (India)

NECS Project-Team

8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. ANR VOLHAND

VOLHAND (**VO**Lant pour personne âgée et/ou **HAN**Dicapée) is a project funded by the ANR (National Research agency). This project, started in October 2009, is a result of collaboration between C. Canudas de Wit and Franck Quaine/Violaine Cahouët (from the biomechanical team of GIPSA-LAB). The project has concerned the development of a new generation of Electrical power-assisted steering specifically designed for disabled and aged people. Our contribution has been to design new assisted laws, taking into account the specific mechanical characteristics of this particular population of drivers. The consortium was composed by: LAMIH, CHRU, Fondation Hopale, GIPSA-LAB, INRETS and JTEKT. More information can be found on-line: <http://www.univ-valenciennes.fr/volhand/>.

8.1.2. PREDIT MoCoPo

The MOCOPo project (Measuring and mOdelling traffic COngestion and POLLution) is funded by the French Ministry in charge of Transport (MEDDTL), through the PREDIT (Research and Innovation in Land Transport Program). The project began in January 2011 and will end up in December 2013. Various research institutes and universities, some teams of the MEDDTL and pollution measurements associations are involved in the project: LICIT (Transport and Traffic Engineering Laboratory, joint unit of IFSTTAR and ENTPE), LTE (Transports and Environment Laboratory, IFSTTAR), LEPSIS (Laboratory for Road Operations, Perception, Simulators and Simulations, IFSTTAR), IM (Infrastructures and Mobility Department, IFSTTAR), MACS (Monitoring, Assessment, Computational Sciences, IFSTTAR), Inria-NECS, Atmo Rhône Alpes, DIR-CE (Center-East Direction of Roads), LRPC Angers (Regional Laboratory of Angers), CERTU (Center for Cities and Urban Transportation), and CEREAs (Center of Teaching and Research in Atmospheric Environment, laboratory Ecole des Ponts ParisTech / EDF Research and Development). NECS is particularly involved in tasks devoted to travel-time estimation and prediction. For this purpose one post-doc (Fabio Morbidi) has been hired. More information can be found on-line: <http://mocopo.ifsttar.fr/>.

8.1.3. PEPS META-TRAM

META-TRAM is a PEPS-CNRS project funded for two years (2013-2015). It aims at studying tensor methods for analyzing traffic data. Indeed, for a better management of mobility in modern cities (avoid or better control episodes of congestion, accurately predict traffic trends, finely analyze urban and suburban trips via multimodal networks), it is necessary to develop appropriate analytic tools that integrate multimodality and heterogeneity of networks from inherently multidimensional measures. Three areas are studied: tensor modeling for estimating origin-destination matrices, dynamic clustering flow and synthesis of distributed algorithms adapted to large volume of data, diversity of sensors, and their spatial dispersion. This project involves also I3S Lab (Sophia Antipolis) and CRAN (Nancy).

8.1.4. Other collaborations

Inertial and magnetic data integration for human movements analysis

The goal of this consortium is to work together on how to deal with inertial data in different or complementary fields. Orange Grenoble lab works on the analysis of inertial data. Orange sells some smart-phones equipped with inertial unit. The goal of Orange is to develop from these data some analysis bricks. The bricks are identified by: a) Monitoring of activity by identifying postures and deduce the activity by a correlation table, b) Prevention of falls by an analysis of walking monitoring, c) Monitoring of indoor and outdoor trajectory, d) Position of the sensor, and e) Identification of the dynamic parts of the signal. Orange offers to provide laboratories participating in the consortium: a) The database created through a 2012 IGS experiment where 7 peoples wore smart-phones for 3 months and the report of the experiment, b) The ability to store the data recorded by the consortium on a server in the capacity limit of the predefined server, c) The loan of smart-phones, and d) A schedule of specifications of a service activity monitoring of remote person. A consortium agreement has been signed by eight laboratories: INSA-INL, UJF-AGIM, UJF-GIPSA, CNRS-LAAS, CNRS-IRIT, Amines- école des mines de Douai, ISFTTAR, UTT et Orange Labs.

8.2. European Initiatives

8.2.1. FP7 Projects

8.2.1.1. Hycon2

Type: COOPERATION

Objective: Engineering of Networked Monitoring and Control Systems

Instrument: Network of Excellence

Objective: Engineering of Networked Monitoring and Control systems

Duration: September 2010 - August 2014

Coordinator: CNRS (France)

Partners: Inria (France), ETH Zurich (Switzerland), TU Berlin (Germany), TU Delft (Netherlands) and many others

Inria contact: C. Canudas de Wit

Abstract: Hycon 2 aims at stimulating and establishing a long-term integration in the strategic field of control of complex, large-scale, and networked dynamical systems. It focuses in particular on the domains of ground and aerospace transportation, electrical power networks, process industries, and biological and medical systems.

See also: <http://www.hycon2.eu>

8.2.1.2. SPEEDD (Scalable Proactive Event-Driven Decision making)

Type: STREP

Objective: ICT-2013.4.2a – Scalable data analytics – Scalable Algorithms, software frameworks and viualisation

Duration: Feb. 2014 to Jan. 2017.

Coordinator: National Centre of Scientific Research ‘Demokritos’ (Greece)

Partners: IBM Israel, ETH Zurich (CH), Technion (Israel), Univ. of Birmingham (UK), NECS CNRS (France), FeedZai (Portugal)

Inria contact: C. Canudas de Wit

Abstract: SPEEDD will develop a prototype for robust forecasting and proactive event-driven decision-making, with on-the-fly processing of Big Data, and resilient to the inherent data uncertainties. NECS will lead the intelligent traffic-management use and show case.

See also: <http://speedd-project.eu>

8.2.1.3. CPSoS

Carlos Canudas de Wit participates to the working group WG1 “Systems of Systems in transportation and logistics” of the support action CPSoS “Towards a European Roadmap on Research and Innovation in Engineering and Management of Cyber-physical Systems of Systems”, led by TU Dortmund (Germany).

8.3. International Initiatives

8.3.1. Inria Associate Teams

NECS has submitted a proposal for the construction of a new associate team: COMFORT, with partner UC Berkeley/PATH. The proposal has been accepted, and the associate team will be funded for the period 2014-2016.

8.3.2. Inria International Partners

H. Fourati has a collaboration with the Kazakhstan National Technical University (KazNTU). He currently co-advises (with Pr. Olga Shiryayeva in KazNTU) Zarina Samigulina, a PhD student in KazNTU.

8.3.3. Participation In other International Programs

8.3.3.1. TeMP

TeMP (Tensor-based information Modelling and Processing) is a project funded in the framework of the French-Brazilian bilateral collaboration program (FUNCAP-Inria). It started from August 2011 and ended in December 2013. It was coordinated for the French part by A. Kibangou and aimed to study, analyze, propose and evaluate new models and techniques for digital communication systems using tensors and multilinear algebra tools, through in-depth theoretical analysis of mathematical models, optimization algorithms, and computational simulations. Distributed and collaborative algorithms have been devised for processing tensors involved in cooperative communications. In addition, new methods for processing very large tensors (big data issue) have been obtained. A special session has been organized in CAMSAP 2013 by A. de Almeida, the coordinator of the Brazilian side of the project.

8.4. International Research Visitors

8.4.1. Visits of International Scientists

- Zarina Samigulina, PhD student, Kazakhstan National Technical University (KazNTU), one-month visit (mid-May to mid-July).
- The following professors from UFC Brazil visited NECS within the framework of the TeMP project: André L. F. de Almeida (Associate Professor) in February and November for one week each stay; Carlos Alexandre Rolim Fernandes (Associate Professor) in May for one week; Carlos Estevao Rolim Fernandes (Associate Professor) in May for three days.
- prof. Antonella Ferrara, from Università di Pavia (Italy), has been visiting NECS regularly, with multiple visit of a few days, for an active collaboration on the traffic application, within Hycon2 project.

8.4.1.1. Internships

- Giulio Bontadini, Master student, Università di Pavia (Italy), from March to August, co-advised by C. Canudas de Wit and A. Ferrara, master thesis: *Modeling and control of traffic systems*
- Yvan Gaudfrin, Master student, University of Bristol (UK), from June to September, co-advised by F. Garin, R. Fabbiano and J. Dumon, master thesis: *Source seeking via Poisson integrals – Practical implementation of a source-localization set-up.*

8.4.2. Visits to International Teams

- D. Pisarski has been a visiting scholar at UC Berkeley, Mechanical Engineering Dept., for three months (Oct.-Dec.). His stay was supported by Inria 'Programme Explorateur' and CMIRA 'Explora Doc'.
- A. Kibangou spent two weeks in UFC, Brazil, in October, within the framework of the TeMP project.

NON-A Project-Team

7. Partnerships and Cooperations

7.1. Regional Initiatives

- Project ARCIR «Estimation distribuée de systèmes dynamiques en réseaux», supervisor Prof. Mihaly Petreczky, URIA – Mines de Douai, 2013–2015
- CPER CIA, "Internet of Things", 2011–2015
- CPER CISIT, "Campus international sur la securite et intermodalite de transport", project "CONTRAERO" with LML and IEMN, 2011–2015
- ADT Inria SLIM "Development of ROS software library for multi-robots cooperation", 2013–2014
- Project Agrégation, Conseil Général du Val d’Oise, (<http://www.scilab.org/fr/community/scilabtec/2013/Projet-Agregation-la-simulation-numerique-dans-les-essais>)

7.2. National Initiatives

- CNRS GDRI DelSys (<http://www.cnrs.fr/ins2i/spip.php?article217>)
- CNRS-CONACYT project with Mexico, "Estimation of state for hybrid systems using sliding mode techniques", 2013
- ANR project ChaSlIM (Chattering-free Sliding Modes), coordinator Prof. B. Brogliato: 2012-2015
- We are also involved in several technical groups of the GDR MACS (CNRS, "Modélisation, Analyse de Conduite des Systèmes dynamiques", see <http://www.univ-valenciennes.fr/GDR-MACS>), in particular: Technical Groups "Identification", "Time Delay Systems", "Hybrid Systems" and "Control in Electrical Engineering".
- Model-free control: collaborations with Professor Brigitte D’Andréa-Novel at Mines ParisTech and Professor Emmanuel Delaleau at ENIB (Brest).
- Atomic Force Microscope (AFM): application of new algebraic methods in tapping mode for AFM, collaboration with the National Laboratory of Metrology (LNE) located at Trappes.

7.3. European Initiatives

7.3.1. FP7 Projects

- *HYCON2* (<http://www.hycon2.eu/>) The FP7 NoE HYCON2, started in September 2010, is a four-year project coordinated by the CNRS (Françoise Lamnabhi-Lagarrigue). It aims at stimulating and establishing a long-term integration in the strategic field of control of complex, large-scale, and networked dynamical systems. It focuses in particular on the domains of ground and aerospace transportation, electrical power networks, process industries, and biological and medical systems.
- *SYSIASS* (<http://www.sysiass.eu/>) Here is the major issue on which the project SYSIASS seeks to answer by developing new technologies and putting them in the service of patients and health professionals from our regions. Indeed preserve the autonomy of the elderly and disabled people is a major issue in today’s society. In Europe, with the progressive ageing of the population policy to support the elderly is increasingly based on the assumption that care must be provided efficiently to the patient where he is based. In addition, special attention is devoted to people with disabilities for their better integration into society. Advances in technology proposed by SYSIASS (SYStème Intelligent et Autonome d’aide aux Soins de Santé / Autonomous and Intelligent Healthcare System) will be realized in practice through an intelligent wheelchair that can provide better mobility to the patient and to allow health care professionals to easily transport patients to desired locations within a clinic or home environment. Moreover such a system must be able to communicate with the outside world, to adapt to specific patient needs and any special disability that he may have, and to facilitate access to medical data for health professionals.

- *ICityForAll: EU Ambient Assisted Living Program* (<http://www.icityforall.eu/>) The project is led by CEA and it includes University of Paris Descartes-UPD, CENTICH, Active Audio (SME, France), Tech. Univ of Munich - TUM (Germany), EPFL (Suisse), ENEA (Italy), Centro Ricerche FIAT-CRF (Italy). The goal of I'City for All (Age sensitive ICT systems for Intelligible City for All) is to enhance speech and audio alarms intelligibility in order to improve the sense of well-being of seniors through better social interactions, better security and then improved mobility. Mamadou Mboup is involved as a subcontractor of UPD.

7.4. International Initiatives

7.4.1. Inria International Partners

7.4.1.1. Informal International Partners

- Professor Emilia Fridman, Tel Aviv University, Israel
- Sliding Mode Control Laboratory, UNAM, Mexico
- Department Control Automatico, CINVESTAV-IPN, Mexico
- Department of Control Systems and Informatics, Saint Petersburg State University of Information Technologies Mechanics and Optics (ITMO), Russia

7.4.2. Inria International Labs

Inria North European Labs 2013, "Dynamical precision improvement for industrial robots", project with Norwegian University of Science and Technology (Trondheim, Norway) and UMEA university (Sweden), 2013–2016

This collaborative project aims on development of algorithms used in software of industrial robots for estimation, regulation and trajectory planning in order to improve accuracy and repeatability of robots in the presence of varying parameters, perturbations and noises. A special attention is paid to the case when it is necessary to realize by robot effector a complex 3D movement with a good precision (3D surface profiling), where conventional calibration procedures fail to guarantee the required technical parameters.

7.5. International Research Visitors

7.5.1. Visits of International Scientists

7.5.1.1. Internships

Lucas Langwagen

Subject: Numerical differentiation of noisy piecewise regular signal

Date: from Apr 2013 until Aug 2013

Institution: University of the Republic (Uruguay)

Leonid Fridman

Subject: State Observation and Parameter Identification in Hybrid Systems via High-Order Sliding-Modes

Date: June 2013 until July 2013

Institution: UNAM (Mexico)

Héctor Rios

Subject: State Observation and Parameter Identification in Hybrid Systems via High-Order Sliding-Modes

Date: June 2013 until July 2013

Institution: UNAM (Mexico)

Emmanuel Cruz

Subject: State Observation and Parameter Identification in Hybrid Systems via High-Order Sliding-Modes

Date: November 2013 until December 2013

Institution: UNAM (Mexico)

Tonametl Sanchez

Subject: State Observation and Parameter Identification in Hybrid Systems via High-Order Sliding-Modes

Date: November 2013 until December 2013

Institution: UNAM (Mexico)

Emilia Fridman

Subject: Time-delay and Hybrid Systems

Date: June 2013 until July 2013

Institution: Tel Aviv University (Israel)

7.5.2. Visits to International Teams

- G. Zheng, Zhejiang University, China, May 2013

OPALE Project-Team

8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. ANR

8.1.1.1. Project "OMD2", Optimisation Multi-Disciplinaire Distribuée (Distributed Multidisciplinary Optimization)

This project funded by ANR deals with the development of a software platform devoted to Multidisciplinary Design Optimization (MDO) in the context of distributed computing.

The notion of optimization platform based on distributed and parallel codes is undertaken with a distributed workflow management system running on a grid infrastructure using the GRID5000 middleware from Inria.

Renault is the coordinator of this project, which involves also EMSE, ENS Cachan, EC Nantes, Université de Technologie de Compiègne, CD-Adapco, Sirehna, Activeon, and Inria project Tao, Oasis and Opale. This contract provides the grant supporting two PhD theses (A. Zerbinati and L. Trifan)

8.1.2. Project "OASIS"

The OASIS project, Optimization of Addendum Surfaces In Stamping, is an R&D consortium (CS, Arcelor-Mittal, ErDF, Inria, UTC, EURODECISION, ESILV, NECS, DeltaCAD, SCILAB-DIGITEO) of the Pole Systemic Paris-Region dedicated to develop an optimal design framework (methods-software platforms-applications) for stamping processes. The EPI OPALE/Inria is the leader within the consortium for the Optimization work-package (one of six WP), the role of which is to develop efficient tools well adapted to Pareto front identification of the multicriteria-dependent stamping processes.

The OASIS project yields 2.4 Meuro total financial support (one Ph.D thesis, two post-doctoral positions and 12 months internship for OPALE).

8.1.3. Project "Memoria"

This project is funded by the National Foundation for Aeronautics and Space (FNRAE). The partners are the University of Toulouse Paul-Sabatier and the CERFACS. The objective is to study optimization methods under uncertainty in the context of aerodynamic problems.

8.2. European Initiatives

8.2.1. FP7 Projects

8.2.1.1. MARS

Title: Manipulation of Reynolds Stress

Type: COOPERATION (TRANSPORTS)

Instrument: Specific Targeted Research Project (STREP)

Duration: October 2010 - September 2013

Coordinator: CENTRE INTERNACIONAL DE METODES NUMERICIS EN ENGINYERIA (Spain)

Others partners: USFD (UK), AIRBUS (SP), FOI (SW), ALENIA (IT), DLR (GER), CNRS (FR), DASSAULT (FR), NUMECA (BEL), UNIMAN (UK), EADS (UK)

See also: <http://www.cimne.com/mars/>

Abstract: The objective is to study flow control devices for aeronautical applications. This project gathers twelve European partners and twelve Chinese partners for a common work that includes both experimental and numerical studies. Opale project-team is in charge of developing numerical algorithms to optimize flow control devices (vortex generators, synthetic jets).

8.2.1.2. *GRAIN 2*

Type: COOPERATION

Defi: Transport (incl. Aeronautics)

Instrument: Coordination and Support Action (CSA)

Duration: October 2013 - September 2015

Coordinator: CENTRE INTERNACIONAL DE METODES NUMERICES EN ENGINYERIA (Spain)

Partner: AIRBUS (SP), ALENIA (I), EADS-IW (F), Rolls-Royce (UK), INGENIA (SP), NUMECA (B), U. SHEFFIELD (UK), U. BIRMINGHAM (UK), CIRA (I), VKI (B), AIRBORNE (NL), LEITAT (SP), CERFACS (F), U. CRANFIELD (UK), CAE (CN), GTE (CN), ARI (CN), FAI (CN), ASRI (CN), SAERI (CN), BIAM (CN), ACTRI (CN), BUAA (CN), NPU (CN), PKU (CN), NUAU (CN), ZJU (CN).

See also: <http://www.cimne.com/grain2/>

Inria contact: Toan Nguyen

Abstract: The main objective of GRAIN2 is to focus its greening activities following the Flight Path 2050 Vision for Aircraft en route to the very ambitious challenge "Protecting the environment and the energy supply" in three major following lines: i) greening the air vehicle, ii) greening the Air transport System and iii) Reducing the carbon foot print of aviation via sustainable alternative fuels. GRAIN2 will identify innovative R & D methods, tools and HPC environments (supercomputers and GPGPUs) in the different KGTs according to the needs of major aeronautical industries to deeper understand the mechanism of engine exhaust emissions, to improve fuel efficiency and environmental performance, to lower noise for landing gear and high lift surfaces, to introduce new materials with multiple functions, to help significantly the development of biofuels for greenhouse gas emission reduction, etc.

8.2.1.3. *TraM3*

Type: IDEAS

Title: TRaffic Management by Macroscopic Models

Instrument: ERC Starting Grant

Objectif: NC

Duration: October 2010 - September 2015

Coordinator: Inria

Inria contact: Paola Goatin

Abstract: The project intends to investigate traffic phenomena from the macroscopic point of view, using models derived from fluid-dynamics consisting in hyperbolic conservation laws. The scope is to develop a rigorous analytical framework and fast and efficient numerical tools for solving optimization and control problems, such as queues lengths control or buildings exits design. See also: <http://www-sop.inria.fr/members/Paola.Goatin/tram3.html>

8.2.2. *Collaborations in European Programs, except FP7*

Program: KIC EIT ITC Labs, IMTS Intelligent Mobility and Transportation Systems

Project title: Multimodal Mobility

Duration: January 2013 - December 2013

Coordinator: Françoise Baude (Inria/UNS), Birgit Kwella (Fraunhofer Fokus)

Other partners: TU Berlin, U. Bologna, Inria, BME, Fraunhofer Gesellschaft, Telecom Italia, Siemens

Abstract: Identify innovation levers and possible joint developments in IMS

8.3. International Initiatives

8.3.1. Inria Associate Teams

8.3.1.1. ORESTE

Title: Optimal RERoute Strategies for Traffic managEment

Inria principal investigator: Paola Goatin

International Partner (Institution - Laboratory - Researcher):

University of California Berkeley (United States) - Electrical Engineering and Computer Science (EECS) - Paola Goatin

Duration: 2012 - 2014

See also: <http://www-sop.inria.fr/members/Paola.Goatin/ORESTE/index.html>

ORESTE is an associated team between OPALE project-team at Inria and the Mobile Millennium / Integrated Corridor Management (ICM) team at UC Berkeley focused on traffic management. With this project, we aim at processing GPS traffic data with up-to-date mathematical techniques to optimize traffic flows in corridors. More precisely, we seek for optimal reroute strategies to reduce freeway congestion employing the unused capacity of the secondary network. The project uses macroscopic traffic flow models and a discrete approach to solve the corresponding optimal control problems. The overall goal is to provide constructive results that can be implemented in practice. Both teams have actively contributed to recent advances in the subject, and we think their collaboration is now mature enough to take advantage of the associate team framework. The Inria team and its theoretical knowledge complement the Berkeley team, with its engineering knowledge anchored in practice.

8.3.2. Inria International Partners

8.3.2.1. Informal International Partners

Jean-Antoine Désidéri maintains close links with Prof. Alfio Borzì (Institut für Mathematik - Universität Würzburg, Germany) on theme of PDE-constrained optimization.

Régis Duvigneau maintains active cooperation with Praveen Chandrashkar (formely Opale post-doctoral fellow, now Assistant Professor at Tata Institute for Fundamental Research, Bangalore, Dept. Applicable Mathematics) on the theme of shape optimization in aerodynamics.

Additionally, Abderrahmane Habbal has a long term thorough collaboration with Moez Kallel from ENIT, Tunis, focusing on new applications of game theory to inverse problems and imaging science. We also have a continuing intensive collaboration with Rajae Aboulaich and Rachid Ellaia, from EMI, Rabat, and their collaborators. The themes addressed are multiobjective optimization, and mathematical modeling in life sciences.

8.3.3. Inria International Labs

- LIRIMA Team ANO 2010-2014:

The agreement governing the creation of the International Laboratory for Research in Computer Science and Applied Mathematics (LIRIMA) was signed on 24th November 2009 in Yaoundé. LIRIMA enables cooperation between Inria research teams and teams in Africa (Sub-Saharan Africa and the Maghreb) to be reinforced. It is the continuation of the major operation undertaken by the SARIMA program (2004-08 Priority Solidarity Fund created by the French Ministry of Foreign & European Affairs).

The LIRIMA team ANO : Numerical analysis of PDEs and Optimization is a partnership between Opale project and the EMI engineering college, Rabat / National Centre for Scientific and Technical Research (CNRST) Morocco. The Team leader is Prof. Rajae Aboulaïch, EMI. Other French participants are the Project Commands at Saclay, Palaiseau and the team-project DRACULA at Inria Lyon.

The ANO team is composed of ten senior researchers from Morocco and ten senior researchers from France and more than fifteen PhD students.

The themes investigated are biomathematics (Models for plants growth, cardiovascular and cerebral diseases, cardio image segmentation), mathematical finance (optimal portfolio, risk management, Islamic finance), multiobjective optimization in structural mechanics, and vehicle traffic and crowd motion. Refer to the website <http://www.lirima.uninet.cm/index.php/en/> for more details on the LIRIMA Africa themes and teams.

8.3.4. Participation In other International Programs

- Inria@SILICONVALLEY :
ORESTE Associated Team with UC Berkeley takes part to the program.

8.4. International Research Visitors

8.4.1. Visits of International Scientists

8.4.1.1. Senior Researchers

Pr. Ellaia Rachid

Subject: Theory and algorithms for global and multiobjective optimization.

Institution: Ecole Mohammadia d'Ingénieurs (EMI) , Rabat (Morocco)

8.4.1.2. PhD Students

Legesse Lemecha Obsu

Subject: Macroscopic traffic flow optimization on roundabouts.

Institution: University of Addis Ababa (Ethiopia)

8.4.1.3. Internships

Bouthaina Yahyaoui, Asma Ghdami and Marwa Mokni

Subject: Multiobjective optimization of laminated composite Mindlin-Reissner plates

Institution: Institut Supérieur des Mathématiques Appliquées et d'Informatique, Kairouan, (Tunisia)

POEMS Project-Team

8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. ANR

- ANR project *AEROSON: Simulation numérique du rayonnement sonore dans des géométries complexes en présence d'écoulements réalistes*
Partners: EADS-IW, CERFACS, Laboratoire d'Acoustique de l'Université du Maine.
Start : 10/01/2009, End : 02/28/2013. Administrator : CNRS. Coordinator : Jean-François Mercier.
- ANR project *PROCOMEDIA: Propagation d'ondes en milieux complexes*
Partners: ESPCI, Laboratoire d'Acoustique de l'Université du Maine, Departamento de Fisica de la Universidad de Chile.
Start : 04/01/2011, End : 03/30/2014. Administrator : CNRS. Coordinator for POEMS : Jean-François Mercier.
- ANR project *METAMATH: modélisation mathématique et numérique pour la propagation des ondes en présence de métamatériaux*. Partners: EPI DEFI (Inria Saclay), IMATH-Université de Toulon, DMIA-ISAE.
Start : 12/01/2011, End : 11/30/2015. Administrator : Inria. Coordinator : Sonia Fliss.
- ANR project *CHROME: Chauffage , réflectométrie et Ondes pour les plasmas magnétiques* Partners: Université Pierre et Marie Curie (Paris 6), Université de Lorraine
Start : 10/01/2012, End : 10/01/2015 Administrator : Inria Coordinator for POEMS: Eliane Bécache
- ANR project *SODDA: Diagnostic de défauts non francs dans les réseaux de câbles* Partners: CEA LIST, ESYCOM, LGEP (Supelec)
Start : 10/01/2012, End : 10/01/2015 Administrator : Inria Coordinator for Poems: Patrick Joly
- ANR project *RAFFINE: Robustesse, Automatisation et Fiabilité des Formulations INTégrales en propagation d'ondes : Estimateurs a posteriori et adaptivité* Partners: CERFACS, EADS, IMACS, ONERA, Thales
Start : January 2013. End : december 2016. Administrator : Inria. Coordinator: Marc Bonnet.
- ANR project *ARAMIS: Analyse de méthodes asymptotiques robustes pour la simulation numérique en mécaniques* Partners: Université de Pau, Université technologique de Compiègne
Start : january 2013. End : december 2016. Administrator : Université de Pau. Participants for POEMS: Marc Bonnet

8.1.2. Competitivity Clusters

- GDR Ultrasons: this GDR, which regroups more than regroup 15 academic and industrial research laboratories in Acoustics and Applied Mathematics working on nondestructive testing. It has been renoveled this year with the participation of Great Britain.

8.2. European Initiatives

8.2.1. FP7 Project : SIMPOSIUM

Title: Simulation Platform for Non Destructive Evaluation of Structures and Materials

Type: COOPERATION (ICT)

Defi: PPP FoF: Digital factories: Manufacturing design and product lifecycle manage

Instrument: Integrated Project (IP)

Duration: September 2011 - August 2014

Coordinator: CEA (Pierre Calmont) (France)

See also: <http://cordis.europa.eu/fetch?CALLER=PROJECT&ACTION=D&CAT=PROJ&RCN=99653>

8.3. International Research Visitors

8.3.1. Visits of International Scientists

- *Sergei Nazarov*, Professor at the University of Saint-Petersbourg.

REALOPT Project-Team

8. Partnerships and Cooperations

8.1. Regional Initiatives

Region Aquitaine is supporting a post-doc in our team. Jinil Han has been recruited to contribute to our team effort to develop efficient decomposition based approach to real-life combinatorial optimization problems. Jinil's research aims at enhancing performance of such approach and prepare the way to high performance computing through parallelisation. Jinil's mission extends to problem solving that serves both as a motivation and an proof-of-concept. Jinil has contributed so far to warm-starting the methods and to convergence acceleration through stabilization techniques [59]. Jinil has pushed the column generation for extended formulation method to the limit on the EDF application [58].

8.2. National Initiatives

Pierre Pesneau has got a grant from the OR research group from **CNRS** to finance mission between Bordeaux and Paris within the context of a collaboration with University Paris 6 (P. Fouilhoux) and University Paris 13 (S. Borne, R. Grappe, M. Lacroix). This collaboration aims to study polyhedral properties and algorithmic aspects to the problem of connected graph partitioning.

8.3. International Initiatives

8.3.1. Inria Associate Teams: SAMBA

Title: "Synergies for Ameliorations and Mastering of Branch-and-Price Algorithms"

International Partner (Institution - Laboratory - Researcher):

Pontificia Universidade Catolica do Rio de Janeiro (Brazil) - ATD-Lab - Marcus Poggi,
and Universidade Federal Fluminense (UFF), Brazil - Eduardo Uchoa.

Duration: 2011 - 2013

See also: https://realopt.bordeaux.inria.fr/?page_id=573

The so-called Dantzig-Wolfe decomposition approach has not yet made its way into general purpose solvers for Mixed Integer Programming (MIP). Despite its proved efficiency, the use of the method is currently restricted to specific applications and requires ad-hoc algorithms developed by experts. Our project is to develop general purpose algorithms to make this method generic. We shall focus in particular on (i) preprocessing procedures, (ii) warm-starting, (iii) stabilization (to improve convergence), (iv) strategies for combining cut and column generation, and (v) primal heuristics. The project builds on the accumulated experience of both the Brazilian and the French teams that have done pioneering work in tackling complex applications and deriving generic solution strategies using this decomposition approach. The new algorithms are implemented and tested in the software platform BaPCod. Hence, the collaborative research on methodological developments should lead to, as a bi-product, a Version 2 of BaPCod as a state-of-the-art Branch-and-Price-and-Cut Solver. This prototype should (i) serve as proof-of-concept code for the research planned in this project and beyond, (ii) enable us to achieve new benchmark results on key problems, (iii) provide incentive for the use of the method by non experts, (iv) leverage technology transfer to industry.

8.3.2. Participation in other International Programs

- Collaboration with University of Minho through FCT Project MST4IRTO: New models and solution techniques for integrated and real-time optimization in the supply chain.

8.4. International Research Visitors

8.4.1. Visits of International Scientists

- Eduardo Uchoa, Professor at Universidade Federal Fluminense (UFF), has visited the University Bordeaux for one month in April 2013.
- Hugo Kramer, PhD student at Universidade Federal Fluminense (UFF), is visiting the University Bordeaux for one year in 2013-2014.

8.4.1.1. Internships

- Silvia Ferretto, from the University of Padova (It) has done her Master intership with us from March until June.

8.4.2. Visits to International Teams

- Ruslan Sadykov visited the Universidade Federal Fluminense (UFF) for two weeks in March 2013.
- Francois Vanderbeck visited PUC-Rio and UFF for two weeks in March 2013.
- Francois Vanderbeck visited Marcos Goycoolea (Prof.), Operations Research and Complex Systems Group School of Business, Universidad Adolfo Ibañez, Chile, for 10 days in November 2013.

REGULARITY Project-Team

8. Partnerships and Cooperations

8.1. National Initiatives

Erick Herbin is member of the CNRS Research Groups:

- GDR Mascot Num, devoted to stochastic analysis methods for codes and numerical treatment;
- GDR Math-Entreprise, devoted to mathematical modeling of industrial issues.

8.2. International Initiatives

8.2.1. Inria International Partners

8.2.1.1. Informal International Partners

- Regularity collaborates with Bar Ilan university on theoretical developments around set-indexed fractional Brownian motion and set-indexed Lévy processes. The PhD thesis of Alexandre Richard is co-supervised by Erick Herbin and Ely Merzbach.
- Regularity collaborates with Michigan State University (Prof. Yimin Xiao) on the study of fine regularity of multiparameter fractional Brownian motion.
- Regularity collaborates with St Andrews University (Prof. Kenneth Falconer) on the study of multistable processes.
- Regularity collaborates with Acadia University (Prof. Franklin Mendivil) on the study of fractal strings, certain fractals sets, and the study of the regularization dimension.
- Regularity collaborates with Milan University (Prof. Davide La Torre) on the study of certain economic growth models.

8.3. International Research Visitors

8.3.1. Visits of International Scientists

Ely Merzbach (Bar-Ilan University) visited the team for one month.

SCIPORT Team

7. Partnerships and Cooperations

7.1. National Initiatives

7.1.1. ANR

7.1.1.1. ECINADS

Sciport is coordinator of the ANR project ECINADS, with CASTOR team, university Montpellier 2, Institut de Mécanique des Fluides de Toulouse and the Lemma company in Sophia-Antipolis. ECINADS concentrates on scalable parallel solution algorithms for state and adjoint systems in CFD, and on the use of this adjoint for mesh adaptation applied to unsteady turbulent flows. ECINADS ended in november.

7.1.1.2. MAIDESC

Sciport is coordinator of the ANR project MAIDESC, with Gamma team, university Montpellier 2, Cemef-Ecole des Mines, Inria-Bordeaux, Lemma and Transvalor. MAIDESC started in october. MAIDESC concentrates on mesh adaption and in particular meshes for interfaces, third-order accuracy, meshes for boundary layers, and curved meshes.

7.2. European Initiatives

7.2.1. FP7 Projects

7.2.1.1. AboutFlow

Type: PEOPLE

Instrument: Initial Training Network

Duration: November 2012 - October 2016

Coordinator: Jens-Dominik Mueller

Partner: Queen Mary University of London (UK)

Inria contact: Laurent Hascoët

Abstract: The aim of AboutFlow is to develop robust gradient-based optimisation methods using adjoint sensitivities for numerical optimisation of flows. <http://aboutflow.sems.qmul.ac.uk/>

7.2.1.2. UMRIDA

Type:AAT

Instrument:Aeronautics and Air Transport

Duration: 2013-2016

Coordinator: Charles Hirsch

Partner: Numeca S.A. (Belgium)

Inria contact: Alain Dervieux

Abstract: UMRIDA addresses major research challenges in Uncertainty Quantification and Robust Design: develop new methods that handle large numbers of simultaneous uncertainties and generalized geometrical uncertainties. The turn-around time must be acceptable for industrial readiness. UMRIDA will apply these methods to representative industrial configurations.

7.3. International Initiatives

7.3.1. Inria International Partners

7.3.1.1. SARDINE

Program: Inria International Partner

Title: Sophia-Antipolis ARgonne DIfferentiation INitiative

Inria principal investigator: Laurent Hascoët

International Partner (Institution - Laboratory - Researcher):

Argonne National Laboratory (USA) - Math and Computer Science - Paul Hovland

Duration: 2012 - 2013

We study theoretical and computer science aspects of Automatic Differentiation (AD) by source transformation. In the context of the adjoint mode of AD, which computes gradients, we focus on the storage-recomputation tradeoffs that are the key to efficiency. We also focus on the correct AD of message-passing communication calls that are found in parallel application. A third goal is the use into Uncertainty Quantification of higher-order derivatives produced through AD. From the point of view of tool development, we aim at building interfaces to bridge between the AD tools of our teams, OpenAD and TAPENADE.

7.3.2. Inria International Labs

The team participates in the JLPC, together with our colleagues at Argonne National Laboratory. Laurent Hascoët attended the JLPC meeting in Lyon on June 12-14, and presented our works on the adjoint of MPI-II one-sided communications. The team co-organizes and will host the next JLPC meeting in June 2014 in Sophia-Antipolis.

7.4. International Research Visitors

7.4.1. Visits of International Scientists

- Jean Utke, Argonne National Laboratory (USA), March 11 to March 22.
- Michel Schanen, RWTH Aachen (Germany), March 11 to March 15.
- Trond Steihaug, from University of Bergen (Norway), June 3 to June 28.

7.4.2. Visits to International Teams

- Laurent Hascoët invited by Argonne National Laboratory (USA) from October 14th to October 25th.

SELECT Project-Team

8. Partnerships and Cooperations

8.1. Regional Initiatives

SELECT is animating a working group on model selection and statistical analysis of genomics data with the Biometrics group of AgroParisTech.

Pascal Massart is co-organizing a working group at ENS (Ulm) on Statistical Learning. This year the group focused interest on regularization methods in regression.

SELECT is animating a working group on Classification, Statistics and fMRI imaging with Neurospin.

8.2. European Initiatives

Gilles Celeux and Pascal Massart are members of the PASCAL (Pattern Analysis, Statistical Learning and Computational Learning) network.

8.3. International Initiatives

Gilles Celeux is one of the co-organizers of the Working Group on Model-Based Clustering. This year this workshop took place in Bologna (Italy).

SequeL Project-Team

8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. ANR-Lampada

Participants: Mohammad Ghavamzadeh, Jérémie Mary, Olivier Nicol, Philippe Preux, Daniil Ryabko.

- *Title:* Learning Algorithms, Models and sPArse representations for structured DATA
- *Type:* National Research Agency (ANR-09-EMER-007)
- *Coordinator:* Inria Lille – Nord Europe (Mostrare)
- *Others partners:* Laboratoire d’Informatique Fondamentale de Marseille; Laboratoire Hubert Curien à Saint Etienne; Laboratoire d’Informatique de Paris 6.
- *Web site:* <http://lampada.gforge.inria.fr/>
- *Duration:* ends mid-2014
- *Abstract:* Lampada is a fundamental research project on machine learning and structured data. Lampada focuses on scaling learning algorithms to handle large sets of complex data. The main challenges are 1) high dimension learning problems, 2) large sets of data and 3) dynamics of data. We consider evolving data. The representation of these data involves both structure and content information and are typically large sequences, trees and graphs. The main application domains are web2, social networks and biological data.

The project proposes to study formal representations of such data together with incremental or sequential machine learning methods and similarity learning methods.

The representation research topic includes condensed data representation, sampling, prototype selection and representation of streams of data. Machine learning methods include edit distance learning, reinforcement learning and incremental methods, density estimation of structured data and learning on streams.

- *Activity Report:*

Philippe Preux has collaborated with Ludovic Denoyer and Gabriel Dulac-Arnold from LIP’6 to investigate further the idea of datum-wise representation, introduced in 2011.

Mohammad Ghavamzadeh and Philippe Preux have collaborated with Hachem Kadri on an operator-based approach for structured output [15].

Daniil Ryabko has developed a theory for unsupervised learning of time-series dependence, where the time series are either coming from a stationary environment or are a result of interaction with a Markovian environment with a continuous state space. Danil Ryabko and Jeremie Mary have developed methods for using binary classification methods for solving various unsupervised learning problems about time series.

8.1.2. ANR CO-ADAPT

Participant: Rémi Munos.

- *Title:* Brain computer co-adaptation for better interfaces
- *Type:* National Research Agency (ANR-09-EMER-002)
- *Coordinator:* Maureen Clerc
- *Other Partners:* Inria Odyssee project (Maureen Clerc), the INSERM U821 team (Olivier Bertrand), the Laboratory of Neurobiology of Cognition (CNRS) (Boris Burle) and the laboratory of Analysis, topology and probabilities (CNRS and University of Provence) (Bruno Torresani).

- *Web site:* <https://twiki-sop.inria.fr/twiki/bin/view/Projets/Athena/CoAdapt/WebHome>
- *Duration:* 2009-2014
- *Abstract:* The aim of Co-Adapt is to propose new directions for BCI design, by modeling explicitly the co-adaptation taking place between the user and the system. The goal of CoAdapt is to study the co-adaptation between a user and a BCI system in the course of training and operation. The quality of the interface will be judged according to several criteria (reliability, learning curve, error correction, bit rate). BCI will be considered under a joint perspective: the user's and the system's. From the user's brain activity, features must be extracted, and translated into commands to drive the BCI system. From the point of view of the system, it is important to devise adaptive learning strategies, because the brain activity is not stable in time. How to adapt the features in the course of BCI operation is a difficult and important topic of research. We will investigate Reinforcement Learning (RL) techniques to address the above questions.
- *Activity Report:* The performances of a BCI can vary greatly across users but also depend on the tasks used, making the problem of appropriate task selection an important issue. We develop an adaptive algorithm, UCB-classif, based on the stochastic bandit theory. This shortens the training stage, thereby allowing the exploration of a greater variety of tasks. By not wasting time on inefficient tasks, and focusing on the most promising ones, this algorithm results in a faster task selection and a more efficient use of the BCI training session. See [4] and <https://twiki-sop.inria.fr/twiki/bin/view/Projets/Athena/CoAdapt/WebHome>

8.1.3. ANR AMATIS

Participant: Pierre Chainais.

- *Title:* Multifractal Analysis and Applications to Signal and Image Processing
- *Type:* National Research Agency
- *Coordinator:* Univ. Paris-Est-Créteil (S. Jaffard)
- *Duration:* 2011-2015
- *Other Partners:* Univ. Paris-Est Créteil, Univ. Sciences et Technologies de Lille and Inria (Lille), ENST (Telecom ParisTech), Univ. Blaise Pascal (Clermont-Ferrand), and Univ. Bretagne Sud (Vannes), Statistical Signal Processing group at the Physics Department at the Ecole Normale Supérieure de Lyon, one researcher from the Math. Department of Institut National des Sciences Appliquées de Lyon and two researchers from the Laboratoire d'Analyse, Topologie et Probabilités (LAPT) of Aix-Marseille University.
- *Abstract:* Multifractal analysis refers to two concepts of different natures: On the theoretical side, it corresponds to pointwise singularity characterization and fractional dimension determination ; on the applied side, it is associated with scale invariance characterization, involving a family of parameters, the scaling function, used in classification or model selection. Following the seminal ideas of Parisi and Frisch in the mid-80s, these two components are usually related by a Legendre transform, stemming from a heuristic argument relying on large deviation and statistical thermodynamics principles: The multifractal formalism. This led to new theoretical approaches for the study of singularities of functions and measures, as well as efficient tools for classification and models selection, that allowed to settle longstanding issues (*e.g.*, concerning the modeling of fully developed turbulence). Though this formalism has been shown to hold for large classes of functions of widely different origins, the generality of its level of validity remains an open issue. Despite its popularity in applications, the interactions between theoretical developments and applications are unsatisfactory. Its use in image processing for instance is still in its infancy. This is partly due to discrepancy between the theoretical contributions mostly grounded in functional analysis and geometric measure theory, and applications naturally implying a stochastic or statistical framework. The AMATIS project aims at addressing these issues, by proposing a consistent and documented framework combining different theoretical approaches and bridging the gap towards applications. To that end, it will both address a number of challenging theoretical issues and devote significant efforts to elaborating a WEB

platform with softwares and documentation. It will combine the efforts of mathematicians with those of physicists and experts in signal and image processing. Dissemination among and interactions between scientific fields are also intended via the organization of summer schools and workshop.

- *Activity Report*: a collaboration with P. Bas (CR CNRS, LAGIS) deals with the steganalysis of textured images. While steganography aims at hiding a message within some support, *e.g.* a numerical image, steganalysis aims at detecting the presence or not of any hidden message in the support. Steganalysis involves two main tasks: first identify relevant features which may be sensitive to the presence of a hidden message, then use supervised classification to build a detector. While the steganalysis of usual images has been well studied, the case of textured images, for which multifractal models may be relevant, is much more difficult. Indeed, textured images have a rich and disordered content which favors hiding information in an unperceptible manner. A student internship of 8 months at Master level in 2012 has led us to consider a very fundamental question. Steganalysis is usually proceeded to a classification based on histograms of features (bag of words). We consider the problem of the optimization of the bins of such histograms with respect to the performance of the classifier. We have shown that a balanced version of K-means which fills each cell equally yields an efficient quantization to this respect [28].

8.1.4. National Partners

- Laboratoire de Mathématiques d'Orsay, France.
 - Mylène Maïda *Collaborator*
Ph. Preux has collaborated with M. Maïda and co-advised a student of the École Centrale de Lille. The motivation of this collaboration is the study of random matrices and the potential use of this theory in machine learning.
- LIF - CMI - Université de Provence.
 - Julien Audiffren *Collaborator*
M. Valko, A. Lazaric, and M. Ghavamzadeh work with Julien on Semi-Supervised Apprenticeship Learning. We have recently developed a maximum entropy algorithm that outperforms the approach without unlabeled data.
- Laboratoire Lagrange, Université de Nice, France.
 - Cédric Richard *Collaborator*
We have had collaboration on the topic of *dictionary learning over a sensor network*. We have published 2 conference papers [29] and [10].
- Laboratoire de Mécanique de Lille, Université de Lille 1, France.
 - Jean-Philippe Laval *Collaborator*
We co-supervise a starting PhD student (Linh Van Nguyen) on the topic of *high resolution field reconstruction from low resolution measurements in turbulent flows*.
- Biophotonics team at the Interdisciplinary Research Institute (IRI), Villeneuve d'Ascq, France.
 - Aymeric Leray *Collaborator*
We have co-supervised an intern student (Pierre Pfennig, 2 months) on the topic of *quantitative guarantees of a super resolution method via concentration inequalities*. A paper is submitted to ICASSP 2014.
- LAGIS, Ecole Centrale Lille - Université de Lille 1, France.
 - Patrick Bas *Collaborator*
We have a collaboration on the topic of *adaptive quantization to optimize classification from histograms of features with an application to the steganalysis of textured images*.

8.2. European Initiatives

8.2.1. FP7 Projects

8.2.1.1. *CompLACS*

Type: COOPERATION

Defi: Composing Learning for Artificial Cognitive Systems

Instrument: Specific Targeted Research Project

Objectif: Cognitive Systems and Robotics

Duration: March 2011 - February 2015

Coordinator: University College London

Partner:

- Centre for Computational Statistics and Machine Learning, University College London (United Kingdom)
- Department of Computer Science, University of Bristol (United Kingdom)
- Department of Computer Science, Royal Holloway, University of London (United Kingdom)
- SNN Machine Learning, Radboud Universiteit Nijmegen (The Netherlands)
- Institut für Softwaretechnik und Theoretische Informatik, TU Berlin (Germany)
- University of Leoben (Austria)
- Computer Science Department, Technische Universitaet Darmstadt (Germany)

Inria contact: Rémi MUNOS

Website: [COMPLACS](#)

Abstract: One of the aspirations of machine learning is to develop intelligent systems that can address a wide variety of control problems of many different types. However, although the community has developed successful technologies for many individual problems, these technologies have not previously been integrated into a unified framework. As a result, the technology used to specify, solve and analyse one control problem typically cannot be reused on a different problem. The community has fragmented into a diverse set of specialists with particular solutions to particular problems. The purpose of this project is to develop a unified toolkit for intelligent control in many different problem areas. This toolkit will incorporate many of the most successful approaches to a variety of important control problems within a single framework, including bandit problems, Markov Decision Processes (MDPs), Partially Observable MDPs (POMDPs), continuous stochastic control, and multi-agent systems. In addition, the toolkit will provide methods for the automatic construction of representations and capabilities, which can then be applied to any of these problem types. Finally, the toolkit will provide a generic interface to specifying problems and analysing performance, by mapping intuitive, human-understandable goals into machine-understandable objectives, and by mapping algorithm performance and regret back into human-understandable terms.

8.2.2. *Collaborations with Major European Organizations*

Alexandra Carpentier: University of Cambridge (UK).

Michal Valko collaborates with Alexandra on extreme event detection (such as network intrusion) with limited allocation capabilities.

Prof. Marcello Restelli and Prof. Nicola Gatti: Politecnico di Milano (Italy).

A. Lazaric continued his collaboration on transfer in reinforcement learning which is leading to an extended version of the last year work on transfer of samples in MDPs. Furthermore, we are going to submit an extended version of an application of multi-arm bandit in a strategic environment such as sponsored search auctions.

8.3. International Initiatives

8.3.1. Inria Associate Teams

- *Inria principal investigator*: Mohammad Ghavamzadeh and Rémi Munos
 - *Institution*: McGill university (Canada)
 - *Laboratory*: Reasoning and Learning Lab
 - *Principal investigator*:
 - * Prof. Joelle Pineau *Collaborator*
 - * Prof. Doina Precup *Collaborator*
 - * Amir massoud Farahmand *Collaborator*
- *Duration*: January 2013 - January 2015

8.3.2. Inria International Partners

8.3.2.1. Declared Inria International Partners

Ronald Ortner and Peter Auer: Montanuniversität Leoben (Austria).

Reinforcement learning (RL) deals with the problem of interacting with an unknown stochastic environment that occasionally provides rewards, with the goal of maximizing the cumulative reward. The problem is well-understood when the unknown environment is a finite-state Markov process. This collaboration is centered around reducing the general RL problem to this case.

In particular, the following problems are considered: representation learning, learning in continuous-state environments, bandit problems with dependent arms, and pure exploration in bandit problems. On each of these problems we have successfully collaborated in the past, and plan to sustain this collaboration possibly extending its scopes.

8.3.2.2. Informal International Partners

- eHarmony Research, California.
 - Václav Petříček *Collaborator*
Michal Valko has started to collaborate with eHarmony on sequential decision making for online dating and offline evaluation.
- University of Alberta, Edmonton, Alberta, Canada.
 - Csaba Szepesvári and Bernardo Avila Pires *Collaborator*
We have been collaborating on the topic of *risk bounds in cost-sensitive multiclass classification* this year. We have an accepted paper [8] at ICML.
- Technion - Israel Institute of Technology, Haifa, Israel.
 - Odalric-Ambrym Maillard *Collaborator*
Daniil Ryabko has worked with Odalric Maillard on representation learning for reinforcement learning problems. It led to a paper in AISTATS [21].
- School of Computer Science, Carnegie Mellon University, USA.
 - Prof. Emma Brunskill *Collaborator*
 - Mohammad Gheshlaghi Azar, PhD *Collaborator*
A. Lazaric started a profitable collaboration on transfer in multi-arm bandit and reinforcement learning which led to two publications at ECML and NIPS. We are currently working on extensions of the previous algorithms and development of novel regret minimisation algorithms in non-iid settings.
- Technicolor Research, Palo Alto.

- Branislav Kveton *Collaborator*
Michal Valko and Rémi Munos worked with Branislav on Spectral Bandits aimed at recommendation for the entertainment content recommendation. Michal continued the ongoing research on online semi-supervised learning and this year delivered the algorithm for a challenging single picture per person setting [19]. Victor Gabillon has spent 6 month at Technicolor as an intern to work on the sequential learning with submodularity, which resulted in 1 accepted paper at NIPS and two submissions to ICML.

8.4. International Research Visitors

8.4.1. Visits of International Scientists

8.4.1.1. Internships

- Daniele Calandriello, student at Politecnico di Milano, Italy
Period: since April 2013.
He is working with A. Lazaric on multi-task reinforcement learning.

8.4.2. Visits to International Teams

- Rémi Munos, since July 2013, Microsoft Research New-England, USA
- Mohammad Ghavamzadeh, since November 2013, Adobe Research, San Jose, CA
- Victor Gabillon visited Technicolor research lab, Palo Alto, from March to September 2013.
- Azadeh Khaleghi visited Walt Disney Animation Studios, Burbank, from March to September 2013.

SIERRA Project-Team

8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. ANR: Calibration

Participant: Sylvain Arlot.

S. Arlot, Membre du projet ANR Calibration

Titre: Statistical calibration

Coordinator: University Paris Dauphine

Leader: Vincent Rivoirard

Other members: 34 members, mostly among CEREMADE (Paris Dauphine), Laboratoire Jean-Alexandre Dieudonné (Université de Nice) and Laboratoire de Mathématiques de l'Université Paris Sud

Instrument: ANR Blanc

Duration: Jan 2012 - Dec 2015

Total funding: 240 000 euros

Webpage: <https://sites.google.com/site/anrcalibration/>

8.1.2. CNRS: Gargantua

Participants: Sylvain Arlot, Francis Bach.

S. Arlot, F. Bach, membres du projet "Gargantua"

Titre: Big data; apprentissage automatique et optimisation mathématique pour les données gigantesques

Coordinator: Laboratoire Jean Kuntzmann (UMR 5224)

Leader: Zaid Harchaoui

Other members: 13 members: S. Arlot, F. Bach and researchers from Laboratoire Jean Kuntzmann, Laboratoire d'Informatique de Grenoble (Université Joseph Fourier) and Laboratoire Paul Painlevé (Université Lille 1).

Instrument: défi MASTODONS du CNRS

Duration: May 2013-Dec 2013 (may be reconducted for 2014)

Total funding: 30 000 euros for 2013

Webpage: <http://lear.inrialpes.fr/people/harchaoui/projects/gargantua/index.html>

8.2. European Initiatives

8.2.1. SIERRA

Participants: Francis Bach [correspondent], Simon Lacoste-Julien, Augustin Lefèvre, Nicolas Le Roux, Mark Schmidt.

Type: IDEAS

Instrument: ERC Starting Grant

Duration: December 2009 - November 2014

Coordinator: Inria (France)

Abstract: Machine learning is now a core part of many research domains, where the abundance of data has forced researchers to rely on automated processing of information. The main current paradigm of application of machine learning techniques consists in two sequential stages: in the representation phase, practitioners first build a large set of features and potential responses for model building or prediction. Then, in the learning phase, off-the-shelf algorithms are used to solve the appropriate data processing tasks. While this has led to significant advances in many domains, the potential of machine learning techniques is far from being reached.

8.2.2. *SIPA*

Participants: Alexandre d'Aspremont [correspondent], Fajwel Fogel.

Type: IDEAS

Instrument: ERC Starting Grant

Duration: May 2011 - May 2016

Coordinator: CNRS

Abstract: Interior point algorithms and a dramatic growth in computing power have revolutionized optimization in the last two decades. Highly nonlinear problems which were previously thought intractable are now routinely solved at reasonable scales. Semidefinite programs (i.e. linear programs on the cone of positive semidefinite matrices) are a perfect example of this trend: reasonably large, highly nonlinear but convex eigenvalue optimization problems are now solved efficiently by reliable numerical packages. This in turn means that a wide array of new applications for semidefinite programming have been discovered, mimicking the early development of linear programming. To cite only a few examples, semidefinite programs have been used to solve collaborative filtering problems (e.g. make personalized movie recommendations), approximate the solution of combinatorial programs, optimize the mixing rate of Markov chains over networks, infer dependence patterns from multivariate time series or produce optimal kernels in classification problems. These new applications also come with radically different algorithmic requirements. While interior point methods solve relatively small problems with a high precision, most recent applications of semidefinite programming in statistical learning for example form very large-scale problems with comparatively low precision targets, programs for which current algorithms cannot form even a single iteration. This proposal seeks to break this limit on problem size by deriving reliable first-order algorithms for solving large-scale semidefinite programs with a significantly lower cost per iteration, using for example subsampling techniques to considerably reduce the cost of forming gradients. Beyond these algorithmic challenges, the proposed research will focus heavily on applications of convex programming to statistical learning and signal processing theory where optimization and duality results quantify the statistical performance of coding or variable selection algorithms for example. Finally, another central goal of this work will be to produce efficient, customized algorithms for some key problems arising in machine learning and statistics.

8.3. International Initiatives

8.3.1. *Inria Associate Team STATWEB*

Title: Fast Statistical Analysis of Web Data via Sparse Learning

Inria principal investigator: Francis Bach

International Partner (Institution - Laboratory - Researcher):

University of California Berkeley (United States) - EECS and IEOR Departments - Francis Bach

Duration: 2011 - 2013

See also: <http://www.di.ens.fr/~fbach/statweb.html>

The goal of the proposed research is to provide web-based tools for the analysis and visualization of large corpora of text documents, with a focus on databases of news articles. We intend to use advanced algorithms, drawing from recent progresses in machine learning and statistics, to allow a user to quickly produce a short summary and associated timeline showing how a certain topic is described in news media. We are also interested in unsupervised learning techniques that allow a user to understand the difference between several different news sources, topics or documents.

8.4. International Research Visitors

8.4.1. *Visits of International Scientists*

Michael Jordan ([U.C. Berkeley](#)), spent one year in our team, until the summer 2013, financed by the Fondation de Sciences Mathématiques de Paris and Inria.

SIMPAF Project-Team

8. Partnerships and Cooperations

8.1. Regional Initiatives

Collaboration with the laser physics department (PhLAM) of Université Lille 1 (C. Besse, S. De Bièvre, M. Gazeau, and G. Dujardin)

8.2. National Initiatives

8.2.1. Collaborations within Inria

REO (A. Gloria)
COFFEE (E. Creusé and C. Calgaro)
POEMS (C. Besse and I. Lacroix-Violet)
CORIDA (C. Besse)
IPSO (C. Besse)

8.2.2. ANR

8.2.2.1. ANR IODISSEE (2009-2013)

Participants: Christophe Besse, Pauline Lafitte.

C. Besse has obtained a 4-years ANR grant, from the Cosinus proposal, for the project IODISSEE. P. Lafitte and C. Yang, also members of the EPI Simpaf, are involved in this project. The project IODISSEE also involves a team of mathematicians from Toulouse, a physicist team from Versailles and the Thales group. It deals with the elaboration of a physical model for helping the industrial partner for the new generation of Galileo satellites. For the last decade, satellite positioning devices became one of the most interesting means of navigation for the displacement of the goods and the people. The only current solution is based on the constellation of satellites Navstar GPS American system. Originally developed for military applications, its use was released under the Clinton administration. However, in order to guarantee its autonomy, Europe decided to launch a competitor program known as Galileo. Galileo system differs from the GPS thanks to its capability to provide real time integrity information to the user. In order to guarantee the stability of this system, it is fundamental to take into account the various problems which can affect the mission and to identify all the potential sources of system unavailability. One of the main source of data unavailability that has been identified is the phenomena of ionospheric scintillations. Indeed scintillation causes radio frequency signal amplitude fades and phase variations as satellite signals pass through the ionosphere. Such effects may induce loss of lock or cycle slips on ranging signals broadcast by Galileo satellites making them totally useless for accurate integrity information determination. Scintillations are clearly identified like a source of disturbances. They appear as the turbulent aspect of a larger disturbance of the ionospheric plasma density which have the shape of a plasma bubble. The difficulty of their modelling is due to the lacks of in situ measurements with regard to them. However, some measurements recently acquired during the mission of satellite DEMETER make possible on the one hand the validation of the models existing but also, using techniques of data-models coupling, to reinforce them. The object of this proposal is therefore to provide a physical model making it possible to anticipate the attenuation of the signals during their propagation within the disturbed Earth ionosphere.

8.2.2.2. ANR AMAM (2011-2014)

Participant: Antoine Gloria.

A. Gloria is involved in the 4-year ANR project “young researcher” AMAM, led by V. Millot (Paris 7). The aim of the project is to develop mathematical tools for the analysis of multiscale problems in material sciences (PDEs and variational methods). The fields of interest are primarily micromagnetics, dislocations, fatigue in nonlinear elasticity, and homogenization.

8.2.2.3. ANR STAB (2013-2017)

Participant: Pauline Lafitte.

STAB : Most of the natural time-evolving systems that one encounters in Physics, Biology, Economics..., can be described by means of evolution equations, or systems of such equations. These equations may include randomness or not. During the last decade, a lot of progress has been made in the understanding of the stabilization of these dynamics, i.e. their convergence to equilibrium. In particular the picture of the qualitative description of the rate of convergence is now almost complete for symmetric models (reversible dynamics). However, the non-reversible setting is still insufficiently understood. One of the most fascinating features of this research area is the strong intricacy between the analysis of partial differential equations and stochastic methods, each approach enlightening the other one. The main goal of this project is to go further, developing tractable and efficient tools, in particular for numerical schemes and algorithms, based on the computation of explicit theoretical bounds. Hence, even if part of the project is devoted to the theoretical study of non-reversible or highly degenerate situations (we typically have to face kinetic or reaction-diffusion models for example), the heart of the project will include discretization schemes, approximating particle systems and concrete simulation situations (including boundary conditions). This concerns the stability of the discretization or numerical methods. The acronym STAB covers both aspects: stabilization and stability. Indeed, sensitivity to small perturbations (or to boundary conditions) is the first definition of large time stability for numerical schemes. The head of the project is I. Gentil (Univ. Lyon1).

8.2.2.4. ANR BECASIM(2013-2017)

Participants: Christophe Besse, Guillaume Dujardin, Ingrid Lacroix-Violet.

C. Besse, G. Dujardin, and I. Lacroix-Violet are members of the new 4-years ANR "Modèles Numériques" project BECASIM. C. Besse is the Toulouse-node coordinator and I. Lacroix-Violet the Lille-node one. The scientific subject deals with mathematical modelling, numerical analysis and simulation of Bose-Einstein condensates (BEC). The goal of this ANR project is to : (i) develop new high-order numerical methods; (ii) develop an integrated and resilient open-source HPC software; (iii) apply these codes to numerically reproduce realistic physical configurations that are not possible to simulate with presently existing software.

8.2.3. Competitivity Clusters

8.2.3.1. LABEX Centre Européen pour les Mathématiques, la Physique et leurs Interactions – CEMPI (2012-2019)

The “Laboratoire d’Excellence” CEMPI was created by the French government within the framework of its “Projets d’Investissement d’Avenir” program, in February 2012. It is a joint venture of the Laboratoire Paul Painlevé (mathematics) and the Laboratoire Physique des Lasers, Atomes et Molecules (PhLAM). Several members of CEMPI participate actively in the CEMPI research and training project, notably through the focus area “The interaction of mathematics and physics”. The corresponding research is described in Sections 3.2.3 and 3.4 .

8.3. European Initiatives

8.3.1. FP7 Projects

ERC starting grant QUANTHOM (starting February 2014).

8.3.2. Collaborations with Major European Organizations

Felix Otto: Max Planck Institute for Mathematics in the Sciences (Germany)
Quantitative stochastic homogenization theory.

8.4. International Research Visitors

8.4.1. Visits of International Scientists

- J.-C. Mourrat (EPFL, 1 week)
- D. Marahrens (MPIMS, 1 week)
- S. Neukamm (WIAS, 1 week)

8.4.2. Visits to International Teams

- A. Gloria, from September to December 2013, Math department, Stanford University

TAO Project-Team

8. Partnerships and Cooperations

8.1. Regional Initiatives

- **TIMCO** – 2012-2015 (432kEuros for TAO). Technology for In Memory Computing. A NUMA architecture with very large memory. FUI project, Coordinator Bull SA, WP *Algorithm adaptation: the paradigm shift* coordinator Cécile Germain.

8.2. National Initiatives

- **ASAP** – 2009-2013 (178 kEuros). *Apprentissage Statistique par une Architecture Profonde*, ANR programme DEFIS 2009 Coordinator Alain Rakotomamonjy, LITIS, Université de Rouen, France; Participants: Sylvain Chevallier, Hélène Paugam-Moisy, Sébastien Rebecchi, Michèle Sebag.
- **IOMCA** – 2010-2013 (264 kEuros). Including Ontologies in Monte-Carlo Tree Search and Applications, ANR international project coordinated by O. Teytaud (TAO, Inria). Participants: Adrien Couëtoux, O. Teytaud.
- **DESCARWIN** – 2010-2013 (201 kEuros). Coordinateur P. Savéant, Thalès R&T. Participants: Mostepha-Redouane Khouadjia, Marc Schoenauer.
- **SIMINOLE** – 2010-2014 (1180kEuros, 250kEuros for TAO). Large-scale simulation-based probabilistic inference, optimization, and discriminative learning with applications in experimental physics, ANR project, Coordinator B. Kégl (CNRS LAL). Participants: Balázs Kégl, Djalel Benbouzid, Nikolaus Hansen, Michèle Sebag, Cécile Germain-Renaud
- **NUMBBO** – 2012-2016 (290kEuros for TAO). Analysis, Improvement and Evaluation of Numerical Blackbox Optimizers, ANR project, Coordinator Anne Auger, Inria. Other partners: Dolphin, Inria Lille, Ecole des Mines de Saint-Etienne, TU Dortmund. Participants: Anne Auger, Nikolaus Hansen, Marc Schoenauer, Ouassim Ait ElHara
- **LOGIMA** – 2012-2016 (136kEuros for TAO). Logics, structural representations, mathematical morphology and uncertainty for semantic interpretation of images and videos, ANR project, Coordinator Céline Hudelot, MAS-ECP. Other partners: TAO, LTCI-Telecom ParisTech. Local coordinator: Jamal Atif

8.2.1. Other

- **GO** – (2011-2013) *Observatoire de la Grille Action de Développement technologique* Inria. Coordinator Cécile Germain-Renaud. Participants: Dawei Feng, Julien Nauroy, Michèle Sebag. Also funded by the France Grilles national initiative.

8.3. European Initiatives

8.3.1. FP7 Projects

- **SYMBRION**
 - Type: COOPERATION (Integrated Project)
 - Program: Embedded systems design
 - Instrument: Integrated Project
 - Objective: FET proactive: Pervasive adaptation
 - Duration: February 2008 - July 2013

Coordinator: Sergey Kornienko and Paul Levi, Stuttgart University (Germany).

Partners: Universität Stuttgart (USTUTT), Universität Graz (IZG), Vrije Universiteit (VU), Universität Karlsruhe (UNIKARL), Flanders Institute for Biotechnology (VIB), University of the West of England, Bristol (UWE), Eberhard Karls Universität Tübingen (UT), University of York (UY), Université Libre de Bruxelles (CENOLI), and Inria-TAO.

Inria contact: M. Schoenauer

Abstract: SYMBRION, an FP7 IP (Integrated Project), involving 10 partners from Robotics (Electronics and Mechanics), Evolutionary Biology, and Computer Science (working on bio-inspired complex systems). Integrating hardware and software design, Symbion IP aims at designing autonomous swarm robots. The software will involve both time-scales of evolutionary learning and on-line learning, in direct connection with TAO research themes.

- **CitInES**

Type: COOPERATION (STREP)

Program: Design of a decision support tool for sustainable, reliable and cost-effective energy strategies in cities and industrial complexes

Instrument: Specific Targeted Research Project

Objective: ICT systems for energy efficiency

Duration: October 2011 - March 2014

Coordinator: Artelys (SME)

Other Partners: AIT (Austria), INESC Porto (Portugal), ARMINES (France), Schneider Electric SAS (France), Comune di Cesena (Italy), Comune di Bologna (Italy), TUPRAS (Turkey), ERVET (Italy)

Inria contact: Olivier Teytaud

Abstract: The overall objective of CitInES is to design and demonstrate a multi-scale multi-energy decision-making tool to optimise the energy efficiency of cities or large industrial complexes by enabling them to define sustainable, reliable and cost-effective long-term energy strategies. Demonstrations will take place in two cities in Italy, Cesena and Bologna, and in one oil refinery in Turkey, Tupras. Innovative energy system modelling and optimization algorithms will be designed to allow end-users to optimize their energy strategy through detailed simulations of local energy production, storage, transport, distribution and consumption, including demand side management and coordination functionalities enabled by smart grid technologies. All energy vectors (electricity, gas, heat...), usages (heating, air conditioning, lighting, transportation...) and sectors (residential, industrial, tertiary, urban infrastructure) will be considered to draw a holistic map of the city/industry energy behaviour. Energy strategy analyses will encompass advanced long-term risk analysis. As economic and technical situations are constantly evolving, a relevant energy strategy should be robust to different prospective scenarios. Hence, a diversified energy portfolio will allow city and industry authorities to react more efficiently to fuel price stresses and to decrease their exposition to a given energy solution. The expected impacts on end-users are threefold : 1) to assess the economic and environmental impacts of urban planning scenarios in terms of energy; 2) to optimise their local energy strategy to cost-effectively reduce CO₂ emissions, including usage of local renewable energies, electric mobility integration, multi-energy coordination, smart grid integration and demand-side management; and 3) to assess financial and environmental long-term risks and propose robust energy schemes to face fuel and CO₂ price uncertainties. The developed software will also be used as a communication tool for end-users to facilitate consultations between actors and to promote local authority decisions towards citizens. CitInES methodology will be demonstrated by optimizing long-term energy strategies for the two partner cities and for the partner oil refinery. The proposed strategies will be assessed and compared to initial end-user strategies to measure energy and CO₂ emission savings.

- **EGI**

Program: Collaborative Project and Coordination and Support Action (CP-CSA)

Project acronym: EGI-Inspire

Project title: European Grid Infrastructures

Duration: May 2010 - April 2014

Coordinator: Steven Newhouse EGI.eu

Other Partners: 40 in Europe and 8 more worldwide (details on <http://www.egi.eu>)

Inria contact: Cécile Germain

Abstract: Collaborative effort involving more than 50 institutions in over 40 countries. Its mission is to establish a sustainable European Grid Infrastructure (EGI). EGI-InSPIRE is ideally placed to join together the new Distributed Computing Infrastructures (DCIs) such as clouds, supercomputing networks and desktop grids, for the benefit of user communities within the European Research Area.

- **Network of Excellence PASCAL**

Type: COOPERATION (FP7)

Program: Pattern Analysis, Statistical Modelling and Computational Learning

Instrument:

Objective: PASCAL is a Network of Excellence funded by the European Union. It has established a distributed institute that brings together researchers and students across Europe, and is now reaching out to countries all over the world.

Duration: March 2008 - July 2013

Coordinator: John Shawe-Taylor, (Scientific coordinator), University College London, UK and Steve Gunn (Operational), University of Southampton, UK

Other Partners:

Inria contact: Michèle Sebag

Abstract: PASCAL is developing the expertise and scientific results that will help create new technologies such as intelligent interfaces and adaptive cognitive systems. To achieve this, it supports and encourages collaboration between experts in Machine Learning, Statistics and Optimization. It also promotes the use of Machine Learning in many relevant application domains such as Machine vision, Speech, Haptics, Brain-Computer Interface, User-modeling for computer human interaction, Multimodal integration, Natural Language Processing, Information Retrieval, Textual Information Access.

- **MASH**

Program: Investigation of the design of complex learning systems to increase the performance of artificial intelligence

Project acronym: MASH

Project title: Massive Sets of Heuristics

Duration: October 2010 - June 2013

Coordinator: Idiap Research Institute (Martigny, Switzerland)

Other Partners: Heudiasyc laboratory (CNRS and UTC, Compiègne, France), University of Potsdam (Germany), Center for Machine Perception of the Czech Technical University, Prague.

Inria contact: Olivier Teytaud

Abstract: The goal of the MASH project is to create new tools for the collaborative development of large families of feature extractors. It aims at starting a new generation of learning software with great prior model complexity. The project is structured around this web platform. It comprises collaborative tools, such as a wiki-based documentation and a forum, and an experiment center to run and analyze experiments continuously. The applications targeted by the project are classical vision problems, and goal-planning in a 3D video game and with a real robotic arm. The scientific issues to be tackled along the course of the project are numerous, from standard Machine Learning questions such as learning and prediction with very large feature spaces and tight computational constraints, to original problems related to clustering in a functional space.

8.3.2. Collaborations in European Programs, except FP7

Program: COST

Project acronym: IC0804

Project title: Energy efficiency in large scale distributed systems

Duration: January 2009 - May 2013

Coordinator: Jean-Marc Pierson IRIT

Other partners: see <http://www.cost804.org>.

Abstract: The COST Action IC0804 proposes realistic energy-efficient alternate solutions to share IT distributed resources. While much effort is nowadays put into hardware specific solutions to lower energy consumptions, a complementary approach is necessary at the distributed system level, i.e., middleware, network and applications. The Action characterizes the energy consumption and energy efficiencies of these components.

8.4. International Initiatives

8.4.1. Inria Associate Teams

8.4.1.1. INDEMA

Title: Intelligent Decision Making Mechanisms with Hidden Information, and Application to Electricity Generation

Inria principal investigator: Olivier Teytaud

International Partner: National University of Tainan (Taiwan)

Duration: 2012 - 2014

See also: <http://www.lri.fr/~teytaud/taiwanday2.html>

The objectives of the project are threefolds:

- Objective 1: Designing consistent iterative realistic algorithms for partially observable 1-player or 2-player games. We mean:
 - consistent algorithms, in the sense that they are mathematically, provably, optimal asymptotically in the computation time.
 - iterative algorithms in the sense that when you give more time to the algorithm, it should be better; and with little time, it should do its best for replying something acceptable. This is also termed an anytime algorithm. Most algorithm which survive decades are iterative.
 - realistic algorithms; we mean that one can easily design a consistent iterative algorithm that will never work in practice in a real-world setting; so, additionally, we want an algorithm which looks reasonable and we refer to the second objective for the assesment of this property.

- Objective 2: Impressive visible applications, e.g., applications in games or puzzles, because such games are very clear assessment tools. Possibilities include Minesweeper (on which we believe that much progress is still possible), Chinese Dark Chess, Kriegspiel, Phantom-Go, card games. Such nice results are critical for advertising and assessing our research.
- Objective 3: Big industrial applications. Having both mathematics and visible realizations in games and industrial applications might be considered as too much; yet, we have chosen to request the maximum possible funding and to include many people in the travelling; also, the persons in the project are all people working in related subjects, with various terminologies, and we already have concrete applications in mind, just far enough from our past activities for being new (we want to tackle in a principled manner partial observability which was somehow ignored in many past works) and close enough for strongly reducing the "warm up" time. In the fully observable case, we worked successfully for these three objectives and want to do the same in the partially observable case. More precisely, when working on real applications in the field of energy generation, we have seen that many problems are simplified so that they boil down to fully observable problems, but that this is a bad application; and our solvers must include some tricks for the partial observability. This is the main motivation for this project; we assume that mathematical analysis can be done on this (objective 1); that it will provide big results in games (objective 2) where many main programs are based on non-consistent algorithms. We believe that requirements above (objective 1) and visible realizations will facilitate the migration to real-world application; also we point out that previous research projects involving us facilitated contacts with industry, in particular in the field of energy generation, which is a key point for this third objective. A roadmap for objective 3 is as follows:
 - Check on simple versions of energy production problems whether the fully observable approximation is ok. We guess that in many cases it is not ok, and we want to clearly state to which extent (by how many percents) we loose in terms of loss function.
 - Experiment our algorithms on real industrial problems. We will work both on Taiwan-centered and on Europe-Centered electricity generation problems in order to widen the scope of the analysis and so that both partners can be helpful in terms of applications in their own countries.

Some continuously updated and more detailed descriptions of several works in progress can be found at <http://www.lri.fr/~teytaud/indema.html>.

8.4.2. Inria International Partners

- On-going collaboration with Christian Schulte (KTH, Stockholm), one of the main developers of the GECODE Constraint Programming platform (see Section 6.2).
- Shinshu University, Faculty of Engineering, project *Global Research on the Framework of Evolutionary Solution Search to Accelerate Innovation*, from the "Strategic Young Researcher Overseas Visits Program for Accelerating Brain Circulation" program, in which TAO and DOLPHIN (Inria Lille) are partner labs and will host Japanese students in the forthcoming 4 years.

8.4.3. Inria International Labs

Olivier Teytaud, 10 days in Inria Chile: meetings with several companies and institutes. They were followed by video-conferences with Endesa and email discussions between our partner Artelys and Cedec-Sing.

8.5. International Research Visitors

8.5.1. Visits of International Scientists

- Visit of a Taiwanese delegation, about power systems and E-learning mainly; more information at <http://www.lri.fr/~teytaud/france2013.html>. Contact: O. Teytaud.

- Visit of a delegation of Shinshu University, Faculty of Engineering, including Dr. Miura (University Trustee and VP), Dr. Tanaka, coordinator of the *Global Research on the Framework of Evolutionary Solution Search to Accelerate Innovation* project (see above).

8.5.2. Visits to International Teams

- **Olivier Teytaud**, invited research fellow, National Dong Hwa University, 4.5 months, 2013.

TOSCA Project-Team

8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. ANR

- N. Champagnat, J. Claisse and D. Villemonais are members of the ANR MANEGE (Modèles Aléatoires en Écologie, Génétique et Évolution, ending in April 2014) whose aim is to provide methodological and conceptual advances in the study of stochastic processes modeling ecology, population genetics and evolution of life. This work is sustained by regular exchanges with biologists from several teams in France. In addition, the three working groups that operate in each of the three poles of the MANEGE project (Paris, Palaiseau, Marseille) gather all local probabilistic interests in the issues of this project. http://www.cmap.polytechnique.fr/~anr-manege/index_en.html
- A. Lejay is member of the ANR SIMUDMRI (Simulation of diffusion MRI signals in biological tissues) which started in November 2010 (directed by Jing-Rebecca Li, Inria Rocquencourt). <http://www.cmap.polytechnique.fr/~jingrebeccali/grants/simudmri.html>
- A. Lejay is member of the ANR H2MNO4 (ANR Cosinus, 2012–2015) on Original Optimized Object Oriented Numerical Model for Heterogeneous Hydrogeology which started in November 2012 (directed by Joceyline Erhel, IRISA, Rennes).

8.1.2. Contract with ADEME

Participant: Mireille Bossy.

Modéol Since April 2013, M. Bossy is the coordinator of the MODÉOL collaboration project funded by the French Environment and Energy Agency (ADEME), and involving the IPSL (CNRS) and the French company Maïa Eolis. The overall goal of the project concerns the modeling and prediction of wind potential in France, in particular the quantification of uncertainties and the analysis of multi-scale variability.

Concerning the Inria workpackage, in collaboration with Antoine Rousseau, from the project-team MOISE, M. Bossy introduced the terrain elevation in the SDM modelling. Selim Kraria is starting to work in MODÉOL. This year we also work on the interface of SDM with the classical and widely used numerical weather prediction solver WRF. For the visualisation purpose with the SDM outputs, we also retained the NUM3SIS platform developed at Inria Sophia Antipolis - Méditerranée.

8.2. International Initiatives

8.2.1. Inria Associate Teams

8.2.1.1. ANESTOC

Title: Stochastic modelling of renewable energies

Inria principal investigator: Denis Talay

International Partner (Institution - Laboratory - Researcher):

Pontificia Universidad Católica de Chile (Chile) - ANESTOC - Denis Talay

Duration: 2011 - 2013

See also: http://www.anestoc.cl/es/?page_id=1112

This associate team complements a CIRIC research program in Chile. We refer to the TOSCA-ANESTOC project on stochastic modelling of renewable energies, especially wind farms, and oceanic resources. Our associate team ("équipe associée Inria") will conduct its joint research at two different levels. Firstly, the mathematical work on its own which we have called the "Mathematical Kernel" (MK), motivated by a number of fundamental problems raised by the specific applications in which we are interested. The second level of research concerns two main axes of Applications: (A1) Applications to Engineering (Renewable energies) and (A2) Applications to Neuroscience. The Mathematical Kernel includes a number of fields in the domains of Stochastic Analysis, Statistics and Numerical Analysis. In particular, it is worth mentioning the following: 1. Probabilistic resolution of Boussinesq non-linear partial differential equations; 2. Stochastic Lagrangian modelling for wind simulation at small scale; 3. Open system dynamics as a bridge between Molecular Dynamics and Stochastic Differential Equations; 4. Inference on Stochastic Processes. 5. Algorithms and simulation. The Applications include the stochastic modelling of renewable energy through ocean resources and wind farms (CIRIC-subproject). This subject will be developed with engineers of Fundacion Inria Chile. In addition, applications to ion-channel dynamics through cell membranes will be considered jointly with biophysicists of the CINV (Neuroscience Centre of Valparaíso).

8.2.1.2. *Informal International Partners*

The TOSCA team project has collaborations with researchers in Japan (Ritsumeikan and Hosei University), Uruguay (Universidad de la República), ...

8.2.2. *Inria International Labs*

The CIRIC Team on *Stochastic Analysis of Renewable Energies: Ocean Energy and Wind Farms; dynamics and numerics* (2012-2014) is managed by TOSCA and ANESTOC (Univ Catolica, Santiago). It is composed of three main projects.

Mireille Bossy is managing the WINDPOS project, in collaboration with Antoine Rousseau (MOISE team) and three engineers of Inria Chile, Cristian Paris, José Espina Dote and Jacques Morice. Based on the stochastic Lagrangian modeling of the wind at small scale (see SDM SOFTWARE), WINDPOS aims to develop a wind farm simulator software, able to provide fine statistical information for the managing of electricity production.

This year the WINDPOS project focused on the introduction on wind mills modeling in the SDM software. This modeling is based on actuator disk and actuator line models. We also introduced inflow/outflow boundary conditions in SDM and added a CIC averaging in order to refine the input for the projection/pressure computation.

8.2.3. *Participation In other International Programs*

8.2.3.1. *Math Amsud project SIN*

Participant: Etienne Tanré.

The Math Amsud project SIN (Stochastic, Inference, Neuroscience) started in 2013. We worked on the part concerned by the stochastic modelling in neuroscience.

It is likely that the stochastic components play an important role in the functions of the neurons and of the networks they form. We describe and study the effect of the noise at different scales of neural activity, such that the level of the ionic channels and the level of neural networks, which are responsible for conveying and processing the information coded in sequences of spikes. The most popular models of this class are integrate and fire (LIF) neural networks. We study the synchronization of neurons in those networks.

8.3. *International Research Visitors*

8.3.1. *Visits of International Scientists*

- The TOSCA *seminar* organized by J. Inglis in Sophia Antipolis has received the following speakers: Eric Luçon (Technische Universität, Berlin), Julien Reygner (UPMC), Khaled Bahlali (Université du Sud Toulon-Var), Bertrand Cloez (Laboratoire d'Analyse et de Mathématiques Appliquées Université Paris-Est - Marne-la-Vallée), Michael Mascagni (Florida State University), Camillo Garcia Trillos (Laboratoire J.A. Dieudonné Nice), Pierre Guiraud (CIMFAV Facultad de Ingeniería, Universidad de Valparaíso), Laurent Michel (Laboratoire J.A. Dieudonné Nice), François Delarue (Laboratoire J.A. Dieudonné Nice).
- L. Beznea (Simion Stoilow of the Institute of Mathematics of the Romanian Academy) has been visiting TOSCA Nancy for two weeks in May and June.

8.3.1.1. Internships

Jonathan Alif

Subject: Étude des grandes variations du modèle de Heston

Date: from May 2013 until August 2013

Institution: Université de Lorraine

Maimoun Ben Taher

Subject: Real options for electricity production

Date: from Feb 2013 until May 2013

Institution: École Polytechnique de Tunisie (Tunisia)

Louis Capietto

Subject: Networks with several populations of neurons

Date: January-June 2013

Institution: École Centrale de Lyon

Benoît Henry

Subject: Population genetics and ancestral inference for continuous time branching processes

Date: from March 2013 until September 2013

Institution: Université de Lorraine

Alexis Papic

Subject: First Passage Times

Date: March 2013

Institution: PUC (Chile)

Khaled Salhi

Subject: Risk measures: detection of crisis periods and computation of Value-at-Risk

Date: from March 2013 until September 2013

Institution: Université de Lorraine

Shih Hau Tan

Subject: Towards efficient risk quantification using GPUs and variance reduction techniques

Date: from April 2013 until September 2013, in co-advising with Françoise Baude (OASIS team)

Institution: Erasmus Mundus MathMods Program, University of Nice Sophia-Antipolis

8.3.2. Visits to International Teams

- J. Inglis was invited for one week by B. Zegarlinski to Imperial College London in January.

CORTEX Team

7. Partnerships and Cooperations

7.1. National Initiatives

7.1.1. ANR project PHEROTAXIS

Participants: Dominique Martinez, Thomas Voegtlin.

How can animals so successfully locate odor sources? This apparently innocuous question reveals on analysis unexpectedly deep issues concerning our understanding of the physical and biological world and offers interesting prospects for future applications. Pherotaxis focuses on communication by sex pheromones in moths. The main aim of the project is to integrate the abundant experimental data on the pheromone plumes, neural networks and search behaviour available in the literature, as well as that collected or being collected by us at the molecular, cellular, systemic and behavioural levels into a comprehensive global model of the pheromonal olfactory processes. To reach this objective, the consortium combines several groups of specialists with different and complementary fields, in physics (Institut Pasteur IP), neurobiology (INRA) and bio-robotics (Inria).

7.1.2. ANR project KEOPS

Participant: Carlos Carvajal-Gallardo.

This «ANR Internal White Project» involving NEUROMATHCOMP and CORTEX (and now MNEMOSYNE since most Cortex members involved in this project are now in this team) Inria EPI in France with the U. of Valparaiso, U. Tecnica Frederico Santa-Maria, and U. De Chili is a 3 years, 248 person-months, sensory biology, mathematical modeling, computational neuroscience and computer vision, project addressing the integration of non-standard behaviors from retinal neural sensors, dynamically rich, sparse and robust observed in natural conditions, into neural coding models and their translation into real, highly non-linear, bio-engineering artificial solutions. An interdisciplinary platform for translation from neuroscience into bioengineering will seek convergence from experimental and analytical models, with a fine articulation between biologically inspired computation and nervous systems neural signal processing (coding / decoding).

7.2. International Initiatives

7.2.1. Participation In other International Programs

Conacyt project with Mexico (2010-2013):

We work with the Cinvestav Tamaulipas research center (Mexico), on the analysis, methods and techniques for the embedded implementation of massively distributed bio-inspired connectionist processing for perception tasks on reconfigurable devices under a hardware/model codesign approach, through a project funded by the Mexican ministry Conacyt. Our works were mostly oriented towards the study of the properties of massively distributed elementary computations in bio-inspired models for vision in order to provide efficient implementation into reconfigurable logic devices. Other activities extended our works to sensori-motor systems, including embedded control of low-level locomotion by means of CPG models (central pattern generators).

7.3. International Research Visitors

7.3.1. Visits of International Scientists

7.3.1.1. Visiting professors/researchers

Chahinez Meriem BENTAOUZA (December 2013)

Funding: University of Mostaganem

Subject: Etude bibliographique de méthodes d'apprentissage statistique pour l'analyse de signaux médicaux

Institution: University of Mostaganem, Algeria

Fatiha HENDEL (April 2013)

Funding: University of Oran

Subject: Apprentissage et classification automatique

Institution: University of Oran, Algeria

Cesar TORRES-HUITZIL (July 2013)

Funding: Conacyt project

Subject: Hardware implementations of neural networks

Institution: Cinvestav Tamaulipas, Mexico

7.3.1.2. Internships

Hariharan NATANASIHAMANI (from May 2013 until Sep 2013)

Subject: Developmental reinforcement learning

Institution: McGill University, Canada

ABS Project-Team

7. Partnerships and Cooperations

7.1. National Initiatives

7.1.1. *Projets Exploratoires Pluridisciplinaires from CNRS/Inria/INSERM*

Title: Modeling Large Protein Assemblies with Toleranced Models

Type: Projet Exploratoire Pluri-disciplinaire (PEPS) CNRS / Inria / INSERM

Duration: two years

Coordinator: F. Cazals (Inria, ABS)

Others partners: V.Doye (Inst. Jacques Monod)

Abstract: Reconstruction by Data Integration (RDI) is an emerging paradigm to reconstruct large protein assemblies, as discussed in section 5.1.3 .

Elaborating on our Toleranced Models framework, a geometric framework aiming at inherently accommodating uncertainties on the shapes and positions of proteins within large assemblies, we ambition within the scope of the two year long PEPS project entitled *Modeling Large Protein Assemblies with Toleranced Models* to (i) design TOM compatible with the flexibility of proteins, (ii) develop graph-based analysis of TOM, and (iii) perform experimental validations on the NPC.

7.2. European Initiatives

7.2.1. FP7 Projects

7.2.1.1. CG-Learning

Title: Computational Geometric Learning (CGL)

Type: COOPERATION (ICT)

Defi: FET Open

Instrument: Specific Targeted Research Project (STREP)

Duration: November 2010 - October 2013

Coordinator: Friedrich-Schiller-Universität Jena (Germany)

Others partners: Jena Univ. (coord.), Inria (Geometrica Sophia, Geometrica Saclay, ABS), Tech. Univ. of Dortmund, Tel Aviv Univ., Nat. Univ. of Athens, Univ. of Groningen, ETH Zürich, Freie Univ. Berlin.

See also: <http://cglearning.eu/>

Abstract: *The Computational Geometric Learning project aims at extending the success story of geometric algorithms with guarantees to high-dimensions. This is not a straightforward task. For many problems, no efficient algorithms exist that compute the exact solution in high dimensions. This behavior is commonly called the curse of dimensionality. We try to address the curse of dimensionality by focusing on inherent structure in the data like sparsity or low intrinsic dimension, and by resorting to fast approximation algorithms.*

7.3. International Initiatives

7.3.1. Inria International Partners

7.3.1.1. Declared Inria International Partners

ABS has regular international collaboration, in particular with the members of the FP7 project *Computational geometric learning* mentioned in section 7.2.1 .

7.4. International Research Visitors

7.4.1. Internships

- Angeliki Kalamara, from the University of Athens, performed a 5 month internship under the dual supervision of F. Cazals and I. Emiris (Univ. of Athens). The topic was *Modeling cryo-electron microscopy density maps*.

AMIB Project-Team

6. Partnerships and Cooperations

6.1. Regional Initiatives

A. Denise is the coordinator of the "Japarin-3D" Digiteo project 2012-2016. This project, in collaboration with PRISM at Versailles, aims to develop new efficient approaches for predicting the 3D structure of large RNA molecules, by applying game theory and graph algorithms.

6.2. National Initiatives

6.2.1. ANR

A. Denise is involved in the NSD-NGD ANR project 2010-2014. Y. Ponty is involved in the MAGNUM ANR project (BLAN program, 12/2010–12/2014).

6.2.2. PEPS

Ch. Froidevaux was responsible for the CNRS-INSERM-INRIA Peps grant *Identification of metabolic capabilities of fungi by comparative genomic* involving IGM, Paris-Sud and UMR GV, CNRS.

6.3. European Initiatives

Program: Partenariat Hubert Curien (PHC) Procope (Jointly funded by Egide and DAAD)

Project acronym: SOSW

Project title: Sharing and Optimizing Scientific Workflows

Duration: 2013 - 2015

Coordinator: Sarah Cohen-Boulakia

International Partner

U. Humboldt (Berlin, Allemagne)

Institute for Computer Science

Ulf Leser

Abstract : Considerable effort has been put into the development of scientific workflow management systems. They support scientists in developing, running, and monitoring chains of data analysis programs. A variety of systems have reached a level of maturity that allows them to be used by scientists for their bioinformatics experiments, especially including analysis of NGS data. However, each scientific group has its own way of analyzing NGS data, using a particular set of tools, in a particular order. The aim of this project is to exploit the complementary skills of the two European groups involved to develop approaches promoting exchange of (optimized) workflows.

6.4. International Initiatives

6.4.1. Inria Associate Teams

6.4.1.1. ITSNAPE

Title: Intelligent Techniques for Structure of Nucleic Acids and Proteins

Inria principal investigator: Julie Bernauer

International Partner (Institution - Laboratory - Researcher):

Stanford University (United States) - Computational Structural Biology, School of Medicine, Structural Biology - Julie Bernauer

Duration: 2012 - 2014

See also: http://www.lix.polytechnique.fr/~bernauer/EA_ITSNAP/

The ITSNAP Associated Team project is dedicated to the computational study of RNA 3D structure and interactions. By developing new molecular hierarchical models for knowledge-based and machine learning techniques, we can provide new insights on the biologically important structural features of RNA and its dynamics. This knowledge of RNA molecules is key in understanding and predicting the function of current and future therapeutic targets.

6.4.2. Inria International Partners

6.4.2.1. Declared Inria International Partners

CARNAGE

Program: Inria-Russia

Title: CARNAGE: Combinatorics of Assembly and RNA in GENomes

Inria principal investigator: Mireille Régnier

International Partner (Institution - Laboratory - Researcher):

State Research Institute of Genetics and Selection of Industrial Microorganisms (Russia (Russian Federation)) - Bioinformatics laboratory - Mireille Régnier

Duration: 2012- 2014

See also: <https://team.inria.fr/amib/carnage>

CARNAGE addresses two main issues on genomic sequences, by combinatorial methods.

Fast development of high throughput technologies has generated a new challenge for computational biology. The recently appeared competing technologies each promise dramatic breakthroughs in both biology and medicine. At the same time the main bottlenecks in applications are the computational analysis of experimental data. The sheer amount of this data as well as the throughput of the experimental dataflow represent a serious challenge to hardware and especially software. We aim at bridging some gaps between the new "next generation"sequencing technologies, and the current state of the art in computational techniques for whole genome comparison. Our focus is on combinatorial analysis for NGS data assembly, interspecies chromosomal comparison, and definition of standard pipelines for routine large scale comparison.

This project also addresses combinatorics of RNA and the prediction of RNA structures, with their possible interactions.

6.4.2.2. Informal International Partners

Polytechnique/UPSud and McGill/U. Montréal

Program: CFQCU

Title: Réseau franco-québécois de recherche sur l'ARN

Inria principal investigator: Jean-Marc Steyaert

International Partner (Institution - Laboratory - Researcher):

Mc Gill and Université de Montréal (Canada)

Computer Science Department

Jérôme Waldispühl

Duration: 2012 - 2014

Résumé : The partners have developed complementary expertise on RNA : bioinformatics, combinatorics and algorithms. machine learning, physics and genomics. Methodologies will be developed that combine theoretical simulations and new (high throughput) experimental data. A common high level training at Master and PhD level is organized.

6.4.3. Inria International Labs

R. Fonseca spent 5 months at SLAC in Stanford to work with Henry van den Bedem. J. Bernauer spent two weeks at SLAC. The associated team members also presented their work at the Inria BIS 2013 Workshop in Stanford <https://project.inria.fr/inria-siliconvalley/workshops/bis2013/>.

6.4.4. Participation In other International Programs

6.4.4.1. NII International Internship Program

Adrien Rougny has been an intern at NII from February to August 2013 with a support of "NII International Internship Program. He worked on the topic "Inference and Learning for Systems Biology and Network Dynamics" in Pr. Katsumi Inoue's group, a long-term collaboration of Ch. Froidevaux.

6.4.4.2. PHC Procore

J. Bernauer is coordinator with Pr. X. Huang at the Hong-Kong University of Science and Technology of a Partenariat Hubert Curien (PHC) Procore project (2012-2013). The project is entitled *Computational studies of conformational dynamics of the RNA-induced silencing complex and design of miRNAs to target oncogenes*.

6.5. International Research Visitors

6.5.1. Visits of International Scientists

H.K. Hwang

Subject: Probabilistic Analysis of A Simple Evolutionary Algorithm

Institution: Taipei University (Taiwan)

V. Reinharz

Subject: RNA 3D structure analysis

Institution: McGill University (Canada)

E. Furltova

Subject: word enumeration

Institution: Institute of Mathematical Problems in Biology (Russia)

6.5.1.1. Internships

- C. Moutet (May and June 2013)
 - Subject: Poor mappability regions in assembly
 - Institution: ENS Lyon and Ecole Polytechnique Fédérale de Lausanne
 - Funding: INRIA
 - Supervision: M. Régnier
- F. Pirot (May and June 2013)
 - Subject: Exceptional words in *Archae* genomes
 - Institution: ENS Lyon
 - Funding: INRIA
 - Supervision: M. Régnier
- B. Fang (May to July 2013)
 - Subject: Clumps combinatorics, automata and word asymptotics
 - Institution: Princeton University (United States)
 - Funding: Ecole Polytechnique
 - Supervision: M. Régnier
- J. Moussu (April to July 2013)

Subject: Repeats in genomic sequences

Institution: Rennes University

Funding: INRIA

Supervision: M. Régnier

- M. Pichene (April to July 2013)
 - Subject: Graph algorithms and protein-protein interactions
 - Institution: Paris-Sud University
 - Funding: INRIA
 - Supervision: J. Bernauer
- L. Uroshlev (June 2013)
 - Subject: Reference state for RNA KB potentials
 - Institution: IOGEN (Moscou, (Russia))
 - Funding: INRIA (CARNAGE)
 - Supervision: J. Bernauer
- O. Berillo (January and december 2013)
 - Subject: miRNAs and oncogenes.
 - Institution: El Farabi University (Almaty, (Kazakhstan))
 - Funding: El Farabi University
 - Supervision: M. Régnier
- A. Bari (March 2013)
 - Subject: stress-inducible miRNAs
 - Institution: El Farabi University (Almaty, (Kazakhstan))
 - Funding: El Farabi University
 - Supervision: M. Régnier

6.5.2. Visits to International Teams

- Sep. 2013–Sep. 2014: Y. Ponty is visiting PIMS and Simon Fraser University (Vancouver, Canada)

ANGE Team

8. Partnerships and Cooperations

8.1. Regional Initiatives

8.1.1. *Instabilities in Hydrodynamics (2011–2015)*

Participant: Nicolas Seguin.

The Emergence project (Ville de Paris and FSMP) “Instabilities in Hydrodynamics” is related to theoretical, applied, and numerical mathematics for the study of hydrodynamical turbulence phenomena. The postdoc of Aude Bernard-Champmartin is held within this project.

8.1.2. *Plasticity of geophysical flows and seismic emissions (2013–2016)*

Participant: Anne Mangeney.

This project is funded by Sorbonne Paris Cité (80.000 euros) and is a collaboration between IPGP and Univ. Paris 13.

8.2. National Initiatives

8.2.1. *GdR EGRIN (2013–2017)*

Participant: Jacques Sainte-Marie.

EGRIN stands for Gravity-driven flows and natural hazards. J. Sainte-Marie is the head of the scientific committee of this CNRS research group. As such, J. Sainte-Marie participated to the consortium of the prospective think tank “Mathematics and the complexity of the system Earth” launched by the French agency for research in the framework of the UNESCO year “Mathematics of Planet Earth”.

8.2.2. *Inria Project Lab “Algae in Silico”*

Participants: Anne-Céline Boulanger, Marie-Odile Bristeau, Raouf Hamouda, Jacques Sainte-Marie.

The team is involved in the GreenStars project (“Investissement d’avenir”) which is a collaboration between academic institutions (INRA, Inria, Univ. Pierre et Marie Curie Paris 6, ...) and the industrial world.² The main purpose of GreenStars is to lay the foundations for the entire sector, from energy generation to waste recycling and production of compounds of interest. GreenStars also plans to play a long-term role in this field by training technicians, engineers and researchers. In order to structure and support the contributions of Inria in this domain, an Inria Project Lab called “Algae in Silico” has been funded.

The PhD thesis of A.-C. Boulanger was a part of this project. Likewise, the ADT In@lgae was launched in this framework in collaboration with the BIOCORE Inria project-team and enabled the recruitment of R. Hamouda as a young engineer.

8.2.3. *ANR LANDQUAKE (2012–2016)*

Participant: Anne Mangeney.

Within the ANR domain “Mathematics and Interfaces”, this ANR project (between Univ. Paris-Est – LAMA, Univ. Denis Diderot Paris 7 – IPGP, Univ. Nantes – LPGN, Univ. Strasbourg EOSt, 180.000 euros) deals with the mathematical and numerical modelling of landslides and generated seismic waves.

²among which are: Air Liquide, ACRI, Alfa Laval, Algaestream, Algenics, Algu’Innov, Bioalgotral, EADS, Eco-Solution, Envolution, Fermentalg, Greensea, IDEE Aquaculture, La Compagnie du Vent-GDF Suez, Microphyt, Naskeo Environnement, Ondalys, Peugeot Citroën Automobiles, Rhodia, Roquette, Sofiprotéol, Soliance, Solvay, Suez Environnement, TIA, TOTAL, Véolia Environnement.

8.2.4. LRC Manon (2010–2014)

Participants: Edwige Godlewski, Yohan Penel, Nicolas Seguin.

CEA and Laboratory Jacques-Louis Lions launched a collaboration 4 years ago. Studies are carried out about compressible two-phase flows and model coupling, for instance in the case of an asymptotic hierarchy of models.

8.2.5. Structure Health Monitoring

Participant: Nicolas Seguin.

This collaboration with the Ifsttar also comprises Inria researchers from the I4S team. The goal is to provide efficient numerical tools to take into account the impact of the flows around the structures. The most challenging part of this project concerns the off-shore wind turbines and the understanding of the ice formation on the structure.

8.2.6. ANR project HJnet (2013–2015)

Participant: Edwige Godlewski.

This research project consists in studying Hamilton-Jacobi equations on networks, and more generally on heterogeneous structures. This theoretical problem has several potential applications, in particular to traffic flow theory.

8.2.7. Hydraulics for environment and sustainable development (HED²)

The scientific group (GIS in French), to which Inria is a partner, brings together scientists and engineers involved in hydraulics, risk management and sustainable development. ANGE belongs to this group. On the one hand, the team can be provided with experimental measurements (erosion, long waves, fluid structure interactions,...) thanks to this collaboration; on the other hand, the GIS can favor the transfer of numerical tools and scientific results.

8.3. European Initiatives

8.3.1. ERC Consolidator Grant (2013–2018)

Participant: Anne Mangeney.

The project SLIDEQUAKES about detection and understanding of landslides by observing and modelling gravitational flows and generated earthquakes has been funded by the European Research Council (2.000.000 euros).

8.4. International Initiatives

8.4.1. Informal International Partners

The team has developed strong relations with researchers from Spanish universities, in particular with Carlos Pares (Malaga), Enrique Fernandez-Nieto and Tomas Chacon Rebollo (Sevilla). They have an expertise in complex flows, including variable density flows, erosion, non-hydrostatic effects, ...

8.5. International Research Visitors

Enrique Fernandez-Nieto and Gladys Narbona-Reina (Univ. Sevilla) were hosted for 1 month by A. Mangeney's team at IPGP.

ARAMIS Team

8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. ANR

8.1.1.1. ANR HM-TC

Participants: Olivier Colliot [Correspondant], Marie Chupin, Didier Dormont, Denis Schwartz, Dominique Hasboun, Linda Marrakchi-Kacem, Yohan Attal, Claire Cury.

Project acronym: HM-TC

Project title: Model of the hippocampo-cortical connectivity in “temporal consciousness” in normal and pathological memory derived from multimodal anatomical and functional brain imaging (aMRI, DT-MRI, MEG, fMRI)

Duration: Nov 2009- Nov 2014

Amount: 2M€

Coordinator: Olivier Colliot (ARAMIS) and Gianfranco Dalla Barba

Other partners: CENIR, ENS Cachan, Neurospin, Grenoble Institut des Neurosciences

Abstract: The aim of this project is to evaluate the role of the medial temporal lobe and its connections with various cortical regions in temporal consciousness related tasks and to derive a neuro-computational model of memory processing from multimodal imaging data. Temporal consciousness is defined as the ability to specify one’s own time-location with respect to past, present and future, and is thus a more general framework than episodic memory. Based on an original cognitive model and relying on memory dysfunctions called confabulations, different groups of participants (controls, patients with Alzheimer’s disease, patients with several memory disorders) will be evaluated through behavioural tests, MEG, anatomical, functional and diffusion-tensor MRI. New signal and image processing methods will be developed for all these modalities, in order to describe in a more robust and precise way both the anatomy and the function of the medial temporal lobe. First, using in vivo ultra high field MRI acquisitions (7 Tesla), we will build a precise anatomical atlas of the hippocampus and its inner structure. This model will allow designing efficient MEG source reconstruction in these regions, and new methods to analyse anatomical and functional connectivity. Using the most recent mathematical achievements in the theory of diffeomorphic deformations, we will propose new registration and morphometry methods in order to analyze very precisely the structural alterations of the medial temporal lobe. These new methods will be applied to the neuroimaging data acquired for the project in order to analyse extensively the relationships between memory disorders and structural and functional brain alterations revealed by neuroimaging.

8.1.2. IHU

Participants: Olivier Colliot, Mario Chavez, Stanley Durrleman, Marie Chupin, Didier Dormont, Dominique Hasboun, Damien Galanaud, Fabrizio de Vico Fallani.

Project acronym: IHU-A-ICM

Project title: Institute of Translational Neuroscience

Founded in 2011

General Director: Bertrand Fontaine

The IHU-A-ICM program was selected, in 2011, in a highly competitive national call for projects. A 10-year, 55M€ program, has been implemented by a recently created foundation for scientific cooperation. Based on the clinical and scientific strenghts of the ICM and the hospital Department of Nervous System Diseases, it mainly supports neuroscience research, but is also invested in improving care and teaching. ARAMIS is strongly involved in the IHU-A-ICM project, in particular in WP6 (neuroimaging and electrophysiology), WP7 (biostatistics), WP2 (Alzheimer) and WP5 (epilepsy). We have started collaborations with the new bioinformatics/biostatistics platform (IHU WP7, head: Ivan Moszer), in particular through a joint project on the integration of imaging and genomics data.

8.1.3. CATI (Alzheimer Plan)

Participants: Olivier Colliot [Correspondant], Marie Chupin [Correspondant], Stanley Durrleman, Didier Dormont, Chabha Azouani, Ali Bouyahia, Johanne Germain, Xavier Badé, Hugo Dary, Ludovic Fillon, Takoua Kaaouana, Alexandre Routier, Sophie Lecomte.

Project acronym: CATI

Project title: Centre d'Acquisition et de Traitement des Images

Founded in 2011

Amount: 9M€

Coordinator: Jean-François Mangin

Other partners: Neurospin, CENIR, Inserm U678, IM2A

Abstract: The CATI project (funded by the National Alzheimer Plan for 9M€, 2.1M€ for ARAMIS) aims at creating a national platform for multicenter neuroimaging studies. CATI aims to be a national resource for the scientific, medical and industrial research community and will provide a wide range of services: access to a national acquisition network, standardization of acquisitions, image quality control, image analysis, databasing/archiving, meta-analyses. Through CATI, our team coordinates a large network composed of over 30 image acquisition centers. CATI already supports over 15 multicenter projects including the national cohort MEMENTO (2300 subjects). CATI is integrated with France Life Imaging (PI: F. Lethimonnier) and the Neugrid for you (N4U, PI: G. Frisoni) network.

8.1.4. Institut Carnot

Participant: Mario Chavez [Correspondant].

ARAMIS is supported by the "Programme de Maturation Carnot" for the following projects:

Etude des interactions cortex-respiration. (Coordinators: P. Pouget and M. Chavez)

Evaluating anesthetic depth using electroencephalographical recording in human and non-human primates. (Coordinators: P. Pouget and M. Chavez)

8.1.5. Other National Programs

Participants: Olivier Colliot, Marie Chupin, Stanley Durrleman, Didier Dormont, Damien Galanaud.

ARAMIS is a partner of the following national projects :

- PHRC (Programme Hospitalier de Recherche Clinique) PredictPGRN, co-funding by Alzheimer Plan, *Caractérisation multimodale prospective de la démence frontotemporale due à des mutations du gène PGRN à un stade symptomatique et présymptomatique.* (Coordinator : A. Brice)
- PHRC (Programme Hospitalier de Recherche Clinique) ImaBio3, co-funding by Roche (pharmaceutical industry), *Rôle des réactions cellulaires sanguines, inflammatoires et immunitaires anti-amyloïde centrales et périphériques dans la maladie d'Alzheimer débutante.* (Coordinator : M. Sarazin)
- PHRC (Programme Hospitalier de Recherche Clinique) CAPP, *Caractérisation linguistique, anatomique/métabolique et biologique des différentes formes d'aphasie primaire progressive : vers le rationnel pour des essais pharmacologiques et des rééducations du langage ciblées.* (Coordinator: M. Teichmann)

8.2. European Initiatives

8.2.1. FP7 Projects

Participants: Stefan Thurner, Vito Latora, Albert Diaz-Guilera, Maxi San Miguel, Cecilia Mascolo, Mirco Murolesi, Mario Chavez [Correspondant].

Project acronym: LASAGNE

Project title: multi-Layer SpAtiotemporal Generalized NETworks

Founded in 2012

Amount: 1.6M€

Coordinator: Stefan Thurner

Other partners: Medical University of Vienna, Queen Mary University of London, Universitat de Barcelona, Universitat de les Illes Balears, University of Cambridge, University of Birmingham.

Abstract: The aim of the LASAGNE project is to provide a novel and coherent theoretical framework for analysing and modelling dynamic and multi-layer networks in terms of multi-graphs embedded in space and time. To do this, we will treat time, space and the nature of interactions not as additional dimensions of the problem, but as natural, inherent components of the very same generalised network description. The theory will be validated on real-world applications involving large and heterogeneous data sets of brain networks, on- and off-line social systems, healthcare systems, and transportation flows in cities. The LASAGNE project will provide new quantitative opportunities in different fields, ranging from the prediction of pathologies to the diffusion of ideas and trends in societies, and for the management of socio-technological systems.

8.3. International Initiatives

8.3.1. Informal International Partners

S. Durrleman has an enduring collaboration with the Scientific Computing and Imaging (SCI) Institute at the University of Utah (USA). He is consultant for NIH Grant "4D shape analysis for modeling spatiotemporal change trajectories in Huntington's Disease "predict-HD". He is part of the PhD committees of J. Fishbaugh and A. Sharma supervised by professor Guido Gerig.

M. Chupin and O. Colliot have an enduring collaboration with the Center for Magnetic Resonance Research, University of Minnesota, USA (P-F Van de Moortele, T. Henry, M. Marjanska, K. Ugurbil) a leading center in 7T MRI.

D. Galanaud has an enduring collaboration with the Massachusetts General Hospital, Harvard University, USA (R. Gupta).

M. Chavez has enduring collaborations with the Center for Applied Medical Research, Pampelune, Spain (M. Valencia), the Department of Physics, Queen Mary University of London, UK (V. Latora) and the Anatomical Neuropharmacology Unit, University of Oxford, UK (J. Mena-Segovia).

8.4. International Research Visitors

8.4.1. Visits of International Scientists

In September 2013, the team welcome James Fishbaugh, as part of its training as PhD candidate at the University of Utah under the supervision of professor Guido Gerig.

ASCLEPIOS Project-Team

7. Partnerships and Cooperations

7.1. European Initiatives

7.1.1. FP7 Projects

7.1.1.1. VPH NOE

Participants: Maxime Sermesant [correspondant], Moulay Fadil, Florian Vichot, Nicholas Ayache.

medinria registration toolbox VPH NOE standards

Title: VPH NoE

Type: COOPERATION (ICT)

Defi: Virtual Physiological Man

Instrument: Network of Excellence (NoE)

Duration: June 2008 - November 2012

Coordinator: University College London, UK

Others partners: Core members include UCL (UK), Oxford (UK), CNRS (FR), ULB (BE), U. of Nottingham (UK), UPF (ES), U. Auckland (NZ), EMBL (DE), U. Sheffield (UK), Karolinka (SE), ERCIM (FR), IOR (IT).

See also: <http://www.vph-noe.eu/>

Abstract: The Virtual Physiological Human Network of Excellence (VPH NoE) is a EU seventh Framework funded project, working to connect and support researchers in the VPH field within Europe and beyond. Inria is one of the core members, and is mostly dedicated, through Asclepios, to the data fusion part of the VPH toolkit. More precisely, a registration toolbox has been delivered which aims at including registration algorithms from the team and elsewhere in the new version of medInria (2.x). During the extension of the project through 2013, we participated in a hackfest on software interoperability (May 20-24, 2013 in Kingston, Canada and Nov 4-8, 2013 in London, UK).

7.1.1.2. MedYMA

Title: Biophysical Modeling & Analysis of Dynamic Medical Images

Type:ERC

Instrument: ERC Advanced Grant (Advanced)

Duration: April 2012 - March 2017

Coordinator: Inria (France)

See also: <http://www.inria.fr/en/centre/sophia/news/medical-imagery-and-i.t.-the-personalised-digital-patient>

Abstract: During the past decades, exceptional progress was made with in vivo medical imaging technologies for capturing the anatomical, structural and physiological properties of tissues and organs in a patient, with an ever increasing spatial and temporal resolution. The physician is now faced with a formidable overflow of information, especially when a time dimension is added to the already hard to integrate 3-D spatial, multimodal and multiscale dimensions of modern medical images. This increasingly hampers the early detection and understanding of subtle image changes which can have a vital impact on the patient's health. To change this situation, this proposal introduces a new generation of computational models for the simulation and analysis of dynamic medical images. Thanks to their generative nature, they will allow the construction of databases

of synthetic, realistic medical image sequences simulating various evolving diseases, producing an invaluable new resource for training and benchmarking. Leveraging their principled biophysical and statistical foundations, these new models will bring remarkable added clinical value after they are personalized with innovative methods to fit the medical images of any specific patient. By explicitly revealing the underlying evolving biophysical processes observable in the images, this approach will yield new groundbreaking image processing tools to correctly interpret the patient's condition (computer aided diagnosis), to accurately predict future evolution (computer aided prognosis), and to precisely simulate and monitor an optimal and personalized therapeutic strategy (computer aided therapy). First applications will concern high impact diseases including brain tumors, Alzheimer's disease, heart failure and cardiac arrhythmia and will open new horizons in computational medical imaging.

7.1.1.3. MD PAEDIGREE

Type: COOPERATION

Defi: ICT for Health

Instrument: Integrated Project

Objectif: validating and advancing patient-specific, computer-based predictive models of six paediatric pathologies into clinical acceptance.

Duration: March 2013 - February 2017

Coordinator: Ospedale Pediatrico Bambino Gesù, Rome, Italy.

Partners: Siemens AG (DE), Siemens SCR (USA), Maat France (FR), MOTTEK (NL), EMP (DE), VUmc (NL), Lynkeus (IT). Universities: KU Leuven (BE), Fraunhofer (DE), UMC Utrecht (NL), TU Delft (NL), Sheffield (UK), Athens (GR), Genoa (IT), Transilvania din Brasov (RO); Hospitals: OPBG (Roma, IT), Gaslini (Genoa, IT), GOSH/UCL (London, UK), JHU (Baltimore, USA).

See also: <http://www.md-paedigree.eu/>

Inria contact: Xavier Pennec

Abstract: MD-Paedigree is a clinically-driven and strongly VPH-rooted project, where 7 world-renowned clinical centres of excellence pursue improved interoperability of paediatric biomedical information, data and knowledge by developing together a set of reusable and adaptable multi-scale models for more predictive, individualised, effective and safer paediatric healthcare, being scientifically and technologically supported by one of the leading industrial actors in medical applications in Europe operating in conjunction with highly qualified SMEs and some of the most experienced research partners in the VPH community.

MD-Paedigree validates and brings to maturity patient-specific computer-based predictive models of various paediatric diseases, thus increasing their potential acceptance in the clinical and biomedical research environment by making them readily available not only in the form of sustainable models and simulations, but also as newly-defined workflows for personalised predictive medicine at the point of care. These tools can be accessed and used through an innovative model-driven infostructure powered by an established digital repository solution able to integrate multimodal health data, entirely focused on paediatrics and conceived of as a specific implementation of the VPH-Share project, planned to be fully interoperable with it and cooperating, through it, also with p-Medicine.

MD-Paedigree's goals are to integrate and share highly heterogeneous biomedical information, data and knowledge, using best practices from the biomedical semantic Web; develop holistic search strategies to seamlessly navigate through and manage the integrative model-driven infostructure and digital repository; jointly develop reusable, adaptable and composable multi-scale VPH workflow models, support evidence-based translational medicine at the point of care, and ultimately facilitate collaborations within the VPH community.

7.1.1.4. VP2HF

Type: COOPERATION

Defi: ICT for Health

Instrument: Specific Targeted Research Project

Objectif: New Patient Management for Heart Failure using Modelling

Duration: October 2013 - September 2016

Coordinator: King's College London (UK)

Partner: Philips Research Hamburg (DE), Universitat Pompeu Fabra (SP), Inria, French National Research Institute in Informatics and Mathematics (FR), Université Catholique de Louvain (BE), Caen University Hospital (FR), Philips Research Paris (FR), Simula Research Laboratory (NO), Centron Diagnostics (UK)

Inria contact: Dominique Chapelle

Abstract: Heart failure (HF) is one of the major health issues in Europe, affecting 6 million patients and growing substantially because of the ageing population and improving survival following myocardial infarction. The poor short to medium term prognosis of these patients means that treatments such as cardiac re-synchronisation therapy and mitral valve repair can have substantial impact. However, these therapies are ineffective in up to 50% of the treated patients and involve significant morbidity and substantial cost. The primary aim of VP2HF is to bring together image and data processing tools with statistical and integrated biophysical models mainly developed in previous VPH projects, into a single clinical workflow to improve therapy selection and treatment optimisation in HF. The tools will be tested and validated in 200 patients (including 50 historical datasets) across 3 clinical sites, including a prospective clinical study in 50 patients in the last year of the project. The key innovations in VP2HF that make it likely that the project results will be commercially exploited and have major clinical impact are: 1) all tools to process images and signals, and obtain the statistical and biophysical models will be integrated into one clinical software platform that can be easily and intuitively used by clinicians and tried out in the prospective clinical study; and 2) by utilising a decision tree stratification approach, only the appropriate parts of the tool chain, that will add maximum value to the predictions, will be used in individual patients, so that the more resource intensive parts will be used when they will add real value. We expect that the study results of substantial improved efficacy of decision making over current guidelines, and an integrated package that is used as part of clinical workflow will ensure the industrial project partners, in particular Philips, will develop project outputs into dedicated products that will have significant clinical impact.

7.1.2. Collaborations in European Programs, except FP7

7.1.2.1. Care4Me

Participants: Xavier Pennec [Correspondant], Nicholas Ayache, Hervé Delingette, Kristin Mcleod, Erin Stretton, Maxime Sermesant, Marco Lorenzi.

Program: ITEA2

Project acronym: Care4Me

Project title: Cooperative Advanced REsearch for Medical Efficiency

Duration: September 2009 - September 2013

Coordinator: Philips, NL.

Other partners: Alma (ES), Bull (FR), CEA (FR), CIMNE (ES), Compasiss (ES), CVSS (ES), Duodecim (FI), Erasmus MC (NL), ESI (NL), HSP (ES), Helsinki Hosp. (FI), ISI (GGR), LUMC (NL), MediConsult (FI), MEDIS (NL), Nokia (FI), Philips (NL), Pie Medical Imag. (NL), Pohjola (FI), Prowellness (FI), Robotiker (ES), UMC (NL), VTT (FI)

Abstract: This project aims at increasing quality and productivity in the healthcare care cycle by using more advanced medical imaging and decision support methods while combining them with different knowledge sources, from early diagnosis to treatment and monitoring. The final outcome of this project were clinical prototypes of novel medical image analysis and decision support systems for three specific disease areas (cancer, cardio-vascular and neurodegenerative diseases), that connect to hospital information systems using a new system architecture. In this project, the role of the Asclepios team is to develop an atlas of the ageing brain and the beating heart, and to model tumor growth.

7.2. International Initiatives

7.2.1. Inria Associate Teams

7.2.1.1. CAPNEONATES

Title: Analysis of structural MR and DTI in neonates

Inria principal investigator: Bertrand Thirion [Parietal]

Asclepios investigator: Xavier Pennec

International Partner (Institution - Laboratory - Researcher):

Institution: University of Southern California (United States)

Laboratory: Image Lab at Children Hospital at Los Angeles

Researcher: Natasha Leporé

Duration: 2011 - 2013

See also: <http://www.capneonates.org/>

While survival is possible at increasingly lower gestational ages at birth, premature babies are at higher risk of developing mental disorders or learning disabilities than babies born at term. A precise identification of the developmental differences between premature and control neonates is consequently of utmost importance. Nowadays, the continuously improving quality and availability of MR systems makes it possible to precisely determine, characterize and compare brain structures such as cortical regions, or white matter fiber bundles. The objective of this project is to understand the developmental differences between premature and normal neonates, using structural and diffusion MRI. This work consists in identifying, characterizing and meticulously studying the brain structures that are different between the two groups. To do so, we join forces with the Parietal team at Inria and the University of Southern California. Parietal has a recognized expertise in medical image registration and in statistical analyses of groups of individuals. USC has a broad knowledge in MR image processing. In particular, the Children's Hospital at Los Angeles (CHLA), which is part of USC, is in the process of collecting a unique database of several hundred MR scans of premature and normal neonates. This joint collaboration consequently offers a unique chance of addressing key questions pertaining to neonatal and premature development. It will make it possible to elaborate new tools for analyzing neonate MR images while tremendously increasing our knowledge of neuroanatomy at an early stage in life.

7.2.2. Inria International Partners

7.2.2.1. Declared Inria International Partners

7.2.2.1.1. Stanford, Statistics Department

France Stanford collaborative project grant (2013-2014): *Understanding Lower Back Pain through Geometric Statistical Analysis of computed tomography (CT) Images*. Stanford, Statistics Dept & Nice Univ. Hospital. Principal investigators X. Pennec (Inria) and S. Holmes (Stanford). Collaboration on statistics on group-valued trees and geometric subspace learning [55].

7.2.2.2. Collaboration with international hospitals

7.2.2.2.1. St Thomas' Hospital, King's College London, United Kingdom

Maxime Sermesant is a visiting lecturer in the Division of Imaging Sciences and Biomedical Engineering, St Thomas' Hospital, King's College London lead by Pr Reza Razavi. The XMR facility within this hospital is a unique opportunity to validate and exploit the cardiovascular modelling work.

7.2.2.2.2. Massachusetts General Hospital, Boston

A collaboration with Dr Jan Unklebach, Assistant Professor of Radiation Oncology and Dr Jayashree Kalpathy-Cramer, radiology instructor was initiated in 2013 around the topics of tumor growth modeling, radiotherapy planning and edema characterization from MRI. Matthieu Lê spent 2013 in the department of Radiation Physics at MGH.

7.2.2.2.3. Other International Hospitals

Collaborations with several other European hospitals have been established through the European projects VP2HF, Care4Me and MD PAEDIGREE.

ATHENA Project-Team

8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. ANR

8.1.1.1. ANR ViMAGINE

Participants: Maureen Clerc, Rachid Deriche, Alexandre Gramfort [Parietal project-team, ENST since september 2012], Emmanuel Olivi [Former member of the Athena Project-Team], Théodore Papadopoulo, Anne-Charlotte Philippe.

Duration: July 2008 to July 2013

The partners of this project are ATHENA, the LENA (CHU Pitié-Salpêtrière), and the Parietal project-team at Inria Futurs and Neurospin-Saclay.

This project takes a new challenge on the non invasive exploration of the Human visual system in vivo. Beyond the basic mechanisms of visual perception – which have already been investigated at multiple scales and through a large variety of modalities – we are primarily interested in proposing and exploring innovative solutions to the investigation of dynamic neural activations and interactions at the systems level. Bridging the elements involved in this endeavour requires that we are capable of observing, modelling and predicting the interplay between the anatomical/functional architecture of the brain systems and some identified timing properties of neural processes. The overall framework in which this project will be conducted is a federation of partners who will be bringing complementary expertise to this multidisciplinary research. The collaborators include experts in (1) electromagnetic and magnetic resonance brain imaging methods, (2) computational models of neural systems and (3) the neuroscience of vision. A central asset of our group is the easy access to state-of-the-art imaging platforms (e.g. high-density MEG and EEG arrays; 3T and 7T MR scanners) that will ensure the acquisition of quality experimental data.

8.1.1.2. ANR CO-ADAPT

Participants: Maureen Clerc, Dieter Devlaminck, Sebastian Hitziger, Loïc Mahé, Théodore Papadopoulo, Eoin Thomas, Romain Trachel.

Duration: December 2009 to April 2014

The partners of this projects are the INSERM U821 laboratory of Bron, the "laboratoire de Neurologie de la cognition" UMR6155 CNRS of Marseille, The Inria Lille Sequel project-team and the "Laboratoire d'Analyse Topologie et Probabilités" UMR6632/CNRS of Université de Provence, Marseille.

Brain Computer Interfaces (BCI) provide a direct communication channel from the brain to a computer, bypassing traditional interfaces such as keyboard or mouse, and also providing a feedback to the user, through a sensory modality (visual, auditory or haptic). A target application of BCI is to restore mobility or autonomy to severely disabled patients, but more generally BCI opens up many new opportunities for better understanding the brain at work, for enhancing Human Computer Interaction, and for developing new therapies for mental illnesses.

In BCI, new modes of perception and interaction come into play, and a new user must learn to operate a BCI, as an infant learns to explore his/her sensorimotor system. Central to BCI operation are the notions of feedback and of reward, which we believe should hold a more central position in BCI research.

The goal of this project is to study the co-adaptation between a user and a BCI system in the course of training and operation. The quality of the interface will be judged according to several criteria (reliability, learning curve, error correction, bit rate). BCI will be considered under a joint perspective: the user's and the system's. From the user's brain activity, features must be extracted, and translated into commands to drive the BCI system. Feature extraction from data, and classification issues, are very active research topics in BCI. However, additional markers may also be extracted to modulate the system's behavior. It is for instance possible to monitor the brain's reaction to the BCI outcome, compared to the user's expectations. This type of information we refer to as meta-data because it is not directly related to the command, and it may be qualitative rather than quantitative. To our knowledge, there is so far no BCI system that integrates such meta-data from the user's brain. From the point of view of the system, it is important to devise adaptive learning strategies, because the brain activity is not stable in time. How to adapt the features in the course of BCI operation is a difficult and important topic of research. A Machine Learning method known as Reinforcement Learning (RL) may prove very relevant to address the above questions. Indeed, it is an adaptive learning method that explicitly incorporates a reward signal, which may be qualitative (hence allowing meta-data integration). The aim of CO-ADAPT is to propose new directions for BCI design, by modeling explicitly the co-adaptation taking place between the user and the system (web site <http://coadapt.inria.fr>).

8.1.1.3. ANR NucleiPark

Participants: Rachid Deriche, Aurobrata Ghosh, Anne-Charlotte Philippe, Antoine Wolfemann.

Duration: *September 2009 to December 2013*

This project is about High field MR imaging (7T and 3T) of the brainstem, the deep nuclei and their connections in the parkinsonian syndromes with applications to prognosis, pathophysiology and improvement of therapeutic strategies. It involves three partners: The NeuroSpin team including C. Poupon and D. Le Bihan, the Inria with our project as well as the VISAGES project-team and the UPMC (University Pierre and Marie Curie, Paris) including INSERM U678 (H. Benali) and the CENIR (S. Lehericy).

The goal of the project is to find new neuroimaging markers of deep brain nuclei in neurodegenerative diseases that can be used for the diagnosis of Parkinsonian syndromes at the early stage. In addition, the goal is the characterization of lesions of deep brain structures and the detection of biomarkers of neuronal lesions in PD that can be related to clinical signs, such as gait disorders. Biomarkers of Parkinsonian syndromes could be used to create a diagnostic tool of the pathology and to correlate the identified markers with clinical signs. We will perform tractography of small fibre bundles using our HARDI techniques and Diffusion markers (anisotropy, apparent diffusion coefficient, fibre density, curvature, average diameter) will be collected along the reconstructed bundles.

Complementary parts of these objectives directly related to the acquisitions protocols have been accepted within the framework of another proposal submitted by the same partners and accepted for grant for two years (2009 & 2010) by the *France-Parkinson Association*

8.1.1.4. ANR Mosifah

Participants: Rachid Deriche, Maureen Clerc, Théodore Papadopoulo, Gonzalo Sanguinetti.

Duration: *October 2013 to September 2017*

This ANR Numerical Models 2013 project is about multimodal and multiscale modelling and simulation of the fiber architecture of the human heart. It started on October 2013 and involves three partners : Creatis Team, INSA, Lyon (I. Magnin, Y. Zhu); TIMC-IMAG, CNRS, Grenoble (Y. Uson) and the ATHENA project team.

It consists in modelling and simulating the ex vivo and in vivo 3D fiber architectures at various scales using multiphysical data from different imaging modalities working at different spatial resolutions. To this end, the myocardium of the human heart will be imaged using respectively Polarized Light Imaging (PLI) and dMRI.

Appropriate diffusion models will be explored including second and fourth order DTI models as well as HARDI models such as the single shell Q-Ball Imaging (QBI). These various types of images will be processed within the right Riemannian mathematical framework to provide tensor as well as Ensemble Average Propagator (EAP) and Orientation Distribution Function (ODF) fields. Virtual cardiac fiber structure (VCFS) will then be modelled using myocardial fiber information derived from each of these imaging modalities. Finally, diffusion behavior of water molecules in these VCFSs will be simulated by means of quantum spin theory, which allows computing ex vivo and in vivo virtual diffusion magnetic resonance (MR) images at various scales ranging from a few microns to a few millimeters. From the obtained virtual diffusion MR images, multiscale and probabilistic atlas describing the 3D fiber architecture of the heart ex vivo and in vivo will be constructed. Meanwhile, the simulation involving a large number of water molecules, grid computing will be used to cope with huge computation resource requirement.

We expect to construct a complete database containing a very wide range of simulated (noise and artifact-free) diffusion images that can be used as benchmarks or ground-truth for evaluating or validating diffusion image processing algorithms and create new virtual fiber models allowing mimicking and better understanding the heart muscle structures. Ultimately, the proposed research can open a completely novel way to approach the whole field of heart diseases including the fundamental understanding of heart physiology and pathology, and new diagnosis, monitoring and treatment of patients.

8.1.1.5. ANR MULTIMODEL

Participants: Théodore Papadopoulo, Maureen Clerc, Sebastian Hitziger, Emmanuel Olivi.

Duration: *December 2010 to May 2014*

The MULTIMODEL project stems from a conjoint INSERM-Inria scientific initiative launched in December 2008 and ended in 2010. It involves 5 partners (Inserm U751 in Marseille, U678 in Paris, U836 in Grenoble, U642 in Rennes and Inria ATHENA project-team).

The general objectives of the MULTIMODEL project are :

- To develop computational models at the level of neuronal systems that will help interpreting neuroimaging data in terms of excitation-, inhibition- and synchronization-related processes.
- To acquire multimodal datasets, obtained in rats and humans under physiological and epileptogenic conditions, which will be used to develop the biophysical models and to test their face validity and predictability.

Specifically, the following questions are dealt with:

- How can models be integrated in order to link data from different modalities (electro/magneto-encephalography, optical imaging, functional MRI)?
- What is the influence of hidden parameters on the observed signals (e.g. ratio of excitation/inhibition and synchronization degree across regions)?
- To what extent can biophysical modelling bring valuable insights on physiological and pathological brain activity ?

We operate at the level of population of cells, i.e. at a scale compatible with the resolution of neuroimaging tools (at the level of the mm). A novel model structure is being investigated, which includes astrocytes at this “mesoscopic” level and operates in networks of connected regions. Moreover, models in physiological and pathological conditions will be compared, which is a step towards a better understanding of mechanisms underlying epileptic condition.

8.1.1.6. ANR VIBRATIONS

Participants: Théodore Papadopoulo, Maureen Clerc, Rachid Deriche.

Duration: *Early 2014 to early 2018*

This Translational ANR project has just been accepted.

Computational modeling, under the form of a “virtual brain” is a powerful tool to investigate the impact of different configurations of the sources on the measures, in a well-controlled environment.

The VIBRATIONS project proposes to simulate in a biologically realistic way MEG and EEG fields produced by different configurations of brain sources, which will differ in terms of spatial and dynamic characteristics. The research hypothesis is that computational and biophysical models can bring crucial information to clinically interpret the signals measured by MEG and EEG. In particular, they can help to efficiently address some complementary questions faced by epileptologists when analyzing electrophysiological data.

The project follows a three-fold strategy:

- construct virtual brain models with both dynamic aspects (reproducing both hyperexcitability and hypersynchronisation alterations observed in the epileptic brain) and a realistic geometry based on actual tractography measures performed in patients
- explore the parameter space through large-scale simulations of source configurations, using parallel computing implemented on a computer cluster.
- confront the results of these simulations to simultaneous recordings of EEG, MEG and intracerebral EEG (stereotactic EEG, SEEG). The models will be tuned on SEEG signals, and tested versus the surface signals in order to validate the ability of the models to represent real MEG and EEG signals.

The project constitutes a translational effort from theoretical neuroscience and mathematics towards clinical investigation. A first output of the project will be a database of simulations, which will permit in a given situation to assess the number of configurations that could have given rise to the observed signals in EEG, MEG and SEEG. A second – and major - output of the project will be to give the clinician access to a software platform which will allow for testing possible configurations of hyperexcitable regions in a user-friendly way. Moreover, representative examples will be made available to the community through a website, which will permit its use in future studies aimed at confronting the results of different signal processing methods on the same ‘ground truth’ data.

8.1.2. ADT

8.1.2.1. ADT MedInria-NT

Participants: Jaime Garcia Guevara, Loïc Cadour, Théodore Papadopoulo, Maureen Clerc, Rachid Deriche.

Duration: *December 2010 to December 2012, prolonged to December 2014*

The goal of this technical project, funded by Inria for 2 years, is to introduce some tools developed at ATHENA into the medInria platform. There are basically two such facilities:

- Integrate the tools developed for the statistical characterization of brain white matter fiber bundles.
- Develop an interface for M/EEG data within MedInria. This will focus on two main goals:
 - Create a facility to read and visualize M/EEG signals.
 - Integrate M/EEG forward problem tools.

8.1.2.2. ADT OpenViBe-NT

Participants: Théodore Papadopoulo, Maureen Clerc, Loïc Mahé.

Duration: *October 2012 to December 2014*

OpenViBE is an opensource software which development started in 2005 with the goal of offering an open research tool for BCI and for supporting disabled people. Since its release in 2009, this software has received a lot of success (+10.000 downloads). But since 2005, new use have appeared as well as some limitations. The current software thus lacks of some features that limit its use, deployment and perennity. The goal of this ADT is to solve these problems, to improve and to extend OpenViBe One main goal is to improve the usability and the attractivity of the software and to retain a large community of users so as to ensure its sustainability. This ADT will allow to support the research made in four Inria teams (ATHENA, HYBRID, NEUROSYS and POTIOC) on hot topics such as adaptive or hybrid BCIs.

8.2. International Initiatives

8.2.1. Inria Associate Teams

8.2.1.1. BRAINCONNECTIVITIES

Title: Fusing anatomical and functional connectivity information using diffusion MRI, MEG and EEG.

Inria principal investigator: Théodore PAPADOPOULO

International Partners (Institution - Laboratory - Researcher):

University of Québec, School of Higher Technology (Canada) - PhysNum Group, Centre de recherches mathématiques, Montréal - Théodore PAPADOPOULO

University of Sherbrooke (Canada) - Département d'Informatique - Théodore PAPADOPOULO

Duration: 2012 - 2014

See also: <http://brainconnectivities.inria.fr/wordpress/>

Currently brain connectivity is studied through two different lenses: 1) Anatomical connectivity aims at recovering the “wires” that connect the various brain cortical “units”, 2) Functional connectivity studies when and how cortical regions are connected. Providing tools to fuse these two complementary views is the central goal of this project. Our effort will focus on three imaging modalities: diffusion MRI (dMRI), Electroencephalography (EEG) and Magnetoencephalography (MEG). dMRI (jointly with traditional MRI) provides a detailed anatomical view of the brain. It allows the recovery of the fiber structure of the white matter: these are the electrical connexions between distant cortical areas. But dMRI does not provide any clue on: 1) on the actual use of connexions during brain activity, 2) on the way information propagates along time for a given task. On the opposite, EEG and MEG (jointly named MEEG) provide (after source reconstruction) time courses of the activity of the cortical areas. It is possible to recover some connectivity information from these time courses, but these are purely signal based and do not take account of the anatomy so there are multiple solutions that are sometimes difficult to discriminate. Furthermore source reconstructions are regularized with purely mathematical a priori taking only partially account of the actual brain structures. The main goals of this project are to provide tools: 1) To acquire diffusion data more efficiently, 2) To use the information of dMRI to define better models and regularization schemes for spatio-temporal MEEG source reconstruction, 3) To use MEEG data to better understand the task-dependent spatio-temporal structure of connectivity patterns.

8.2.2. Inria International Partners

8.2.2.1. Informal International Partners

- CMRR, University of Minnesota, USA (Christophe Lenglet)
- Department of CISE, the University of Florida, Gainesville, USA (Baba C. Vemuri)
- Centre for Medical Image Computing (CMIC), Dept. Computer Science, UCL, UK (D. Alexander)
- SBIA, University of Pennsylvania Medical School, USA (R. Verma).
- University Houari Boumedienne (USTHB, Algiers) (L. Boumghar) and University of Boumerdes, (D. Cherifi), Algeria.
- BESA company of EEG/MEG source localisation.

8.3. International Research Visitors

8.3.1. Visits of International Scientists

- Maxime Descoteaux (USherbrooke) visited ATHENA (September 10-15 2013) and (December 13-20, 2013).

- Gabriel Girard (USherbrooke) has joined ATHENA for one year for a joint PhD (Samuel de Champlain grant) from October 10th, 2013 to September 30th, 2014. He is co-supervised by M. Descoteaux and R. Deriche.
- Jean-Marc Lina (CRM) visited ATHENA from December 17th to December 21th.

8.3.1.1. Internships

- Susana Merino-Caviedes (Valladolid University) visited ATHENA from Sep 2013 until Nov 2013.
- Mouloud Kachouane (USTHB, Algiers) visited ATHENA from October 20 until December 20, 2013).
- Thinhinane Megherbi (USTHB, Algiers) and Mouloud Kachouane (USTHB, Algiers) visited ATHENA (June 2013).

BAMBOO Project-Team

7. Partnerships and Cooperations

7.1. Regional Initiatives

- Title: Inférence de graphes de régulations génétiques à partir de données d'expression
- Coordinator: H. Charles
- BAMBOO participant(s): H. Charles, L. Brinza, M.-F. Sagot
- Type: Pré-Projet de Recherche de l'IXXI (2012-2013)
- Web page: Not available

7.2. National Initiatives

7.2.1. ABS4NGS

- Title: Solutions Algorithmiques, Bioinformatiques et Logicielles pour le Séquençage Haut Débit
- Coordinator: E. Barillot
- BAMBOO participant(s): V. Lacroix
- Type: ANR (2012-2015)
- Web page: Not available

7.2.2. Colib'read

- Title: Methods for efficient detection and visualization of biological information from non assembled NGS data
- Coordinator: P. Peterlomgo
- BAMBOO participant(s): V. Lacroix, A. Julien-Lafférière, C. Marchet, G. Sacomoto, M.-F. Sagot, B. Sinimeri
- Type: ANR (2013-2016)
- Web page: <http://colibread.inria.fr/>

7.2.3. Exomic

- Title: Functional annotation of the transcriptome at the exon level
- Coordinator: D. Auboeuf (Inserm, Lyon)
- BAMBOO participant(s): V. Lacroix, M.-F. Sagot
- Type: INSERM Systems Biology Call (2012-2015)
- Web page: Not available

7.2.4. ImmunSymbArt

- Title: Immunity and Symbiosis in Arthropods
- Coordinator: D. Bouchon
- BAMBOO participant(s): F. Vavre
- Type: ANR Blanc (2010-2014)
- Web page: Not available

7.2.5. Metagenomics of *Bemisia tabaci*

- Title: Metagenomics of *Bemisia tabaci* symbiotic communities

- Coordinator: L. Mouton (LBBE, UCBL)
- BAMBOO participant(s): F. Vavre, M.-F. Sagot
- Type: Genoscope Project
- Web page: Not available

7.2.6. *SpeciAphid*

- Title: Evolutionary genetics and mechanisms of plant adaptation in aphids
- Coordinator: Jean-Christophe Simon (IGEPP, INRA, Rennes)
- BAMBOO participant(s): H. Charles, Y. Rahbé
- Type: ANR (2012-2014)
- Web page: Not available

7.3. European Initiatives

7.3.1. FP7 Projects

7.3.1.1. *BacHBerry*

- Title: BACterial Hosts for production of Bioactive phenolics from bERRY fruits
- Coordinator: Jochen Förster (Novo Nordisk Foundation Center for Biosustainability (CFB), Copenhagen, Denmark)
- BAMBOO participant(s): V. Lacroix, Alice J. Lafferièrre, M.-F. Sagot, A. Viari, M. Wannagat
- Type: KBBE (2013-2016)
- Web page: Not yet available.

7.3.1.2. *DroParCon*

- Title: Drosophila parasitoid consortium
- Coordinator: Jochen Förster (Novo Nordisk Foundation Center for Biosustainability (CFB), Copenhagen, Denmark)
- BAMBOO participant(s): F. Vavre
- Type: PHC (2012-2014)
- Web page: <http://www.droparcon.org>.

7.3.1.3. *Microme*

- Title: The Microme Project: A Knowledge-Based Bioinformatics Framework for Microbial Pathway Genomics
- Coordinator: P. Kersey (EBI)
- European partners: Amabiotics (France), CEA (France), CERTH (Greece), CSIC (Spain), CNIO (Spain), DSMZ (Germany), EBI (UK), HZI (Germany), Isthmus (France), Molecular Nertwork (Germany), SIB (Switzerland), Tel Aviv Univ. (Israel), Université Libre de Bruxelles (Belgium), WTSI (UK), Wageningen Univ. (The Netherlands)
- BAMBOO participant(s): Anne Morgat
- Type: Collaborative Project. Grant Agreement Number 222886-2
- Web page: <http://www.microme.eu>

7.3.1.4. *SISYPHE*

- Title: Species Identity and SYmbiosis Formally and Experimentally explored
- Coordinator: M.-F. Sagot
- BAMBOO participant(s): Whole BAMBOO team

- Type: ERC Advanced Grant (2010-2015)
- Web page: <http://pbil.univ-lyon1.fr/members/sagot/htdocs/team/projects/sisyphes/sisyphes.html>

7.3.1.5. SWIPE

- Title: Predicting whitefly population outbreaks in changing environments
- Coordinator: E. Zchori-Fein
- BAMBOO participant(s): F. Vavre
- Type: European ERA-NET program ARIMNET (2012-2015)
- Web page: http://www.arimnet.net/index.php?p=fp_swipe

7.3.1.6. Symbiox

- Title: Role of the oxidative environment in the stability of symbiotic associations
- Coordinator: F. Vavre
- BAMBOO participant(s): F. Vavre
- Type: Marie Curie IOF for Natacha Kremer (2011-2014)
- Web page: <http://www.2020-horizon.com/SYMBIOX-Role-of-the-oxidative-environment-in-the-stability-of-symbiotic-associations%28SYMBIOX%29-s4673.html>

7.4. International Initiatives

7.4.1. Inria International Partners

Bamboo has an Inria International Partnership, called AMICI (see <http://team.inria.fr/bamboo/amici/>), with three partners in Italy (Universities of Rome “La Sapienza”, Florence, and Pisa) and one in the Netherlands (Free University of Amsterdam / CWI). There are two unifying interests to all the projects of AMICI: algorithmics, and biology. At the present time, mostly because the current work of BAMBOO is centered on the ERC project SISYPHE (“Species Identity and SYmbiosis Formally and Experimentally explored”), the biology is very oriented to the general study, at the molecular level, of the symbiotic relation (genomics and other associated “omics”, evolution, biochemical and interaction networks). This should evolve in future to extend the symbiotic study to either the ecological or a more health-oriented level, or to address new biology-related problems using mathematical modelling and techniques, and algorithmics.

7.4.2. Inria International Labs

BAMBOO participates in a project within the Inria-Chile CIRIC (Communication and Information Research and Innovation Center) titled “Omics Integrative Sciences”. The main objectives of the project are the development and implementation of mathematical and computational methods and the associated computational platforms for the exploration and integration of large sets of heterogeneous omics data and their application to the production of biomarkers and bioidentification systems for important Chilean productive sectors. The project started in 2011 and is coordinated in Chile by Alejandro Maass, Mathomics, University of Chile, Santiago.

7.4.3. Participation In other International Programs

BAMBOO is member of a CNRS-UCBL-Inria Laboratoire International Associé (LIA) with the Laboratório Nacional de Computação Científica (LNCC), Petrópolis, Brazil. The LIA has for acronym LIRIO (“Laboratoire International de Recherche en bioinformatique”) and is coordinated by Ana Tereza Vasconcelos from the LNCC and Marie-France Sagot from BAMBOO. The LIA was created in January 2012 for 4 years, renewable once. A preliminary web page for the LIA LIRIO is available at this address: <http://team.inria.fr/bamboo/en/cnrs-lia-laboratoire-international-associe-lirio/>.

BAMBOO has two other projects with Brazil. One is the Inria-Faperj project RAMPA ("Bioinformatics for the Reconstruction and Analysis of the Metabolism of Parasites") whose coordinators are M.-F. Sagot (France) and A. T. Vasconcelos (LNCC, Brazil). This project will finish at the end of 2013. Its main objective was to computationally and experimentally study the dialog between the trypanosomatids *Angomonas deanei* and *Strigomonas culicis* and their respective endosymbiont mainly at the metabolic level. The second project is the CAPES-COFECUB project titled: "Multidisciplinary Approach to the Study of the Biodiversity, Interactions and Metabolism of the Microbial Ecosystem of Swines". The coordinators are M.-F. Sagot (France) and A. T. Vasconcelos (LNCC, Brazil) with also the participation of Arnaldo Zaha (Federal University of Rio Grande do Sul). The project started in 2013 for 2 years, renewable once. The main objective of this project is to experimentally and mathematically explore the biodiversity of the bacterial organisms living in the respiratory tract of swines, many of which are pathogenic.

7.5. International Research Visitors

7.5.1. Visits of International Scientists

During 2013, the team had 4 international scientists visiting our group for at least one week. These included:

- Carlos Norberto Fischer, São Paulo State University, Rio Claro, Brazil, visit 3 months;
- Maria Cristina Motta, Federal University of Rio de Janeiro, Rio de Janeiro, Brazil, visit 15 days;
- Susana Vinga, INESC-ID, IST Lisbon, Portugal, visit of 1 week;
- Arnaldo Zaha, Federal University of Rio Grande do Sul, Porto Alegre, Brazil, visit 15 days.

The above does not count the frequent visits of our external collaborators, members of the Inria International Partnership AMICI or of the LIA LIRIO.

7.5.2. Visits to International Teams

The visits to international teams were done mostly in the context of the Inria International Partnership AMICI, the LIA LIRIO, or the CIRIC project with Chile. Besides those, there were also visits of at least one week to Susana Vinga, INESC-ID, IST Lisbon, Portugal.

BANG Project-Team

7. Partnerships and Cooperations

7.1. Regional Initiatives

7.1.1. CIRB-Collège de France

Jonathan Touboul is leading the team “Mathematical Neuroscience Laboratory” in the Centre for Interdisciplinary Research in Biology of the Collège de France. Several collaborations have been initiated, two postdocs have been recruited (Jérôme Ribot and Alberto Romagnoni), student scholarships have been provided and 3 PhD students have started their research in the laboratory (C. Quiñinao and L. C. García del Molino in 2012, Tanguy Cabana in 2013).

7.1.2. DIGITEO and Cancéropôle IdF

The DIGITEO IdF LSC *ALMA* and *ALMA2* programs, coordinated by C. Bonnet (DISCO team, Inria Saclay IdF) studies a model of leukaemia based on previous works by M. Adimy and F. Crauste (Lyon), with theoretical model design adjustments and analysis in J. L. Avila Alonso’s Ph D thesis (supervised by C. Bonnet, S. Niculescu and J. Clairambault) and experimental parameter identification initiated by F. Merhi, Bang postdoc (Dec. 2010-Nov. 2011), then continued by A. Ballesta (Sep. 2011-Feb. 2013), Bang postdoc detached at INSERM, working at St. Antoine Hospital (Paris), under the supervision of J. Clairambault and C. Bonnet to link experimental and theoretical aspects and of J.-P. Marie and R.P. Tang (INSERM-UPMC) to supervise biological experiments on leukaemic cells. *ALMA* has been granted for 3 years, beginning in December 2010.

A. Ballesta’s postdoc at St. Antoine Hospital, granted by Cancéropôle IdF *ALMA2* has led to increased collaboration of the same with the Commands Inria team (F. Bonnans, X. Dupuis, Saclay) with the aim to design optimisation procedures for anti-leukaemic therapies by cytosine arabinoside and by an anti-Flt3 targeted agent (see above “Optimisation of cancer chemotherapy”).

7.2. National Initiatives

7.2.1. ANR and other national projects

7.2.1.1. ANR program Bimod

This ANR program, coordinated by V. Volpert (Lyon), involves 3 partners: CNRS (Institut Camille Jordan) in Lyon (V. Volpert), University Bordeaux II (P. Magal) and Inria (Bang project-team and DISCO team, Saclay IdF). It associates PDE models, both spatial and physiologically structured, with individual-based models in *hybrid models* to represent cancer growth (leukaemia and colorectal cancer) and therapy. It has been granted for 4 years, beginning in December 2010.

7.2.1.2. ANR Sine2Arti

Participation in the ANR project Sine2Arti. The project considers tissue homeostasis and cell reprogramming. The project is coordinated by Gregory Batt (coordinator, Contraintes research team, Inria), PIs are Oded Maler (Univ. of Grenoble) and Dirk Drasdo, an external collaborator is Ron Weiss (MIT)

7.2.1.3. GDR DarEvCan

The GDR DarEvCan, for Darwinian Evolution and Cancer, is a interdisciplinary consortium which associates 10 teams in France around the theme of evolution and cancer, in particular evolution of cancer cell populations towards drug resistance [18]. It has held its first national meeting in December 2011 in Paris, another one in April 2012 in Montpellier, and has organised an international conference in Roscoff in November 2013 http://www.cnrs.fr/insb/cjm/archives/2013/Hochberg_e.html, to which J. Clairambault presented an invited talk on behalf of the Bang team. The Bang team takes an active part in its development, which relies mainly on applying methods from evolutionary theory to cancer biology [22] (<http://www.darevcan.univ-montp2.fr/>).

7.2.1.4. PEPS PTI ‘Ondes de concentration en bactéries’

People of the BANG team are involved in this project funded by the CNRS. This is a collaboration with biophysicists of the Institut Curie dedicated to the description of the collective motion of bacteria by chemotaxis.

7.2.1.5. PEPS PTI ‘Neuro-Info’ (Jonathan Touboul)

Jonathan Touboul obtained a support of the CNRS for a collaboration with Princeton University on the information in biological systems, including neuronal networks and quorum sensing.

7.2.1.6. PEPS PTI ‘NeuroGauge’ (Jonathan Touboul and Alberto Romagnoni)

Alberto Romagnoni (Postdoc in the Mathematical Neuroscience Team) and Jonathan Touboul obtained a support from the CNRS program PEPS PTI in order to use tools from the non-abelian gauge theory for the modeling of the visual cortex. This is a collaboration with theoretical physicists from U. Autonoma of Madrid (Carlos Pena).

7.2.1.7. ITMO-Cancer grant PhysCancer

Participation in the ITMO-Cancer (Aviesan) project Physics of Cancer. The project studies the impact of a constraining extracellular material on the growth and division of cells and cellular aggregates. The project is coordinated by Pierre Nassoy (Institut Curie), collaborators are Dirk Drasdo and Christophe Lamaze (INSERM).

7.2.1.8. INVADE

Participation in the project INVADE (INSERM). The project studies invasion patterns of breast cancer cells. The project is coordinated by Emmanuel Barillot (Inst. Curie), collaborators include Dirk Drasdo and other groups from Institut Curie.

7.3. European Initiatives

7.3.1. FP7 Projects

7.3.1.1. ERASysbio+ C5Sys European network.

This European program (<http://www.erasysbio.net/index.php?index=272>) has begun in April 2010 to end up in June 2013, with the title “Circadian and cell cycle clock systems in cancer”. Coordinated by F. Lévi (Villejuif) and D. Rand (Warwick), it studied both from a theoretical and from an experimental viewpoint the relationships between molecular circadian clocks and the cell division cycle, in cancer and in healthy tissues. A postdoctoral fellow (F. Billy) has been hired at Inria-Bang until November 2012 on this funding, giving rise to various publications in 2013 [7], [8], [9], [27].

7.3.1.2. NOTOX

Type: COOPERATION

Instrument: Integrated Project

Objective: NC

Duration: January 2011 - December 2015

Coordinator: Elmar Heinzle, Universität des Saarlandes, Saarbrücken

Partner: Centre National de la Recherche Scientifique, Strasbourg

Partner: Stichting Het Nederlands Kanker Instituut - Antoni Van Leeuwenhoek Ziekenhuis, Amsterdam

Partner: Karolinska Institutet, Stockholm

Partner: Insilico Biotechnology AG, Stuttgart

Partner: Institut National de Recherche en Informatique et en Automatique, Rocquencourt

Partner: Deutsches Forschungszentrum für Künstliche Intelligenz GmbH, Saarbrücken

Partner: Forschungsgesellschaft für Arbeitsphysiologie und Arbeitsschutz e.V, Dortmund

Partner: Biopredic International, F35760 St. Grégoire

Partner: Weizmann Institute of Science, Rehovot, Israel

Partner: Cambridge Cell Networks Ltd, Cambridge, UK

Partner: European Research and Project Office GmbH, Saarbrücken

Inria contact: Dirk Drasdo

Abstract: NOTOX will develop and establish a spectrum of systems biological tools including experimental and computational methods for (i) organotypic human cell cultures suitable for long term toxicity testing and (ii) the identification and analysis of pathways of toxicological relevance. NOTOX will initially use available human HepaRG and primary liver cells as well as mouse small intestine cultures in 3D systems to generate own experimental data to develop and validate predictive mathematical and bioinformatic models characterizing long term toxicity responses. Cellular activities will be monitored continuously by comprehensive analysis of released metabolites, peptides and proteins and by estimation of metabolic fluxes using ^{13}C labelling techniques (fluxomics). At selected time points a part of the cells will be removed for in-depth structural (3D-optical and electron microscopy tomography), transcriptomic, epigenomic, metabolomic, proteomic and fluxomic characterisations. When applicable, cells derived from human stem cells (hESC or iPS) and available human organ simulating systems or even a multi-organ platform developed in SCREEN-TOX and HEMIBIO will be investigated using developed methods. Together with curated literature and genomic data these toxicological data will be organised in a toxicological database (cooperation with DETECTIVE, COSMOS and TOXBANK). Physiological data including metabolism of test compounds will be incorporated into large-scale computer models that are based on material balancing and kinetics. Various omics, data and 3D structural information from organotypic cultures will be integrated using correlative bioinformatic tools. These data also serve as a basis for large scale mathematical models. The overall objectives are to identify cellular and molecular signatures allowing prediction of long term toxicity, to design experimental systems for the identification of predictive endpoints and to integrate these into causal computer models.

Webpage: <http://notox-sb.eu/fp7-cosmetics-europe/>

7.3.1.3. ERC Starting Grant SKIPPER^{AD}

Type: IDEAS

Instrument: ERC Starting Grant

Duration: December 2012 - November 2017

Coordinator: Marie Doumic

Partner: INRA Jouy-en-Josas, France

Inria contact: Marie Doumic

Abstract: Amyloid diseases are of increasing concern in our aging society. These diseases all involve the aggregation of misfolded proteins, called amyloid, which are specific for each disease (PrP for Prion, Abeta for Alzheimer's). When misfolded these proteins propagate the abnormal configuration and aggregate to others, forming very long polymers also called fibrils. Elucidating the intrinsic mechanisms of these chain reactions is a major challenge of molecular biology: do polymers break or coalesce? Do specific sizes polymerize faster? What is the size of the so-called nucleus, i.e., the minimum stable size for polymers? On which part of the reactions should a treatment focus to arrest the disease? Up to now, only very partial and partially justified answers have been provided. This is mainly due to the extremely high complexity of the considered processes, which may possibly involve an infinite number of species and reactions (and thus, an infinite system of equations).

The great challenge of this project is to design new mathematical methods in order to model fibril reactions, analyse experimental data, help the biologists to discover the key mechanisms of polymerization in these diseases, predict the effects of new therapies. Our approach is based on

a new mathematical model which consists in the nonlinear coupling of a size-structured Partial Differential Equation (PDE) of fragmentation-coalescence type, with a small number of Ordinary Differential Equations. On the one hand, we shall solve new and broad mathematical issues, in the fields of PDE analysis, numerical analysis and statistics. These problems are mathematically challenging and have a wide field of applications. On the other hand we want to test their efficacy on real data, thanks to an already well-established collaboration with a team of biophysicists. With such a continuing comparison with experiments, we aim at constantly aligning our mathematical problems to biological concerns.

7.4. International Initiatives

7.4.1. ECOS-CONICYT

B. Perthame and K. Vilches take part in the Franco-Chilean project 'Functional analysis, asymptotics and dynamics of fronts' headed by J. Dolbeault (University Paris-Dauphine) funded by ECOS-CONICYT.

7.4.2. EuroMed 3+3

M3CD, *Mathematical Models and Methods in Cell Dynamics*, a transmediterranean EuroMed3+3 program, has begun in January 2012 for 4 years, under the coordination of J. Clairambault. It associates 2 Inria teams: Bang and Dracula (Mostafa Adimy, Lyon) with the IAC-CNR in Rome (Roberto Natalini), the LMDP team in Marrakech (Hassan Hbid) and the MoMinBi team at Institut Pasteur, Tunis (Slimane BenMiled, Amira Kebir) to work on the general theme "Mathematical Models and Methods in Cell Dynamics". It has fostered in 2013 visits of students to Paris and Lyon, for Y. Bourfia, PhD student at Marrakech and UPMC, who works under the supervision of H. Hbid, M. Adimy and J. Clairambault and for Rym Jaroudi, M2 student at the University of Tunis, who works under the supervision of Slimane BenMiled and Amira Kebir.

A 2-day M3CD workshop, organised by Hassan Hbid, following a first one organised in November 2012 in Tunis, will take place in January 2014 (27-28) in Marrakech. Newcomers, researchers from the Northern side, who will be present in this workshop, will join the network in 2014: Marcello Delitala (Polito, Turin) and Oscar Angulo (University of Valladolid).

7.4.3. Xuguang Qi-Hubert Curien program

C. Emako-Kazianou and N. Vauchelet take part in a Xuguang Qi-Hubert Curien program funded by Campus-France in collaboration with Shanghai Jiao Tong university. This program no 30043VM entitled "PDE models for cell self-organization" is headed by N. Vauchelet and allows visits for both parts of the project. The chinese researchers involved in this program are Min Tang and Jie Lao.

7.4.4. Inria International Partners

1. German Research Ministry (BMBF) funded project on the systems biology of lung cancer.

The major aim is to better understand the early metastasis formation and invasion of lung cancer, including therapeutical options. Data on all levels ranging from intracellular up to organ level will be used to establish successively an integrated multiscale model of cellular and migration decisions in lung cancer. A particular focus will be on dissecting how cellular organisation and communication in spheroid cultures and co-cultures of lung cancer cell lines with selected endothelial cells affects information processing and the proliferation and migration decisions downstream. To reveal the inhomogeneous spatio-temporal organisation in these tumour growth models, specific probes for medical imaging, quantify extracellular cytokine concentrations will be used, and the effects of pharmacological inhibitors be monitored. By data and model integration, parameters should be identified that critically determine early spread and facilitate to predict possibilities for improved therapeutic options.

The project coordinator is Ursula Klingmueller, German Cancer Research Centre (DKFZ), Heidelberg (<http://www.lungsys.de/>)

2. **German Research Ministry (BMBF) funded project on the systems biology of liver (Virtual Liver Network).** The aim of the VLN project is to set up multiscale models of liver. The Virtual Liver will be a dynamic model that represents, rather than fully replicates, human liver physiology morphology and function, integrating quantitative data from all levels of organisation. Our part ranges from the intracellular up to the level of groups of liver lobules. A liver lobule is the basic repetitive functional unit of liver. Applications are explained in the text. The networks has 69 Principle Investigators organised in about 10 work packages, each of which have a number of sub-projects (<http://www.virtual-liver.de/about/>).

7.5. International Research Visitors

7.5.1. Visits of International Scientists

- H.T. Banks (North Carolina State University), 2 weeks at UPMC (SKIPPER^{AD} project)
- Bard Ermentrout (University of Pittsburgh), 1 week at the Mathematical Neuroscience Team
- Miguel Escobedo (University of Bilbao, BECAM), 2 weeks at UPMC (SKIPPER^{AD} project)
- Thibaud Tallefumier (University of Princeton), 2 weeks at the Mathematical Neuroscience Team
- Jonathan Rubin (University of Pittsburgh), 3 days at the Mathematical Neuroscience Team
- Justyna Signerska (Polish Academy of Mathematics), 10 days at the Mathematical Neuroscience Team
- Suzanne Sindi (University of California MERCED), 1 week at UPMC (SKIPPER^{AD} project)
- Wei-Feng Xue (University of Canterbury), 2 days at UPMC (SKIPPER^{AD} project)
- Min Tang (Shanghai Jiaotong Univ.) , 1 month at BANG (Xu GuangQi Hubert Curien program no30043V M PDE models for cell self-organization, N. Vauchelet)

7.5.1.1. Internships

- Rym Jaroudi (University of Tunis) on the subject “Applying evolutionary game theory and adaptive dynamics to modelling cancer treatments”, supervised by S. Ben Miled, A. Kebir (Tunis) and J. Clairambault: October

7.5.2. Visits to International Teams

- 10 days at the University of Pittsburgh (J. Touboul)
- 1 week at the North Carolina State University (M. Doumic and C. Kruse)
- 3 weeks at the Biophysics Lab in Princeton (J. Touboul)
- 2 days at the Courant Institute (New-York) (J. Touboul)
- 3 days at BECAM Center (Bilbao) (M. Doumic)
- 4 weeks at the CEDOC center at Gulbenkian Science Institute (L. Almeida)
- 10 days at the CMM, University of Chile (B. Perthame)
- 10 days at MIT, USA (F. Bertaux)

BEAGLE Project-Team

7. Partnerships and Cooperations

7.1. National Initiatives

7.1.1. ANR

- Stochagene (2011-2014). Objective: identify the molecular basis of the stochasticity of gene expression in eukaryotic cells. Partners: CGPhyMC (Olivier Gandrillon, Lyon, Leader), Genethon (Andras Paldi, Evry). Participants: G Beslon, H Berry, Gael Kaneko
- Ancestrome: phylogenetic reconstruction of ancestral "-omes", a five-year project (2012-2016), call "Bioinformatics" of the "Investissements d'avenir". Supervisor: V. Daubin (CNRS, LBBE, Lyon) ; with Institut Pasteur, ENS Paris, ISEM (Univ Montpellier 2) Participant: Eric Tannier.
- Foster: Spatiotemporal data mining: application to the understanding and monitoring of soil erosion (2011-2014). Supervisor: Nazha Selmaoui and Frédéric Flouvat (PPME Univ. Nouvelle Calédonie); with LISTIC Univ. Savoie, ICube Univ. Strasbourg, BlueCham Company. Participant: Christophe Rigotti.

7.1.2. CNRS

- E Tannier participates to a PEPS (Projet exploratoire premier soutien) called C1P: algorithmics of 1D structures, 2012-2013. Supervisor: M. Raffinot (CNRS, LIAFA, Paris), involved teams from Marne-la-Vallée, Nantes, Marseille, Bordeaux, Lyon.

7.2. European Initiatives

7.2.1. FP7 Projects

7.2.1.1. EvoEvo

Type: COOPERATION

Defi:

Instrument: Specific Targeted Research Project

Objectif: NC

Duration: November 2013 - October 2016

Coordinator: Guillaume Beslon (Inria)

Partners: Université Joseph Fourier (France, D. Schneider), Utrecht University (Nederland, P. Hogeweg), University of York (UK, S. Stepney) and CSIC (Spain, S. Elena)

Inria contact: Guillaume Beslon

Abstract: Evolution is the major source of complexity on Earth, at the origin of all the species we can observe, interact with or breed. On a smaller scale, evolution is at the heart of the adaptation process for many species, in particular micro-organisms (e.g. bacteria, viruses). Microbial evolution results in the emergence of the species itself, and it also contributes to the organisms' adaptation to perturbations or environmental changes. These organisms are not only organised by evolution, they are also organised to evolve. The EvoEvo project will develop new evolutionary approaches in information science and will produce algorithms based on the latest understanding of molecular and evolutionary biology. Our ultimate goal is to address open-ended problems, where the specifications are either unknown or too complicated to express, and to produce software able to operate in unpredictable, varying conditions. We will start from experimental observations of micro-organism evolution, and abstract this to reproduce EvoEvo, in biological models, in computational models, and in application software. Our aim is to observe EvoEvo in action, to model EvoEvo, to understand EvoEvo and, ultimately, to implement and exploit EvoEvo in software and computational systems. The EvoEvo project will have impact in ICT, through the development of new technologies. It will also have impact in biology and public health, by providing a better understanding of micro-organism adaptation (such as the emergence of new pathogens or the development of antibiotic resistances).

7.2.1.2. Neuron-Astro-Nets

Type: PEOPLE

Defi:

Instrument: ERCIM and Marie Curie International Outgoing Fellowships for Career Development

Objectif: NC

Duration: Juin 2013-Mai 2017 (ERCIM Juin 2013-mai 2014 puis IOF Marie Curie Juin 2014-mai 2017)

Coordinator: Hugues Berry

Partner: N. Brunel, Statistics Dept, University of Chicago (USA)

Inria contact: Maurizio DE PITTA

Abstract: Healthy functionality in the brain relies on intricate neuron-glia networks. Recent data suggest that glial, including astrocytes, play a crucial role in the processing and storing on by the brain. In particular, synapses might not be bipartite, but rather tripartite structures, comprised of the pre- and the postsynaptic terminals and the surrounding astrocyte. Moreover, astrocytes, like neurons, form intricate interconnected networks that afford long-range communication via the propagation of calcium waves. Therefore, neurons and astrocytes form intertwined neuron-glia networks supporting active partnership between the two cell populations. Hence, understanding the nature of neuron-glia interactions is essential to understand how the brain functions, and will serve as a stepping stone for deciphering brain disorders. Our long-term goal is to reveal the mechanisms that control and regulates the activity of combined neuron-glia networks. The specific objectives of this application, which are fundamental in the pursuit of that goal, are (1) to determine the properties of astrocytic modulation of synaptic transmission; and (2) to characterize how such modulation shapes neuronal activity in neuron-glia networks of the brain. To pursue these aims we will employ a comprehensive theoretical investigation to develop mathematical and biophysical models in support to experiments, at the many levels and scales of action of neuron-astrocyte signaling. The significance of understanding glia-neuron interactions is several-fold as it pertains to a very wide range of applications, from basic understanding of neuronal activity, to developing therapeutic strategies toward the treatment of neurological disorders. Here, we will focus on how modulations of synaptic transmission by astrocytes could favor the emergence of synchronized neuronal, leveraging the predictions of our theoretical approach in the perspective of brain disorders, and epilepsy in particular.

7.2.2. Collaborations with Major European Organizations

European PRACE 7th regular call.

Allocation of 34 million hours computing on the Curie super-computer for the project "Thousands of trees for 4 billion years of life evolution on Earth" led by Bastien Boussau (LBBE, UMR CNRS 5558, Lyon) and involving Eric Tannier from the Beagle team.

7.3. International Initiatives

7.3.1. Inria International Partners

7.3.1.1. Informal International Partners

- Ecole Polytechnique Fédérale de Lausanne (EPFL). We collaborate with Marion Leleu and Jacques Rougemont of the Bioinformatics and Biostatistics Core Facility of the EPFL. The general objective of this exploratory work is to investigate the relationships between epigenetic profiles and 3D structure of the genome. More precisely, we currently compare the clustering of DNA intervals based on descriptors computed from epigenetic profiles in two cases: with and without making use of information about the 3D structure of the genome. We have co-supervised a Master student (Duc Thanh Phan) in 2012-2013 on this topic.

7.3.2. Participation In other International Programs

7.3.2.1. Research Networks Program of the High Council for Scientific and Technological Cooperation between France-Israel: Astrocytic regulation of neuronal network activity (2012-2013)

The specific objectives of this joint project with groups from Tel Aviv University are to determine the properties of astrocytic calcium wave propagation and to reveal how astrocyte signals dynamically affect synaptic information transfer, thus regulating neuronal network activity. To this aim, we combine theoretical and experimental investigations of small neuron-glia networks.

Beagle (H. Berry) is coordinator of the project for the French side and supervises the modeling aspects. The coordinator for the Israeli group is Pr. Y. Hanein (Tel Aviv University Institute for Nanoscience and Nanotechnology, <http://nano.tau.ac.il/hanein>), who is responsible for the experimental parts. The other partner is Pr. E. Ben-Jacob (School of Physics and Astronomy, Tel Aviv University, <http://tamar.tau.ac.il/~eshel/EBJG/>). The project also gathers 4 PhD or Master students in Tel Aviv and Lyon.

Total amount funded : 160 k€.

7.3.2.2. ANR/NSF Bilateral programme for Collaborative Research in Computational Neuroscience (CRCNS): Modelling the vocal apparatus of birds (2013-2016)

This joint project with F. Theunissen (UC Berkeley, USA) aims at modelling the vocal apparatus of birds (Zebra Finches) to recreate vocal range of this bird using a sparser representation than the spectrum. This new representation can be used as a new parameter space to test acoustic neural coding.

This collaboration has been granted by ANR/NSF Bilateral program for Collaborative Research in Computational Neuroscience (CRCNS)(CRCNS 2012), which promotes collaborations between French and American teams. Beagle (H. Soula) is coordinator of the project for the French side and supervises the modeling aspects.

7.3.2.3. France Berkeley Fund: User-friendly phylogenomics: Bayesian simultaneous reconstruction of gene trees and species trees

We obtained a grant for a common project with J. Huelsenbeck's lab (UC Berkeley, USA) on the development of probabilistic models of genome and sequence evolution to simultaneously reconstruct gene trees and species trees, and thus study how species and their genomes have changed through time.

7.4. International Research Visitors

7.4.1. Visits of International Scientists

7.4.1.1. Visiting Professors

Participant: Sergei Fedotov.

Dates: 3 weeks in March 2013 and 3 weeks in September 2013

Institution: Mathematical School, University of Manchester (UK)

Funded by the "Lyon Mathematics Labex MiLyon, and by Inria's visiting professor's program.

Participant: Nadia El-Mabrouk.

Dates: April 2013

Institution: Département d'Informatique et de Recherche Opérationnelle in Montréal (Canada)

Funded by Inria's visiting professor's program.

7.4.1.2. Internships

Osama Khalil

Subject: Computational systems biology of signal transduction in living cells: synaptic plasticity of striatum neurons

Date: from Feb 2013 until May 2013

Institution: American University in Cairo (Egypt)

7.4.2. Visits to International Teams

During the whole 2012-2013 academic year, Hédi Soula was an Invited Professor at UC Berkeley (USA) in F. Theunissen's lab.

BIGS Project-Team

8. Partnerships and Cooperations

8.1. National Initiatives

- *Optique-PDT* (2012-2014), mOdélisation et oPTimisation de l'Irradiance dans les tissus biologiques hétérogènes traités par Thérapie PhotoDynamique interstitielle, Funding organism: *PEPS CNRS-INSERM-Inria*, Leader: M. Thomassin (CRAN, U. Lorraine).
- *Nano-Xrays* (2011-2014), Nanoparticles-based X ray-induced photodynamic therapy in glioblastoma multiforme, Funding organism: *Institut National du Cancer (INCa)*, Leader: M. Barberi-Heyob (CRAN, U. Lorraine).
- *PDTX* (2010-2013), Active Nanoplatforms for Photodynamic Therapy, Funding organism: *French National Agency for Research (ANR)*, Leader: M. Verelst (U. Paul Sabatier, Toulouse).
- *MASTERIE* (2010-2013), Malliavin Stein Random Irregular Equation, Funding organism: *French National Agency for Research (ANR)*, Leader: F. Russo (ENSTA, Paris).

8.2. European Initiatives

8.2.1. FP7 Projects

- *Target-PDT* (2009-2013), Photodynamic Therapy using photosensitizer-doped targeted organic nanoparticles, Funding organism: FP7 ERA-NET EuroNanoMed: **European Innovative RTD Projects Proposals in Nanomedicine**, Leader: P. Boisseau (CEA LETI, Grenoble).

BIOCORE Project-Team

8. Partnerships and Cooperations

8.1. National initiatives

8.1.1. National programmes

- **ANR-GeMCo:** The objective of this project is to do model reduction, experimental validation, and control for the gene expression machinery in *E. coli*. The project is funded by ANR (2010-BLAN-0201-01) and coordinated by M. Chaves.
- **ANR-Facteur 4:** The objective of this project to propose non OGM strain of microalgae with enhanced performance. BIOCORE is involved in the directed selection of microalgae with interesting properties from an industrial point of view. The theory of competition is used to give a competitive advantage to some species. This competitive advantage can be provided by an online closed loop controller.
- **ANR-Purple Sun:** The objective of this project (ANR-13-BIME-004) is to propose study and optimize a new concept consisting in coupling the production of microalgae with photovoltaic panels. The main idea is to derive the excess of light energy to PV electricity production, in order to reduce both the phenomena of photoinhibition and process overwarming.
- **ANR-FunFit:** The objective of this project is to develop a trait-based approach linking individual fitness of fungal plant pathogens to ecological strategies. The idea is to derive eco-epidemiological strategies from fitness optimization in colonized environments and during colonization, as well as understanding the coexistence of sibling species. This project is co-coordinated by F. Grogard.
- **SIGNALIFE:** Biocore is part of this Labex (scientific cluster of excellence) whose objective is to build a network for innovation on Signal Transduction Pathways in Life Sciences, and is hosted by the University Nice Sophia Antipolis.
- **RESET:** The objective of this project is to control the growth of *E. coli* cells in a precise way, by arresting and restarting the gene expression machinery of the bacteria in an efficient manner directed at improving product yield and productivity. RESET is an “Investissements d’Avenir” project in Bioinformatics (managed by ANR) and it is coordinated by H. de Jong (Ibis, Inria)
- **FUI-Salinalgue:** The objective of this project is to take benefit of endemic microalgae species in areas of high salinity (previously used to produce salt) to produce both biofuel (either lipid based or methane) and co products. BIOCORE is in charge of lab scale experiments and of the modelling of the process.

8.1.2. Inria funding

- **ColAge:** The goal of this joint Inria-INSERM consortium is to study bacterial growth and aging by using mathematical modelling and computational predictions to design and implement a *de novo* biological system. This Large-Scale Initiative Action is partly funded by Inria and supervised by H. Berry (Beagle, Inria).

8.1.3. INRA funding

- **Propagules:** INRA-SPE is funding the project “Effet de différentes composantes de la pression de propagules sur le succès d’établissement d’un auxiliaire de lutte biologique” in which BIOCORE is a partner with INRA Sophia Antipolis (2011-2013).
- **Dynamique spatiale:** INRA-SPE is funding the project “Intégration des approches comportementales et démographiques de la dynamique spatiale des populations d’insectes” in which Biocore is a partner with INRA Sophia Antipolis and Agrocampus Ouest (2012-2014).

- **Take Control:** This project, “Deployment strategies of plant quantitative resistance to take control of plant pathogen evolution,” is funded by the PRESUME call of the SMaCH INRA metaprogram. BIOCORE is a partner together with INRA PACA (Sophia Antipolis and Avignon) and INRA Toulouse (2013-2016). This project will provide the major part of the funding for the experiments held for Elsa Rousseau’s thesis.

8.1.4. Networks

- **RTP-M3D:** BIOCORE is a participant in the RTP-M3D workgroup (Mathématiques et décision pour le développement durable) that is supported by the “Environment and sustainable growth” department of CNRS. L. Mailleret is one of the co-leaders of M3D.
- **GDR PROBBE:** The objective of this GDR is the development of new biotechnological processes based on microorganisms producing metabolites which can be used as fuel for transportation (lipids, sugars, methane, hydrogen, ...). BIOCORE is taking part mainly in the modelling and control aspects of the processes involving anaerobic bacteria or microalgae.
- **COREV:** BIOCORE is an active participant in the research group COREV (Modèles et théories pour le contrôle de ressources vivantes et la gestion de systèmes écologiques).
- **Seminar:** BIOCORE organizes a regular seminar “Modeling and control of ecosystems” at the station zoologique of Villefranche-sur-Mer, at INRA-ISA or at Inria.

8.2. European Initiatives

8.2.1. FP7 Projects

8.2.1.1. PURE

Title: Pesticide Use-and-Risk reduction in European farming systems with Integrated Pest Management

Type: COOPERATION (ICT)

Instrument: Collaborative Project (CP)

Duration: 2011 - 2014

Coordinator: Françoise Lescourret (INRA Avignon, FR)

Other partners: **Research:** Institut National de la Recherche Agronomique - INRA (FR) Rothamsted Research - RReS (UK) Aarhus University - AU (DK) Julius Kühn Institut - JKI (DE) Stichting DLO - DLO (NL) Wageningen University - WU (NL) Consiglio Nazionale delle Ricerche - CNR (IT) Agricultural Institute of Slovenia - KIS (SLO) James Hutton Institute - JHI (UK) Fondazione Edmund Mach - FEM (IT) Instituto Valenciano de Investigaciones Agrarias - IVIA (ES) Institute of Plant Protection - IOR (PL) University of Debrecen - Centre of Agricultural Sciences - UDCAS (HU) Joint Research Centre - Institute for Prospective Technological Studies - JRC-IPTS (EU) **Extension:** Knowledge Centre for Agriculture - VFL (DK) Association de Coordination Technique Agricole - ACTA (FR) **Industry:** Bayer Crop Science (DE) BIOTOP (FR) Natural Plant Protection (FR) Burkard Manufacturing Co Ltd (UK) Blgg Bv (NL) **Management:** INRA Transfert (FR)

See also: <http://www.pure-ipm.eu/project>

Abstract: The overall objective of PURE is to provide practical integrated pest management (IPM) solutions to reduce dependence on pesticides in selected major farming systems in Europe, thereby contributing to a reduction of the risks to human health and the environment and facilitating the implementation of the pesticides package legislation while ensuring continued food production of sufficient quality.

PURE will provide IPM solutions and a practical toolbox for their implementation in key European farming systems (annual arable and vegetable, perennial, and protected crops) in which reduction of pesticide use and better control of pests will have major effects. In that project, L. Mailleret develops modeling approaches dedicated to the optimization of plant protection methods relying on biological control and integrated pest management.

8.2.2. Collaborations with Major European Organizations

Imperial college, Department of Chemical engineering (UK)

Modelling and optimization of microalgal based processes.

Imperial College, Centre for Synthetic Biology and Innovation, Dept. of Bioengineering (UK)

Study of metabolic/genetic models

University of Stuttgart, Institute for Systems Theory and Automatic Control (D)

Identification of gene networks

8.3. International Initiatives

8.3.1. Inria International Partners

8.3.1.1. Inria informal international partners

Universidad Técnica Federico Santa María, Departamento de Matemática, Valparaíso, Chile

Universidad de Chile, Departamento de Matemáticas, Ñuñoa Santiago, Chile

Ben-Gurion University of the Negev, Microalgal Biotechnology Laboratory, Beer Sheva, Israel

Center for Environmental Technology and Engineering, Massey University, Palmerston North, New Zealand.

8.3.2. Participation In International Programs

BIOCORE is involved in the Bionature project from Inria Chile – CIRIC (the Communication and Information Research and Innovation Center), in collaboration with four Chilean universities (Universidad de Chile, Universidad Tecnica Federico Santa Maria, Pontificia Universidad Catolica de Valparaiso, and Universidad de la Frontera). The Bionature project is devoted to natural resources management and the modeling and control of bioprocesses.

8.4. International Research Visitors

8.4.1. Visits of International Scientists

We only list the visitors that stayed more than 2 days in our project-team or presented a seminar

- Claude Aflalo (Ben Gurion University of the Negev, Israel), 1 week;
- Andrei Akhmetzhanov (Université de Montpellier II, F), 1 week;
- Gonzalo Ruiz (Catholic University of Valparaiso, Chile), 2 days;
- David Jeison (University of La Frontera, Chile), 2 days;
- Benoit Guieysse (Massey University, New Zealand), 1 day;
- Quentin Béchet (Massey University, New Zealand). 6 days;
- Yves Dumont (CIRAD, F), 1 week;
- Andreas Kremling (TU Munchen, Germany), 1 day;
- Leon Glass (McGill University, Canada), 3 days;

8.5. Project-team seminar

BIOCORE organized a 3-day seminar in October in Tournettes-sur-Loup. On this occasion, every member of the project-team presented his/her recent results and brainstorming sessions were organised.

An additionnal 2-day seminar was dedicated to modelling and control of microalgae.

BONSAI Project-Team

7. Partnerships and Cooperations

7.1. Regional Initiatives

- Projet émergent call 2011. “Scénarios d’évolution génomique basés sur les régions de cassure des réarrangements génomiques” involving GEPV (UMR CNRS 8198, Université Lille 1) and BONSAI.
- Projet émergent call 2011. “ABILES – Algorithmes bioinformatiques pour le diagnostic de leucémie résiduelle par séquenceurs haut-débit” involving IRCL (Institut de recherche sur le cancer de Lille, Inserm, Université Lille 2), Hematology department of Lille Hospital and BONSAI (see the Vidjil software, Section 5.7).

7.2. National Initiatives

7.2.1. ANR

- ANR Mappi (2010-2013): National funding from the French Agency Research (call *Conception and Simulation*). This project involves four partners: LIAFA (Université Paris 7), Genescale (Inria Rennes), Genoscope (French National Center for Sequencing) and BONSAI. The topic is *Nouvelles approches algorithmiques et bioinformatiques pour l’analyse des grandes masses de données issues des séquenceurs de nouvelle génération*.
- PIA France Génomique: National funding from Investissements d’Avenir (call *Infrastructures en Biologie-Santé*). France Génomique is a shared infrastructure, whose goal is to support sequencing, genotyping and associated computational analysis, and increase French capacities in genome and bioinformatics data analysis. It gathers 9 sequencing platforms and 8 bioinformatics platforms. Within this consortium, we are responsible for the workpackage devoted to the computational analysis of sRNA-seq data, in coordination with the bioinformatics platform of Génomole Toulouse-Midi-Pyrénées
- Mastodons (2012): National funding from CNRS (call *Scientific big data*). This call targets the management, analysis and exploitation of massive scientific data sets. We have a collaborative project for Next Generation Sequencing data analysis with LIRMM (Montpellier) and Genscale (Inria Rennes).
- PEPS Bio-Math-Info *Silenes* (2012-2013): National funding from CNRS. This project involves the GEPV (P. Touzet) and the IBMP⁸ (J. Gualberto, L. Maréchal-Drouard). The topic is *Etude comparative de l’architecture du génome mitochondrial chez les Caryophyllacées et les Poacées*. It aims to sequence and analyze the genome structure of a number of *Silene* ecotypes and to compare them to other species.
- PEPS Bio-Math-Info *ReSeqVar* (2013-2014): National funding from CNRS. This new project aims at designing new read mapping algorithms in the context of human genome resequencing, taking into account known variants. We are two partners: UMR 8199 (Génomique et maladie métabolique, Ph Froguel, O. Sand, part of the LIGAN sequencing platform) and BONSAI.

⁸Institut de Biologie Moléculaire des Plantes - UPR2357, Strasbourg

7.2.2. PEPS

- PEPS Biology-Mathematics-Computer science: “Etude comparative de l’architecture du génome mitochondrial chez les Caryophyllacées et les Poacées”. This project involves three partners: IBMP (Institut de Biologie Moléculaire des Plantes), GEPV (UMR CNRS 8198, Université Lille 1) and BONSAI.
- PEPS Biology-Mathematics-Computer science: “Algorithmes pour l’alignement des lectures et la découverte de variants dans les projets de reséquençage”. This project involves two partners: UMR 8199 Génomique et Maladies Métaboliques and BONSAI.

7.2.3. ADT

- ADT biosciences resources (2011-2013): this ADT aims to build a portal of available applications in bioinformatics at Inria. The projects involves all the 8 teams from theme Bio-A and is more specifically developed by BONSAI and Rennes. An engineer was hired from 2011 to 2013 and worked in Rennes and another one was hired in 2012 and works in Lille.

7.3. International Initiatives

7.3.1. Inria International Partners

7.3.1.1. Informal International Partners

- *Universität Tübingen* : We have a collaboration with Tilmann Weber on the topic of computational biology for nonribosomal peptides. We co-organized a workshop in Lille with him.
- We have a collaboration with Martin C. Frith from the *Computational Biology Research Center* (Tokyo) on the topic of transition spaced seeds.
- *LaCIM (Laboratoire de Combinatoire et d’Informatique Mathématique)*: Since 2009, we have been collaborating with Anne Bergeron (Univ. du Québec à Montréal), Krister Swenson (Univ. de Montréal), and Cédric Chauve (Simon Fraser Univ.) on theoretical and applied aspects of gene orders evolution. In 2011, we began a new project on the analysis of exonic gene structure evolution.
- *Universität Bielefeld (Germany)*: This collaboration started through a PHC Procope bilateral cooperation project with the team of Pr. Robert Giegerich (2010-2011). The goal was to work on a generic parallelization of the Algebraic Dynamic Programming methodology. This partnership is still ongoing, with several visits of Robert Giegerich these last few months. It is the source of our recent work for an extension of Algebraic Dynamic Programming [9].

7.4. International Research Visitors

7.4.1. Visits of International Scientists

The following scientists visited the team and gave a talk at the team or the laboratory seminar:

- Mihai Pop, University of Maryland (28 may)
- Veli Mäkinen, university of Helsinki (11 december)
- Krister M. Swenson, UQAM (12 november)

CARMEN Team

8. Partnerships and Cooperations

8.1. Regional Initiatives

- Project Modélisation pour les données multimodales (2012-2015) funded by the Conseil Regional Aquitaine. Coordinator J.-F. Aujol (Pr University Bordeaux 1). The PhD of G. raven is funded within this project: 3D reconstruction by inverse problem in cardiac optical mapping.

8.2. National Initiatives

8.2.1. IHU LIRYC

Our work is partially funded by the LIRYC project (ANR 10-IAHU 04).

- For 2013: the salary of M. Potse, member of Carmen, is payed by the LIRYC.
- The LIRYC gives us a partial financial support. In 2013: support to go to the conference IEEE EMBC in Osaka, Japan (<http://embc2013.embs.org>), and partial support for a PhD jury.
- For 2012-2015: 1/2 PhD thesis associated to the project *Modélisation pour les données multimodales* (see section Regional Initiaves).

8.2.2. ANR HR-CEM

In 2013, we obtained a financial support for the project “High Resolution Cardiac Electrophysiology Models: HR-CEM” within the call for project « Modèles Numériques » of the ANR.

The scientific start of the project was on November, 4th, 2013.

It is an international project that involves three partners, Inria (coordinator), IHU LIRYC, and UMI-CRM at Montréal (Canada). The project has some external collaborators in Univ. Nantes, Univ. Pau and BCAM (Basque Center for Applied Math) at Bilbao (Spain).

Based on these collaborations and new developments in structural and functional imaging of the heart available at LIRYC, we plan to reconsider the concepts behind the models in order to improve the accuracy and efficiency of simulations. Cardiac simulation software and high-resolution numerical models will be derived from experimental data from animal models. Validation will be performed by comparing of simulation output with experimentally recorded functional data. The validated numerical models will be made available to the community of researchers that take advantage of in-silico cardiac simulation and, hopefully, become references. In particular we shall provide the first exhaustive model of an animal heart including the four chambers coupled through the special conduction network, with highly detailed microstructure of both the atria and the ventricles. Such a model embedded in high-performance computational software will provide stronger medical foundations for in-silico experimentation, and elucidate mechanisms of cardiac arrhythmias.

8.2.3. AMIES – Medic Activ

We were granted by the Agency AMIES a financial support to complete the one obtained from the Région Aquitaine for the Medic Activ project (see above). The objective of this support is to develop reduced order models of cardiac electrophysiology that might enter the MedicActiv framework. The difficulty is to define qualitatively realistic but fast numerical simulations of the ECG and cardiac function, for educational purpose.

8.2.4. ANR Labcom CardioXcomp

We are participant in the ANR Labcom project between Inria and the society Notocord (www.notocord.com). At Inria, the project is leaded by JF. Gerbeau from the Reo team and we participate to the study and development of cardiac electrophysiology models suited to the context of the project.

The project is in its starting phase in 2013: the objective of the first 6 months is to define precisely the nature and objectives of the common laboratory between Inria and Notocord. A contract is planned to be signed after these 6 months, and the ANR financial support to be granted at that time.

8.3. European Initiatives

8.3.1. Collaborations with Major European Organizations

Partner 1: Computational Biology Group, Department of Computer Science, Oxford University (United Kingdom).

Our work with the computational biology group concerns the development of multi-scale models of the drugs and their effect on the electrical activity of the heart. The main goal is to assess the drug-induced effects on the electrocardiogram, using a computational model describing the physiology from ion channel to body surface potentials.

Partner 2: BCAM (Basque Center for Applied Mathematics), Bilbao (Spain).

We collaborate with L. Gerardo Giorda, research fellow at the BCAM on: the development of our new software CEPS, the design and study of new domain decomposition methods suited to our cardiac electrophysiology models, the evaluation of some sensitivity analysis issues in cardiac electrophysiology.

Partner 3: Department of Experimental Cardiology, Academic Medical Center, University of Amsterdam (Netherlands).

With the groups of Pr J. de Bakker and of Dr R. Coronel, we work on the arrhythmias related to degradations of the tissues (due to aging or cardiomyopathies), combined with diseases of the ionic channels, such as the Brugada syndrome.

8.4. International Initiatives

8.4.1. Inria International Partners

8.4.1.1. Informal International Partners

- Collaboration with the Pr. Y. Bourgault (<http://aix1.uottawa.ca/~ybourg/personal.html>) from the department of Mathematics and statistics of the University of Ottawa (Canada).

Subject: models and numerical methods for cardiac electrophysiology.

Support: This collaboration has been supported by the ANR project Momme (ANR-JCJC-07-0141), the Region des Pays de la Loire and the Natural Sciences and Engineering of Research council of Canada (NSERC). From 2013, it is supported by the ANR project HR-CEM. Y. Bourgault had an “invited researcher” position at Inria for two months for October and November, 2013.

8.4.2. Inria International Labs

- LIRIMA: Equipe Problèmes Inverses et Contrôle (EPIC), University Tunis Al Manar et Laboratoire de Modélisation Mathématique et Numérique dans les Sciences de l'Ingénieur (LAMSIN), Tunisia.

The EPIC team has an important experience in dealing with ill-posed inverse problems for static and evolution problems. The goal of this collaboration is to apply the methods developed in this team to inverse problems in electrocardiography.

This collaboration is mainly supported by the international laboratory LIRIMA.

8.5. International Research Visitors

8.5.1. Visits of International Scientists

- Y. Bourgault, Pr. University of Ottawa, Department of mathematics and statistics. Invited researcher for 2 months, 1/10/2013 to 30/11/2013.
Comparison between the monodomain and bidomain models for cardiac electrophysiology, and design of an optimalmonodomain approximation of the bidomain equations.
- In July, 2013, B. Smaill, Professor at the Auckland Bioengineering Institute (ABI) and leader of the Cardiac Electrophysiology group, and M. Nash, Professor and Associate Director of the ABI, visited the LIRYC Institute, including a visit to our team Carmen and rich exchanges about our approaches of modelling and the role of experimental data.
- Mohamed Jebalia, Assistant professor, ENIT (Tunisia), researcher from the LAMSIN, May to July 2013.

8.5.1.1. Internships – Visiting PhD Students

- Mohammed Addouche, March 2013.
Institution: University of Tlemcen (Algeria)
Subject: On using factorisation methods for the quasistatic inverse problems of electrocardiology.
- Najib Fiakl, PhD student, December 2013.
Institution: University of Rabat (Morocco)
Subject: Study of the uncertainties on the thoracic electrical conductivities on the resolution of the direct problem of electrocardiology.
- Wajih Mbarki, November to December 2013.
Institution: Université El Manar of Tunis, Tunisia
Subject: Theoretical and numerical study of the Purkinje-muscle coupling in cardiac electrophysiology.
- Jamila Lassoued, September 2013.
Institution: ENIT of Tunis, Tunisia
Subject: application of model reduction techniques to the inverse problems in cardiac electrophysiology.
- Laura Bear, October to December 2013, was co-localized between the LIRYC and Inria.
Institution: University of Auckland (New Zealand), Auckland Bioengineering Institute
Subject: Laura started to work on our inverse solutions for the cardiac electrical imaging problem using the datasets obtained during the first two years of her PhD at the Auckland Bioengineering Institute. The objective is to investigate the possibility and limitations of cardiac non-invasive electrical imaging.

8.5.1.2. Internships

- Hamed Bourenane, July to August 2013
Institution: Student in medicine at the University Bordeaux Segalen
Subject: Segmentations of CT-scan images from the CardioInsight system including fat, bones, lungs, etc.
- Valentin heisel, June to September 2013
Institution: ENSEIRB-MATMECA
Subject: Developed a fortran module to account for 2nd order solvers in cardiac electrophysiology and compared various solvers for cellular electrophysiology.
- Nina Le Devehat, June to July 2013
Institution: First year of University Bordeaux I, supported by the programme “stages d’excellence” from the University

Subject: She studied the modelling of cellulat electrophysiology by the Vanderpol equations.

- Abdessamad Sobhi, July to September 2013
Institution: ENSEIRB-MATMECA
Subject: Inverse problem of cardiac electrophysiology.
- Thibaut Vandromme, June to September 2013
Institution: ENSEIRB-MATMECA
Subject: Fast solvers for cardiac electrophysiology, continued the work in SOFA of a previous trainee (N. Claude in 2012).
- Bastien Verot, June to September 2013
Institution: ENSEIRB-MATMECA
Subject: Numerical approximation of the microscopic bidomain equations of cardiac electrophysiology in a simplified linear context.
- Mathias Cassonnet, January 2013
Institution: secondary school pupil
Subject: Trainee for observation only
- Alexandre Lourenco Peirera, January 2013
Institution: secondary school pupil
Subject: Trainee for observation only

8.5.2. Visits to International Teams

- Y. Coudière visited the GIREF (« Groupe Interdisciplinaire de Recherche en Éléments Finis »), June, 2013.

CASTOR Team

8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. ANR

- ANR ECINADS
Castor is associated to the ANR ECINADS project started in end of 2009, devoted to the design of new solution algorithms for unsteady compressible flows, adapted to scalable parallelism and to reverse (adjoint) Automatic Differentiation. See in the activity report of Ecuador.
- ANR ESPOIR
The ANR ESPOIR (Edge Simulation of the Physics Of Iter Relevant turbulent transport) associates the CASTOR team with the M2P2, LPIIM and LATP laboratories in Marseille and IRFM in Cadarache to investigate edge plasma turbulence. The numerical simulation of the plasma wall interactions requires efficient codes and thus the development of advanced numerical methods and solvers. The aim of this project is to study different numerical strategies for edge plasma models in the real geometrical and magnetical configurations corresponding to the future Iter machine.
- ANEMOS : ANR-11-MONU-002
ANEMOS : Advanced Numeric for Elms : Models and Optimized Strategies associates JAD Laboratory/Inria (Nice, Manager), IRFM-CEA (Cadarache), Maison de la Simulation (Saclay) and Inria EPI Bacchus (Bordeaux) Elms are disruptive instabilities occurring in the edge region (SOL) of a tokamak plasma. The development of Elms poses a major challenge in magnetic fusion research with tokamaks, as these instabilities can damage plasma-facing components, particularly divertor plates. The mitigation or suppression of large Elms is a critical issue for successful operation of ITER. Goal for ANEMOS is to develop and improve numerical tools in order to simulate physical mechanisms of Elms and qualifies some strategies for their control. We then need to design efficient numerical strategies on the most advanced computers available to contribute to the science base underlying of proposed burning plasma tokamak experiments such as ITER.
- ANR IODISEE : IOnospheric DIsturbanceS and SatEllite-to-Earth communications. <http://iodissee.math.cnrs.fr/project/index.html>. In this ANR project, CASTOR will address the use of data-models coupling method to identify the input model parameters (especially, the initial data for the electronic density).

8.1.2. Federation on Magnetic Confinement Fusion Projects

- FR FCM (Federation on Magnetic Confinement Fusion) project within Euratom-CEA association, "Reconstruction, simulation and control of plasma equilibrium"
- FR FCM (Federation on Magnetic Confinement Fusion) project within Euratom-CEA association, "Two-fluid numerical modelling of edge plasma in tokamak; Application to ITER".

8.2. European Initiatives

8.2.1. Collaborations with Major European Organizations

EFDA (European Fusion Development Agreement)

EFDA ITM Task Force (Integrated Tokamak Modelling) CEDRES++ and Equinox are developed within the framework of the Task Force on Integrated Tokamak Modelling of the European Fusion Development Agreement.

EFDA (European Fusion Development Agreement)

JOREK, BOUT++ non-linear MHD modelling of MHD instabilities and their control in existing tokamaks and ITER

8.3. International Initiatives

8.3.1. Participation In other International Programs

8.3.1.1. Euromediterranée 3+3 Medlagoon program

Participants: Hervé Guillard, Marco Bilanceri.

The goal of the Medlagoon project (<https://project.inria.fr/medlagoon/en>) is to contribute to the design of simulations tools aimed to the integrated mathematical modeling of Mediterranean lagoons ranging from hydrodynamics and sediment transport modeling to biological models for phyto and zoo-plankton. This program associates CASTOR with the Mohamedia Engineering school and the university of Oujda in Morocco, the University of Pisa (Italy), the Polytechnic school of Tunis in Tunisia, the University of Paris 13, The Ain Sham University in Egypt and the Department of Applied Mathematics, University of Crete in Greece.

8.4. International Research Visitors

8.4.1. Visits of International Scientists

8.4.1.1. Internships

- Pavla Frankova, University of Pilzen : Algebraic Multigrid Solvers. In the framework of a collaboration on algebraic multigrid solvers with Petr Vanek and Roman Kuzel of the University of Pilzen, Czech Republic, Pavla Frankova PhD student in Pilzen has visited CASTOR in November.
- Abdou Hafar, Ecole Mohamedia Ingénieur, Rabat : In the framework of the Medlagoon program, Abou Hafar PhD student has visited CASTOR in November to work on meshless methods.

CLIME Project-Team

8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. ANR

- The ANR project Estimair aims at quantifying the uncertainties of air quality simulations at urban scale. The propagation of uncertainties requires the use of model reduction and emulation. A key uncertainty source lies in the traffic emissions, which will be generated using a dynamic traffic assignment model. Ensembles of traffic assignments will be calibrated and used in the uncertainty quantification. Estimair is led by Clime.
- Clime is one partner of the ANR project GeoFluids. It focuses on the specification of tools to analyse geophysical fluid flows from image sequences. Clime objectives concern the definition of reduced models from image data.
- Clime takes part to the ANR project IDEA that addresses the propagation of wildland fires. Clime is in charge of the estimation of the uncertainties, based on sensitivity studies and ensemble simulations.

8.1.2. PRIMEQUAL (ADEME)

- Clime takes part to the PRIMEQUAL project PREQUALIF, “Programme Pluridisciplinaire de REcherche sur la QUALité de l’air en Île-de-France” (i.e., “Multidisciplinary Program on Air quality research in Île-de-France”). The objective is to investigate the impact of low emission zones. The project aims at designing a new generation of diagnostic tools for assessment of health and analysis of economic benefits attributed to traffic restrictions. Clime brings data assimilation expertise which allows to compute the most accurate air pollution maps.

8.2. European Initiatives

8.2.1. Collaborations in European Programs, except FP7

Program: COST Action ES104.

Project acronym: EuMetChem.

Project title: European framework for online integrated air quality and meteorology modeling.

Duration: January 2011 - December 2014.

Coordinator: Alexander Baklanov, Danish Meteorological Institute (DMI) Denmark.

Other partners: around 14 european laboratories, experts from United States, ECMWF.

Abstract: European framework for online integrated air quality and meteorology modeling (Eu-MetChem) focuses on a new generation of online integrated Atmospheric Chemical Transport (ACT) and Meteorology (Numerical Weather Prediction and Climate) modeling with two-way interactions between different atmospheric processes including chemistry (both gases and aerosols), clouds, radiation, boundary layer, emissions, meteorology and climate. Two application areas of the integrated modeling are considered: (i) improved numerical weather prediction (NWP) and chemical weather forecasting (CWF) with short-term feedbacks of aerosols and chemistry on meteorological variables, and (ii) two-way interactions between atmospheric pollution/ composition and climate variability/change. The framework consists of four working groups namely: 1) Strategy and framework for online integrated modeling; 2) Interactions, parameterizations and feedback mechanisms; 3) Chemical data assimilation in integrated models; and finally 4) Evaluation, validation, and applications. Establishment of such a European framework (involving also key American experts) enables the EU to develop world class capabilities in integrated ACT/NWP-Climate modeling systems, including research, forecasting and education.

8.2.2. Collaborations with Major European Organizations

Partner: ERCIM working group “Environmental Modeling”.

The working group gathers laboratories working on developing models, processing environmental data or data assimilation.

8.3. International Initiatives

8.3.1. Inria International Partners

8.3.1.1. Informal International Partners

Partner: Chilean meteorological office (Dirección Meteorológica de Chile)

The partner produces its operational air quality forecasts with Polyphemus. The 3-day forecasts essentially cover Santiago. The forecasts are accessible online in the form of maps, time series and video (<http://www.meteochile.gob.cl/modeloPOLYPHEMUS.php>).

Partner: Marine Hydrophysical Institute <http://mhi.nas.gov.ua/eng/>, Ukraine.

The collaboration concerns the study of the Black Sea surface circulation and the issue of image assimilation in forecasting models.

Partner: IBM Research, Dublin, Ireland

The collaboration addresses the assimilation of classical observations as well as images, with application to geophysics. New assimilation methods are developed, mainly based on minimax filtering.

8.4. International Research Visitors

8.4.1. Visits of International Scientists

- Sergiy Zhuk, IBM, Dublin Research Lab, Ireland, September 2013.

COFFEE Project-Team

7. Partnerships and Cooperations

7.1. National Initiatives

7.1.1. ANR

The ANR-project Monumentalg, led by M. Ribot, is devoted to the modeling and simulation of biological damage on monuments and algae proliferation.

7.1.2. National and European networks

- GdR MoMas.
The research group MoMaS (Mathematical Modeling and Numerical Simulation for Nuclear Waste Management Problems) has activities centered around scientific computing, design of new numerical schemes and mathematical modelling (upscaling, homogenization, sensitivity studies, inverse problems,...). Its goal is to coordinate research in this area, as well as to promote the emergence of focused groups around specific projects
- S. Junca is involved in the GdR-e “Wave Propagation in Complex Media for Quantitative and non Destructive Evaluation”.
- GdR EGRIN is a newly created CNRS-network, devoted to gravitational flows and natural risks; Coffee is among the members of this network.

7.2. International Initiatives

7.2.1. Inria Associate Teams

As of March 2014, the project CoKLyCo will start: this is a joint research program with the group of F. Filbet from the Math. Dept. of the University of Lyon and the team of K. Aoki from the Dept. of Mechanical Engineering at Kyoto University. The project is concerned with fluid and kinetic model for some rarefied gases.

7.2.1.1. Informal International Partners

Quite recently, S. Junca has started a collaboration with Mathias Legrand, from the Mechanical Engineering department at Mc Gill, Montréal with the supervision of the internship of a master student (S. Heng, 6 months, June-Nov. 2013). Furthermore, S. Junca is an active member of the European network “Wave propagation in complex media for quantitative and non destructive evaluation”¹

S. Krell has a collaboration with Martin Gander (University of Geneva, Switzerland) on domain decomposition methods, adapted to DDFV discretizations.

M. Ribot started a collaboration with Roberto Natalini a couple of years ago. Connections with experts in Firenze was the starting point of the research on biofilm formation and algae proliferation. M. Ribot and R. Natalini have also worked on new well-balanced strategy — the so-called AHO schemes — in order to preserve equilibria and to capture correctly large time solutions for complex PDEs system, without knowing explicitly the equilibrium solution. They have co-advised 2 PhD thesis.

Finally, we have many international collaborations, with variable peaks of activity, in our research networks: A. Vasseur (U. T. Austin), P.E. Jabin (Univ. Maryland), J.-A. Carrillo (Imperial College London), S. Jin (U. W. Madison and Jiao Tong Univ.), R. Aavatsmark (Univ. of Bergen), etc.

7.3. International Research Visitors

7.3.1. Visits of International Scientists

A. Vasseur, from UT Austin, J. A. Carrillo from ICL, Corrado Mascia from Sapienza, Università di Roma and Gabriella Puppo from Politecnico di Torino visited the team

¹<http://www.gdre-us.cnrs-mrs.fr/spip.php?rubrique8>

DEMAR Project-Team

8. Partnerships and Cooperations

8.1. Regional Initiatives

8.1.1. Appel d'Offre Interne (AOI) CGS Merri (CHU Montpellier)

Development and evaluation of a freezing detection system for people subject to the Parkinson disease : CHU Montpellier - UM1 M2H (Montpellier) - DEMAR

8.1.2. Labex NUMEV

Optimization of the sitting to stand-up transfer under FES for paraplegic people : preliminary study.

8.1.3. Running CPP protocols (Comité de Protection des Personnes)

- Optimisation du transfert assis-debout sous électro myostimulation fonctionnelle du patient paraplégique : Etude préliminaire, PROPARA, Montpellier. CPP Sud Méditerranée III - ID RCB : 2010-A00808-31 + Amendement.
- Détection et quantification du freezing chez le sujet parkinsonien CHU Montpellier, A. Balmes. CPP Sud Méditerranée 4 - étude qualifiée "soins courants".
- Observation du cycle de marche chez des patients hémiplésiques dans le but d'améliorer le déclenchement de la stimulation électrique fonctionnelle CHU Nîmes, Grau du Roi. CPP Sud Méditerranée III
- Mise au point d'une stratégie pour le stimulation sélective chez le lapin. Laboratoire de recherches chirurgicales Institut de Biologie, Université Montpellier I. Comité d'Ethique pour l'Expérimentation Animale Languedoc-Roussillon

8.2. National Initiatives

8.2.1. DEMAR / MXM Innovation Lab "SoftStim" project

Participants: David Guiraud, David Andreu.

Inria Innovation-Lab "SoftStim" project (2011-2014). 1 engineer (3 y.), 20keuros.

The aim of this Inria's national initiative is to favor the scientific collaboration and technological transfer of the innovation between DEMAR and MXM.

The aim of this project is to prototype concepts conjointly patented like stimulation unit 's embedded sequencer and processor (new set of instructions), and implantable FES controller with its dedicated software environment.

8.2.2. Cosinus ANR - SoHuSim

Participants: Benjamin Gilles, Mitsuhiro Hayashibe, David Guiraud, Maxime Tournier.

Project SoHuSim on modeling muscle tissue during contraction in 3D movements using SOFA software and functional modeling of the organs. 150 kE. Partners: Inria Evasion, Tecnalía, HPC, CHU Montpellier (Oct. 2010 - Oct. 2014).

8.2.3. ADT SENSAS - SENSBIO

Participants: Christine Azevedo-Coste, David Andreu, Daniel Simon.

SENSAS is an Inria ADT (Actions de Développement Technologique), implying several Inria project teams on the “SENSor network ApplicationS” theme. SENSAS aims to propose applications based on wireless sensor and actuator network nodes provided from the work done around senslab and sensstools preliminary projects. SENSAS is organized around the following work packages :

- SensRob : Robotics applications
- SensBio : Bio-Logging applications
- SensMGT : Wireless sensor/actuator network management/configuration applications
- SensBox : Wireless sensor/actuator network simulation applications and tools

Our team is mainly implied in the SensBio work package, in particular for the following applications: Spinal Cord Injured Patients FES-Assisted Sit to Stand, Post-Stroke Hemiplegic Patient FES-correction of drop foot, Gait analysis of parkinson freezing and Motion analysis of longterm race data.

8.2.4. *Programme de recherche en qualité hospitaliere (PREQHOS)*

Participants: Leader: Jean-Christophe Lucet [GH Bichat - Claude Bernard], Christine Azevedo-Coste, Eric Fleury [Inria DANTE], Bruno Grandsebastien [CHRU Lille].

Project: Surgery room behaviour and impact on infectious risks (ARIBO : Attitudes et Risque Infectieux au Bloc Operatoire)

8.2.5. *INTENSE project*

Participants: David Guiraud, Pawel Maciejasz, Olivier Rossel, Christine Azevedo-Coste, David Andreu, Fabien Soulier.

INTENSE (Initiative Nationale Technologique d’Envergure pour une NeuroStimulation Evoluée) is a PIA-PSPC Project (Programme Investissement d’Avenir, Projets RD Structurants des Pôles de Compétitivité) [2012-2018]. The aim of this project is to develop new implantable devices, based on neurostimulation, for heart failure.

Partners of this project are: DEMAR, SORIN CRM, MXM-Obélia, 3D plus, CEA-Leti, INRA Rennes, INSERM Rennes, HEGP, CHU Rennes.

8.3. European Initiatives

8.3.1. *FP7 European project TIME*

Participants: David Guiraud, David Andreu, Fabien Soulier, Pawel Maciejasz.

(2008-2013). 375keuros, "*Transverse, Intrafascicular Multichannel Electrode system for induction of sensation and treatment of phantom limb pain in amputees*".

Partners : AAU (Aalborg, Denmark), MXM (Vallauris, France), SSSA (Pisa, Italy), IMTEK (Freiburg, Germany), UAB (Barcelona, Spain), UCBM (Roma, Italy), IUPUI (Indianapolis, USA).

<http://www.project-time.eu/>

8.3.2. *FP7 European project EPIONE*

Participants: David Guiraud, David Andreu, Fabien Soulier, Pawel Maciejasz.

(2013-2017) "*Natural sensory feedback for phantom limb pain modulation and therapy*,

Partners: AAU (Aalborg, Denmark), École polytechnique fédérale de Lausanne (EPFL), IUPUI (Indianapolis, USA), Lund University (LUNDS UNIVERSITET), MXM (Vallauris, France), Novosense AB (NS), IMTEK (Freiburg, Germany), UAB (Barcelona, Spain), Aalborg Hospital, Università Cattolica del Sacro Cuore (UCSC), Centre hospitalier Universitaire Vaudois (CHUV)

<http://project-epione.eu/>

8.4. International Initiatives

8.4.1. Participation In other International Programs

8.4.1.1. STIC AmSud

Title: CARAT (Computer Aided Rehabilitation Algorithms and Tools)

Inria principal investigator: Mitsuhiro Hayashibe

International Partner (Institution - Researcher):

Universidade de Brasília (UnB,Brazil) - Antônio P.L. Bó, Geovany Borges

Pontificia Universidad Católica del Perú (PUCP,Brazil) - Dante Elias

Duration: 2012 - 2013

Throughout the world there is an increasing need for better technologies for rehabilitation and assistance. These new solutions must present improved performance in terms of therapy effectiveness, while at the same time minimizing the corresponding costs. In this scenario, computer-aided methods represent a promising alternative for the challenges currently faced by the rehabilitation domain. Within this collaborative research project, we focus on the following research topics: - Algorithms for human motion analysis for both clinical and residential settings based on portable and external sensing technologies - Sensory feedback devices to improve effectiveness on rehabilitation procedures - Robotic platforms for rehabilitation - Software development for telerehabilitation

8.5. International Research Visitors

8.5.1. Visits of International Scientists

- Prof. Dante Elias (Professor, Pontificia Universidad Católica del Perú) visited and presented his work on "Characteristics of a walking simulator with parallel manipulators" (7th, Nov 2013).

8.5.1.1. Internships

David Andreu supervised Milan Demarcq on "Mesure et Optimisation de la consommation de systèmes numériques implantables", Engineer final internship, from March. 2013 to Sep. 2013.

David Guiraud supervised Charles Juillet on «Transmission d'énergie et de données à un implant via un câble bifilaire », Engineer final internship, from March. 2013 to Sep. 2013.

David Andreu supervised Arthur Hiairassary on "Architecture logicielle temps-réel d'un contrôleur de SEF implantable", Projet Industriel de Fin d'Etudes (engineer final year project), from Sep. 2013 to Feb. 2014.

David Andreu supervised Joannick Azama on "Implémentation d'un protocole application multi-charge pour réseau de SEF sans-fil", Projet Industriel de Fin d'Etudes (engineer final year project), from Sep. 2013 to Feb. 2014.

David Andreu supervised Chams Jied on "Architecture logicielle d'un contrôleur temps-réel de stimulation électrique fonctionnelle", Projet Industriel de Fin d'Etudes (engineer final year project), from Sep. 2013 to Feb. 2014.

David Andreu supervises Guillaume Magro. "Spécification et prototypage d'un contrôleur de SEF implantable". Industrial Informatics Engineer, Inria Expert Engineer contract (3 years contract, Inria).

Daniel Simon supervised Jonathan Peguet on "Attitude Reconstruction of an Inertial Measurement Unit using IMUSim Software", IFMA (Clermont-Ferrand) engineer final year project, from Apr. to Sep. 2013.

Mitsuhiro Hayashibe supervised Sourav Chandra on "Dynamic modeling of fatigue induced hand tremor", PhD internship, Svaagata.eu: experience Europe as an Indian Erasmus Mundus, Indian Institute of Technology Madras, India, from Sep. 2013 to Feb. 2014.

8.5.2. Visits to International Teams

- Mitsuhiro Hayashibe visited Pontificia Universidad Católica del Perú for STIC Amsud - CARAT project and made a seminar on "Modeling and Control for Neuroprosthetic Systems and Rehabilitation" (15th May 2013 -25th May 2013).
- Mitsuhiro Hayashibe was Visiting Researcher at RIKEN BSI-TOYOYA research institute and worked on "Tacit Motor learning for rehabilitation" (Jul.-Aug. 2013).

DRACULA Project-Team

8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. ANR

Projects coordination by a member of Dracula

- ANR (jeunes chercheurs) ProCell "Mathematical Methods for Erythropoiesis Modelling: from Proteins to Cell Populations", 2009-2013.
Participants: Samuel Bernard, Fabien Crauste [Coordinator], Olivier Gandrillon, Laurent Pujou-Menjouet, Vitaly Volpert.
- ANR (jeunes chercheurs) MADCOW "Modelling amyloid dynamics and computation output work: applications to Prion and Alzheimer's disease", 2008-2013.
Participants: Samuel Bernard, Fabien Crauste, Laurent Pujou-Menjouet [Coordinator], Vitaly Volpert.
- ANR BIMOD "Hybrid models of cell populations. Application to cancer modelling and treatment", 2010-2014.
Participants: Mostafa Adimy, Fabien Crauste, Vitaly Volpert [Coordinator].
- ANR STOCHAGENE "Role of the chromatin dynamics on the stochasticity in gene expression in higher eukaryotic cells", 2011-2015.
Participant: Olivier Gandrillon [Coordinator].

Collaboration in other projects

- ANR RPIB PrediVac "Innovative modeling tools for the prediction of CD8 T cell based vaccine efficacy", 2013-2015. Partners: U1111 Inserm (J. Marvel, coordinator), Dracula, Altrabio (small company), CoSMo (small company). For Dracula, the budget in 2013 is 88 keuros, including two one-year post-doc positions, recruited in February (Floriane Lignet) and in April (Sotiris Prokopiou).
- Thomas Lepoutre participates in the ANR (jeunes chercheurs) MODPOL (head Vincent Calvez (ENS Lyon)) "Cell polarization modeling", 2011-2015.
- Thomas Lepoutre is a member of the ANR KIBORD (head L. Desvillettes) dedicated to "kinetic and related models in biology". 2012-2016.
- Olivier Gandrillon participates in the ANR (Investissement d'Avenir) Iceberg (head Gregory Batt (Inria)) "From population models to model populations: single cell observation, modeling, and control of gene expression".

8.2. European Initiatives

8.2.1. Collaborations with Major European Organizations

- University of Valladolid (Spain). Collaboration with Oscar Angulo, Juan Carlos Lopez-Marcos and Miguel Ange Lopez-Marcos, on the analysis of an age-structured model describing erythropoiesis, and its numerical resolution.
- Karolinska University Hospital of Stockholm (Sweden). Collaboration with Peter Arner, Mats Eriksson, Erik Arner, Mikael Rydén and Kirsty L. Spalding, on the study of dynamics of human adipose lipid turnover in health and metabolic disease.

8.3. International Initiatives

8.3.1. Inria Associate Teams

8.3.1.1. Modeling leukemia

Title: Modeling quiescence and drug resistance in Chronic Myeloid Leukemia

Inria principal investigator: Thomas Lepoutre

International Partner (Institution - Laboratory - Researcher):

University of Maryland (United States), Center for Scientific Computation and Mathematical Modeling.

Leukemia is the most famous disease of the blood cell formation process (hematopoiesis). Chronic myeloid leukemia results in a uncontrolled proliferation of abnormal blood cells. As the hematopoiesis involves stem cells (not accessible to observations), mathematical modeling is here a great tool to test hypothesis. We will join the expertise of Inria team DRACULA specialized on the modeling of blood cell formation and the Center for Scientific Computation and Applied Mathematical Modeling (CSCAMM, University of Maryland, College Park). The theoretical and modeling experience of team DRACULA and the numerical expertise combined with the links with experimentalists of members of CSCAMM will allow us to study deeply evolution of leukemia. We will especially focus on the behavior of leukemic stem cells and their possibility of becoming quiescent (dormant). Then we will study (using the knowledge obtained on leukemic stem cells) the phenomenon of drug resistance and its propagation over time and finally the mechanisms of multidrug resistance.

8.3.2. Participation In other International Programs

8.3.2.1. M3CD

Program: **Euromediterranean 3+3**

Title: Mathematical Models and Methods in Cell Dynamics

Inria principal investigator: Mostafa Adimy

International Partners (Institution - Laboratory - Researcher):

Institut Pasteur de Tunis (Tunisia) - Slimane Ben Miled

Consiglio Nazionale delle Ricerche- Istituto per le Applicazioni del Calcolo Mauro Picone (Italy) - Istituto per le Applicazioni del Calcolo Mauro Picone - Roberto Natalini

Cadi Ayyad University (Morocco) - Populations Dynamics Laboratory - Moulay Lhassan Hbid

Duration: Jan 2012 - Dec 2015

The aim of this project is to establish a network working on mathematical and computational models in cell dynamics. This network consists of five groups which have already established close bilateral relations. Those are the Inria teams Bang and Dracula in Paris and Lyon, France, the team IAC-CNR in Rome, Italy, the laboratory of Mathematical Population Dynamics (LMDP) from the university of Marrakech in Morocco, and the team of Mathematical Modelling and Computing in Biology (MoMinBi) from the Pasteur Institute in Tunis. Modelling cell dynamics and related processes is one of the main subjects of interest for the partners for many years. The issues addressed in the present project can be divided into five parts:

- 1) Analysis of structured models in cell population dynamics ;
- 2) Dynamics of normal and pathological haematopoiesis ;
- 3) Dynamics of Darwinian adaptation, in particular by drug resistance in competing cell or parasite populations, healthy and pathological / pathogenic (cancer, bacteria, parasites) ;

4) Dynamics of chemical and physical determinants of filament formation and intracellular spatial organisation of the cytoskeleton conformation ;

5) Coupling of the molecular mechanisms of control of the cell division cycle and cell proliferation.

The first part has been developed for many years by all the partners in this project. It tackles issues related to cell dynamics and biological mechanisms, physiological and chemical properties of cells and cell populations. The other four aspects of the project have been studied in the past by the Inria teams "Bang" and "Dracula" (2, 4, 5) and the IAC-CNR team (Rome), or are a rapidly emergent theme in Bang (3, cell Darwinism) with possible and natural connections with the other teams, in particular IAC-CNR and MoMinBi in Tunisia. Themes (2, 4, 5) have also been initiated (for their fundamental part) in a recent collaboration between Dracula and the teams from Morocco and Tunisia. The objectives of the present project are to pursue and deepen the study of cell proliferation dynamics and cellular mechanisms using structured models that take into account some new structure variables. The development of computer models will also be investigated in this project. Training and research activities related to these topics are currently underway between the Inria teams and the teams from Marrakech and Tunis, and between the Italian team and Bang. Two co-supervised theses are currently in progress, a Spring school on this subject will be organised by the partners in 2012. This program comes at the right time to give a new impetus to this collaboration. It will lead to the establishment of a multi-site laboratory expertise in population dynamics modelling, especially in cellular dynamics. This project will also allow the teams from Morocco and Tunisia to use their knowledge on mathematics applied to cell dynamics.

8.4. International Research Visitors

8.4.1. Visits of International Scientists

8.4.1.1. Internships

Evgenia Babushkina

Subject: Numerical simulations of blood flows and blood coagulation

Date: from Apr 2013 until Jul 2013

Institution: St. Petersburg State University (Russia (Russian Federation))

8.4.1.2. Visits of other international scientists

- Malay Banerjee - Kanpur, India - from May 2013 until June 2013.
- Dana-Adriana Botesteanu - University of Maryland, USA - from May 2013 until June 2013
- Peter Kim - University of Sydney, Australia - from January 2013 until February 2013
- Nemanja Kosovalic - York University, Canada - March 2013
- Michael Mackey - McGill University, Canada - February 2013
- Jianhong Wu - York University, Canada - March 2013

DYLISS Project-Team

7. Partnerships and Cooperations

7.1. Regional Initiatives

7.1.1. Regional partnership with computer science laboratories in Nantes

Participants: Anne Siegel, Jérémie Bourdon, Damien Eveillard, François Coste, Jacques Nicolas, Oumarou Abdou-Arbi, Vincent Picard, Santiago Videla, Sven Thiele.

Methodologies are developed in close collaboration with university of Nantes (LINA) and Ecole centrale Nantes (Ircyn). This is acted through the Biotempo and Idealg ANR projects and co-development of common software toolboxes within the Renabi-GO platform process. The Ph-D students V. Picard and J. Laniau are also co-supervised with members of the LINA laboratory.

7.1.2. Regional partnership in Marine Biology

Participants: Anne Siegel, Catherine Belleannée, Jérémie Bourdon, Jeanne Cambefort, François Coste, Damien Eveillard, Jacques Nicolas, Guillaume Collet, Clovis Galiez, Gaëlle Garet, Julie Laniau, Vincent Picard, Sylvain Prigent.

A strong application domain of the Dyliss project is marine Biology. This application domain is co-developed with the station biologique de Roscoff and their three UMR and involves several contracts. The IDEALG consortium is a long term project (10 years, ANR Investissement avenir) aiming at the development of macro-algae biotechnology. Among the research activities, we are particularly interested in the analysis and reconstruction of metabolism and the characterization of key enzymes. Other research contracts concern the modeling of the initiation of sea-urchin translation (former PEPS program Quantoursin, Ligue contre le cancer and ANR Biotempo), the analysis of extremophile archebacteria genomes and their PPI networks (former ANR MODULOME and PhD thesis of P.-F. Pluchon) and the identification of key actors implied in competition for light in the ocean (PELICAN ANR project).

7.1.3. Regional partnership with Inra and Health

Participants: Oumarou Abdou-Arbi, Geoffroy Andrieux, Aymeric Antoine-Lorquin, Catherine Belleannée, Charles Bettembourg, François Coste, Olivier Dameron, Michel Le Borgne, Jacques Nicolas, Anne Siegel, Valentin Wucher.

We have a strong and long term collaboration with biologists of INRA in Rennes : PEGASE and IGEEP units. This partnership is acted by the co-supervision of one post-doctorant and the co-supervision of several PhD students. The Ph-D thesis of O. Abdou-Arbi [11] and C. Bettembourg were supported by collaborations with the PEGASE laboratory [14]. This collaboration is also reinforced by collaboration within ANR contracts (Lepidolf, MirNadapt, FatInteger).

We also have a strong and long term collaboration with the IRSET laboratory at Univ. Rennes 1, acted by the defense of the co-supervised Ph-D thesis of G. Andrieux [12]. This partnership is reinforced by the ANR contract Biotempo. It was also supported in the framework of the previous CPER by a project, BasicLab, on a lab on chip for cell assays. Future studies will focus on the understanding of the metabolism of xenobiotics, funded by Anses.

7.2. National Initiatives

7.2.1. Long-term contracts

7.2.1.1. "Omics"-Line of the Chilean CIRIC-Inria Center

Participants: Anne Siegel, Jérémie Bourdon, François Coste, Damien Eveillard, Gaëlle Garet, Jacques Nicolas, Andres Aravena, Sven Thiele, Santiago Videla.

Cooperation with Univ. of Chile (MATHomics, A. Maass) on methods for the identification of biomarkers and software for biochip design. It aims at combining automatic reasoning on biological sequences and networks with probabilistic approaches to manage, explore and integrate large sets of heterogeneous omics data into networks of interactions allowing to produce biomarkers, with a main application to biomining bacteria. Co-funded by Inria and CORFO-chile from 2012 to 2022, the program includes a co-advised Ph-D student (A. Aravena) [13] and a post-doc (S. Thiele). In this context, IntegrativeBioChile is an Associate Team between Dyliss and the Laboratory of Bioinformatics and Mathematics of the Genome hosted at Univ. of Chile funded from 2011 to 2013.

7.2.1.2. ANR Idealg

Participants: Anne Siegel, Catherine Belleannée, Jérémie Bourdon, Jeanne Cambefort, François Coste, Olivier Dameron, Damien Eveillard, Jacques Nicolas, Guillaume Collet, Clovis Galiez, Gaëlle Garet, Sylvain Prigent.

IDEALG is one of the five laureates from the national call 2010 for Biotechnology and Bioresource and will run until 2020. It gathers 18 different partners from the academic field (CNRS, IFREMER, UEB, UBO, UBS, ENSCR, University of Nantes, INRA, AgroCampus), the industrial field (C-WEED, Bezhin Rosko, Aleor, France Haliotis, DuPont) as well as a technical center specialized in seaweeds (CEVA) in order to foster biotechnology applications within the seaweed field. It is organized in ten workpackages. We are participating to workpackages 1 (establishment of a virtual platform for integrating omics studies on seaweed) and 4 (Integrative analysis of seaweed metabolism) in cooperation with SBR Roscoff. Major objectives are the building of brown algae metabolic maps, flux analysis and the selection extraction of important parameters for the production of targeted compounds. We will also contribute to the prediction of specific enzymes (sulfatases) within workpackage 5 .[[details](#)]

7.2.2. Methodology: ANR Biotempo

Participants: Anne Siegel, Jérémie Bourdon, François Coste, Damien Eveillard, Jacques Nicolas, Michel Le Borgne, Geoffroy Andrieux, Andres Aravena, Vincent Picard, Sylvain Prigent, Santiago Videla.

The BioTempo projects aims at developing some original methods for studying biological systems. The goal is to introduce partial quantitative information either on time or on component observations to gain in the analysis and interpretation of biological data. Three biological applications are considered regulation systems used by biomining bacteria, TGF-*beta* signaling and initiation of sea-urchin translation. It is funded by ANR Blanc (SIMI2) and coordinated by A. Siegel from 2011 to 2014. Teams involved include LINA (Nantes), I3S (Nice), DIMPP (Montpellier), Contrainte project team (Inria), IRSET (Rennes) and Station biologique de Roscoff [[details](#)]

7.2.3. Proof-of-concept on dedicated applications

7.2.3.1. ANR Fatinteger

Participants: Aymeric Antoine-Lorquin, Catherine Belleannée, Jacques Nicolas, Olivier Quenez, Anne Siegel.

This project (ANR Blanc SVE7 "biodiversité, évolution, écologie et agronomie" from 2012 to 2015) is led by INRA UMR1348 PEGASE (F. Gondret). Its goal is the identification of key regulators of fatty acid plasticity in two lines of pigs and chickens. To reach these objectives, this project has for ambition to test some combination of statistics, bioinformatics and phylogenetics approaches to better analyze transcriptional data of high dimension. Data and methods integration is a key issue in this context. We work on the recognition of specific common cis-regulatory elements in a set of differentially expressed genes and on the regulation network associated to fatty acid metabolism with the aim of extracting some key regulators.

7.2.3.2. ANR Lepidolf

Participants: François Coste, Jacques Nicolas.

The LEPIDOLF project aims at better understanding olfactory mechanisms in insects. The goal is to establish the antennal transcriptome of the cotton leafworm *Spodoptera littoralis*, a noctuid representative of crop pest insects. It is funded by ANR call Blanc and coordinated by E. Jacquin-Joly from UMR PISC (INRA Versailles) from 2009 to 2013. Our contribution is to use grammatical inference to build characteristic signatures of the Olfactory Receptor family, which will be used to scan directly 454-sequencing reads and available partial cDNAs of genes expressed in the antenna of Lepidoptera or deduced proteins.

7.2.3.3. ANR *Mirnadapt*

Participants: Jacques Nicolas, Catherine Belleannée, Anne Siegel, Valentin Wucher.

This ANR project is coordinated by UMR IGEPP, INRA Le Rheu (D. Tagu) and funded by ANR SVSE 6 "Génomique, génétique, bioinformatique, biologie systémique" from 2012 to 2014. This cooperation is strengthened by a co-tutored PhD thesis (V. Wucher). It proposes an integrative study between bioinformatics, genomics and mathematical modeling focused on the transcriptional basis of the plasticity of the aphid reproduction mode in response to the modification of environment. An important set of differentially expressed mRNAs and microRNAs are available for the two modes, asexual parthenogenesis and sexual reproduction. Our work is to combine prediction methods for the detection of putative microRNA/mRNA interactions as well as transcription factor binding sites from the knowledge of genomic sequences and annotations available on this and other insects. The results will be integrated within a coherent putative interaction network and serve as a filter for the design of new targeted experiments with the hope to improve functional annotations of implied genes.

7.2.3.4. ANR *Pelican*

Participant: François Coste.

The PELICAN project addresses competition for light in the ocean. It proposes an integrative genomic approach of the ecology, diversity and evolution of cyanobacterial pigment types in the marine environment, which arises from differences in the composition of the light-harvesting complexes (PBS). Our work is to build characteristic signatures of targeted PBS enzymes. This ANR project (génomique et biotechnologies végétales) is coordinated by F. Partensky (CRNS Roscoff) from 2010 to 2013.

7.2.4. Programs funded by research institutions

7.2.4.1. Inria Bioscience Ressource

Participants: Claudia Hériveau, Jacques Nicolas.

This project started in november 2011 and aims at promoting bioinformatics software and resources developed by Inria teams and their partners. A web portal will be deployed to allow users to test the software online. A tool is also developed to enhance the search of a specific resource using different criteria. The project is funded by Inria ADT program from 2011 to 2013, involves 8 research teams and is coordinated by the GenOuest platform and the Dyliss team (J. Nicolas and O. Collin).

7.2.4.2. PEPS VAG

Participants: François Coste, Jacques Nicolas, Clovis Galiez.

PEPS VAG started a collaboration between IMPMC UMR 7590, Institut de biologie de l'Ecole Normale Supérieure (IBENS) UMR8197, Atelier de Bioinformatique UPMC and Dyliss. It aims at defining the needs and means for a larger project about viruses in marine ecosystems. Indeed, we aim at developing new methods based on both sequential and structural information of proteins to improve the detection of viral sequences in marine metagenomes, to identify new viruses and to compare the viral populations specifically associated with different environment parameters (temperature, acidity, nutriments...) and ultimately to connect them with the potential hosts identified by population sequencing.

7.3. European Initiatives

7.3.1. Collaborations with Major European Organizations

Partner: EBI (Great-Britain)

Title: Modeling the logical response of a signalling network with constraints-programming.

Partner: Potsdam university (Germany)

Title: Constraint-based programming for the modelling and study of biological networks.

7.4. International Initiatives

7.4.1. Inria Associate Teams

7.4.1.1. INTEGRATIVEBIOCHILE

Title: Bioinformatics and mathematical methods for heterogeneous omics data

Inria principal investigator: Anne Siegel

International Partner (Institution - Laboratory - Researcher):

University of Chile (Chile) - Center for Mathematical Modeling - Alejandro Maass

Duration: 2011 - 2013

See also: <http://www.irisa.fr/dyliss/public/EA/index.html>

IntegrativeBioChile is an Associate Team between Inria project-team "Dyliss" and the "Laboratory of Bioinformatics and Mathematics of the Genome" hosted at CMM at University of Chile. The Associated team is funded from 2011 to 2013. The project aims at developing bioinformatics and mathematical methods for heterogeneous omics data. Within this program, we funded long and short stay visitings in France.

7.4.2. Inria International Labs

The Dyliss team is strongly involved in the Inria CIRIC center, and the research line "Omics integrative center": the associated team "IntegrativeBioChile", the post-doc of S. Thiele and the co-supervised of A. Aravena contribute to reinforce the complementarity of both Chilean and French teams. In 2013, a workshop was organized in Chile to develop new French-Chilean collaboration within the framework of the CIRIC center. See Sec. 7.2.1 for details.

7.4.3. Participation In other International Programs

7.4.3.1. Argentina - MinCYT-Inria 2011-13

Partner: Universidad Nacional de Cordoba, *Grupo de Procesamiento de Lenguaje Natural (PLN)*, Argentina.

Title: Modélisation linguistique de séquences génomiques par apprentissage de grammaires

Financial support: MinCYT-Inria program 2011-13

The projects aims at developing new grammatical inference methods to learn automatically linguistic models of genomic sequences.

7.4.3.2. International joint supervision of PhD

Title: Introduction des approches combinatoires dans des modèles probabilistes pour la découverte d'évènements de régulation d'un système biologique à partir de données hétérogènes [A. Aravena]

Inria principal investigator: Anne Siegel

International Partners (Institution - Laboratory - Researcher):

University of Chile (Chile) - Center of Mathematical Modelling - Alejandro Maass

Duration: Jul 2011 - Dec 2013

Title: Analyse automatisée et générique de réseaux métaboliques en nutrition [O. Abdou-Arbi]

Inria principal investigator: Anne Siegel

International Partner (Institution - Laboratory - Researcher):

University of Ouagadougou (Burkina Faso) - Department of mathematics - T. Tabsoba.

Duration: October 2010 - September 2013

Title: Applying logic programming to the construction of robust predictive and multi-scale models of bioleaching bacteria [S. Videla]

Inria principal investigator: Anne Siegel

International Partner (Institution - Laboratory - Researcher):

University of Postdam (Germany). Department of computer science. T. Schaub.

Duration: October 2011 - September 2014

7.5. International Research Visitors

7.5.1. Visits of International Scientists

- **Germany.** Department of Computer Science, Potsdam [T. Schaub]
- **Chile.** Centro de Modelamiento Matemático, Santiago [A. Maass, N. Loirà]
- **Burkina-Faso.** Laboratoire de mathématiques, Ouagadougou [T. Tabsoba]

7.5.1.1. Internships

Andres Aravena

Subject: Programmation par Ensemble-Réponse pour l'identification de régulateur clés en biologie des systèmes

Date: from Jan 2013 until Jul 2013

Institution: University of Chile (Chile)

7.5.2. Visits to International Teams

- **Burkina-Faso.** Department of Computer Science, Ouagadougou. *Multi-objective methods for the static analysis of metabolic network.* Jan. 2013 (1 month) [O. Abdou-Arbi]
- **Niger.** University of Maradi. *Multi-objective methods for the static analysis of metabolic network.* Feb. 2013 (1 month) [O. Abdou-Arbi]
- **UK** EMBL-European Bioinformatics Institute. *Learning logical rules for protein signaling networks.* Feb. 2013 (2 days) [A. Siegel, S. Thiele, S. Videla]
- **UK** Brunel University *Learning logical rules for protein signaling networks.* Feb. 2013 (3 days) [A. Siegel, S. Thiele, S. Videla]
- **Germany.** Max Planck Institute (Klamt lab), Magdeburg. *Application of ASP to the control of signaling networks.* June 2013 (2 days) [S. Thiele, S. Videla]
- **Argentina.** Departamento Universitario de Informática, Córdoba. *Collaboration on grammatical inference.* Jul. 2013 (14 days) [F. Coste]

- **Argentina.** Departamento Universitario de Informática, Cordoba. *Collaboration on grammatical inference.* Jul. 2013 (1 month) [G. Garet]
- **Germany.** Department of Computer Science, Potsdam. *Application of ASP to biology, meeting with Klamt and Schaub labs.* Oct 2013 (3 days) [A. Siegel, S. Videla]
- **Germany.** Department of Computer Science, Potsdam. *Application of ASP for sequence annotation.* Oct. Nov. Dec. 2013 (3 months) [G. Garet]
- **Chile.** Centro de Modelimiento Matematico, Santiago. *Applications of ASP.* Nov. & Dec 2013 (2 monthes) [S. Videla]
- **Chile.** Centro de Modelimiento Matematico, Santiago. *Metabolic modeling of bacteria.* Dec. 2013 (14 days) [D. Eveillard]
- **Chile.** Centro de Modelimiento Matematico, Santiago. *Data integration.* Dec. 2013 (7 days) [A. Siegel, S. Prigent, J. Laniau, V. Picard, F. Coste]

FLUMINANCE Project-Team

8. Partnerships and Cooperations

8.1. Regional Initiatives

8.1.1. Brittany concil ARED IMAGEO:

Participants: Cédric Herzet, Etienne Mémin, Véronique Souchaud.

duration 36 months. This project of the Brittany concil, which finances the PhD thesis of Véronique Souchaud, aims at studying methods for the estimation of reduced order modeling of fluid flows evolution laws from image sequences. The goal consists here at defining the estimation of a reduced basis describing the flow evolution as a motion estimation problem.

8.2. National Initiatives

8.2.1. ANR-COSINUS PREVASSEMBLE: Ensemble methods for assimilation of observations and for prevision in Meteorology and Oceanography

Participants: Sébastien Beyou, Anne Cuzol, Etienne Mémin.

duration 36 months.

The purpose of this project is to further study ensemble methods -, and to develop their use for both assimilation of observations and forecast. Among the specific questions to be studied are the theory of Particle Filters and Ensemble Kalman Filters, the possibility of taking temporal correlation into account in ensemble assimilation, the precise assessment of what can and cannot be achieved in ensemble prediction, and the objective validation of ensemble methods.

The partners of this project are Laboratoire de Météorologie Dynamique/ENS (leader), Météo-France and three Inria groups (ALEA, ASPI, FLUMINANCE).

8.2.2. ANR SYSCOMM MSDAG: MultiScale Data Assimilation in Geophysics

Participants: Patrick Héas, Dominique Heitz, Cédric Herzet, Etienne Mémin.

duration 36 months.

Changing scale is a well-known topic in physics (geophysics, fluid mechanics and turbulence, theoretical and statistical physics, mechanics, porous media, etc.). It has led to the creation of powerful sophisticated mathematical tools: renormalization, homogenization, etc. These ideas are also used in numerical analysis (the so-called multigrid approach) for solving efficiently partial differential equations. Data assimilation in Geophysics is a set of methods that allows to combine optimally numerical models in large spaces with large dataset of observations. At the confluence of these two topics, the goal of this project is to study how to embed the change of scales (a multiscale point of view) issue into the framework of geophysical data assimilation, which is a largely unexplored subject.

The partners of this 3 years project are the CEREAL/ CLIME Inria group (leader), the LSCE/CEA, the Inria groups MOISE and FLUMINANCE.

8.2.3. ANR SYSCOMM GeoFluids: Analyse et simulation d'écoulements fluides à partir de séquences d'images : application à l'étude d'écoulements géophysiques

Participants: Dominique Heitz, Etienne Mémin.

duration 48 months.

The project Geo-FLUIDS focuses on the specification of tools to analyze geophysical fluid flows from image sequences. Geo-FLUIDS aims at providing image-based methods using physically consistent models to extract meaningful features describing the observed flow and to unveil the dynamical properties of this flow. The main targeted application domains concern Oceanography and Meteorology . The project consortium gathers the Inria research groups: FLUMINANCE (leader), CLIME and MOISE. The group of the “Laboratoire de Météorologie Dynamique” located at the ENS Paris, the IFREMER-CERSAT group located at Brest and the METEOFRANCE GMAP group in Toulouse.

8.2.4. ANR JCJC GERONIMO : Advanced GEophysical Reduced-Order Model construction from Image Observations

Participant: Cédric Herzet.

duration 48 months. The GERONIMO project which starts in January 20014 aims at devising new efficient and effective techniques for the design of geophysical reduced-order models from image data. The project both arises from the crucial need of accurate low-order descriptions of highly-complex geophysical phenomena and the recent numerical revolution which has supplied the geophysical scientists with an unprecedented volume of image data. The project is placed in the intersection of several fields of expertise (Bayesian inference, matrix factorization, sparse representations, etc) which will be combined to handle the uncertainties associated to image measurements and to characterize the accurate reduced dynamical systems.

8.2.5. INSU-LEFE: Vers de nouvelles méthodes d'estimation de la sous-mésoéchelle océanique

Participants: Patrick Héas, Cédric Herzet.

duration 36 months. This project tackles the problem of deriving a precise submesoscale characterization of ocean currents from satellite data. The targeted methodologies should in particular enable the exploitation of data of different nature (for example sea surface temperature or height) and/or resolutions. This 36-month project benefits from a strong collaboration with Guillaume Lapeyre (Laboratoire de Météorologie Dynamique, Ecole Normale Supérieure, Paris).

GALEN Project-Team

8. Partnerships and Cooperations

8.1. Regional Initiatives

8.1.1. Excellence Clusters

- Program: DIGITEO (OMTE)
Project acronym: Curator
Project title: Real-time 2D/3D Deformable Fusion Towards Computer Assisted Surgery
Duration: 01/2013-01/2014
Coordinator: ECP - FR
- Program: MEDICEN
Project acronym: ADOC
Project title: ADOC – Diagnostic peropératoire numérique en chirurgie du cancer
Duration: 11/2011-10/2014
Coordinator: LLTECH - FR

8.2. National Initiatives

8.2.1. ANR

- Program: ANR Blanc International
Project acronym: ADAMANTIUS
Project title: Automatic Detection And characterization of residual Masses in pAtients with lymphomas through fusioN of whole-body diffusion-weighted mri on 3T and 18F-flUorodeoxyglucoSe pet/ct
Duration: 9/2012-8/2015
Coordinator: CHU Henri Mondor - FR
- Program: ANR JCJC
Project acronym: HICORE
Project title: HIERarchical COMpositional REpresentations for Computer Vision
Duration: 10/2010-9/2014
Coordinator: ECP - FR
- Program: ITMOs Cancer & Technologies pour la santé d'Aviesan / INCa
Project acronym: CURATOR
Project title: Slice-to-Image Deformable Registration towards Image-based Surgery Navigation & Guidance
Duration: 12/2013-11/2015
Coordinator: ECP - FR

8.3. European Initiatives

8.3.1. FP7 Projects

- Project acronym: MOBOT

Project title: Intelligent Active MObility Assistance RoBOT integrating Multimodal Sensory Processing, Proactive Autonomy and Adaptive Interaction

Duration: 01/2013-12/2015

Coordinator: TUM - DE

- Project acronym: RECONFIG

Project title: Cognitive, Decentralized Coordination of Heterogeneous Multi-Robot Systems

Duration: 01/2013-12/2015

Coordinator: KTH - SE

8.3.2. Collaborations in European Programs, except FP7

- Program: European Research Council

Project acronym: DIOCLES

Project title: Discrete bIOimaging perCeption for Longitudinal Organ modeling and computer-aided diagnosis

Duration: 9/2011-8/2016

Coordinator: ECP - FR

8.4. International Initiatives

8.4.1. Inria Associate Teams

8.4.1.1. SPLENDID

Title: Self-Paced Learning for Exploiting Noisy, Diverse or Incomplete Data

Inria principal investigator: Nikos Paragios

International Partner (Institution - Laboratory - Researcher):

Stanford University (United States) - Artificial Intelligence Lab - Nikos Paragios

Duration: 2012 - 2014

The goal of the project is to develop methods for learning accurate probabilistic models using diverse (consisting of fully and weakly supervised samples), incomplete (consisting of partially labeled samples) and noisy (consisting of mislabeled samples) data. To this end, we will build on the intuitions gained from self-paced human learning, where a child is first taught simple concepts using simple examples, and gradually increasing the complexity of the concepts and the examples. In the context of machine learning, we aim to impart the learner with the ability to iteratively adapt the model complexity and process the training data in a meaningful order. The efficacy of the developed methods will be tested on several real world computer vision and medical imaging applications using large, inexpensively assembled datasets.

8.4.2. Inria International Partners

8.4.2.1. Informal International Partners

Europe

- Technical University of Munich (DE) – Collaborative research with the Chair for Computer Aided Medical Procedures & Augmented Reality at the department of Computer Science. Collaboration Topic: Graph-based methods for linear/deformable registration, segmentation, and tracking.
- University College London (UK) – Collaborative research with the Gatsby Computational Neuroscience Unit. Collaboration Topic: Kernel measures of dependence.

- University of Oxford (UK) – Collaborative research with the Visual Geometry Group of the Department of the Electrical Engineering. Collaboration Topic: Structured prediction, invariance, and parts-based models.
- University of Oulu (Finland) – Collaborative research with the Machine Vision Group at the department of Electrical Engineering. Collaboration Topic: Ranking based learning algorithms for cascaded object detection.

Americas

- University of California at Los Angeles (US) – Collaborative research with the UCLA Vision Lab and the UCLA Center for Cognition, Vision, and Learning Lab at the Departments of Computer Science and Statistics. Collaboration Topic: Action Recognition & Object Detection Parsing.
- University of Pennsylvania (USA) – Collaborative research with the section of Biomedical Imaging of the Department of Radiology. Collaboration Topic: Graph-based methods for linear/deformable registration.
- StonyBrook University, Computer Science Department (USA) – Collaborative research with the image analysis lab in the context of the SubSample DIGITEO Chair. Collaboration Topic: Higher Order Graph-based methods in graph-matching, cocaine addiction analysis with sparse graph models, object detection and implicit 3D pose estimation
- Ecole Polytechnique de Montreal (CA) – Collaborative research with the Canada Research Chair in Medical Imaging and Assisted Interventions. Collaboration Topic: Higher Order Graph-based methods in Spine Imaging

Asia

- International Institute of Information Technology, Hyderabad (India) – Collaborative research with Center for Visual Information Technology. Collaboration Topic: Average precision with weak supervision & self-paced learning for deep convolutional neural networks.

8.5. International Research Visitors

8.5.1. Visits of International Scientists

Professor Spyretta Golemati lecturer at the school of medicine at the University of Athens has visited during her sabbatical the team from June 1st, 2013 to July 30th, 2013.

8.5.1.1. Internships

Siddhartha Chandra

Subject: machine learning for 3D reasoning.

Date: from May 2013 until December 2013.

Institution: IIIT Hyderabad (India)

Dimitrios Damopoulos

Subject: Automatic Detection and Characterization of Liver Tumors

Date: from Nov 2013 until Apr 2014

Institution: National Technical University of Athens (Greece)

José Ignacio Orlando

Subject: Machine Learning for Ophthalmology

Date: from Apr 2013 until Sep 2013

Institution: National University of the Center of the Buenos Aires Province (Argentina)

Eduard Trulls

Subject: Segmentation-aware descriptors

Date: from March 2013 until July 2013

Institution: Polytechnical University of Catalonia (Spain)

8.5.2. Visits to International Teams

- M. Pawan Kumar (Inria): one week visit to Stanford University (May 2013).
- M. Pawan Kumar (Inria): one week visit to Stanford University (June 2013).
- Matthew Blaschko (Inria): one week visit to Stanford University (December 2013).

GENSCALE Project-Team

8. Partnerships and Cooperations

8.1. Regional Initiatives

8.1.1. Program from Région Bretagne : MIRAGE

Participants: Liviu Ciortuz, Claire Lemaitre, Pierre Peterlongo.

The MIRAGE project is funded by Région Bretagne in the framework of the SAD call (Stratégie Attractivité Durable) which aims at attracting international post-doctorant for one year. The MIRAGE project was funded from Sept. 2012 until August 2013 and coordinated by C. Lemaitre. It enabled to hire Liviu Ciortuz as a postdoctoral student for 12 months, for developing new methods to detect complex variation (structural variations) in non-assembled NGS data.

8.1.2. Program from Région Bretagne : DGASP

Participants: Antonio Mucherino, Douglas Goncalves.

This project is funded by Région Bretagne in the framework of the SAD call (Stratégie Attractivité Durable), from April 2013 to March 2014 and coordinated by A. Mucherino. It enabled to hire Douglas Goncalves as a postdoctoral student for 12 months for working on a discretizable class of distance geometry problems. The project is in collaboration with Carlile Lavor (IMECC-UNICAMP, Brazil) and Jacques Nicolas (équipe Dyliss, IRISA).

8.1.3. Poly-BNF

Participants: Dominique Lavenier, Claire Lemaitre, Pierre Peterlongo, Erwann Scaon.

This projects aims to develop bioinformatics strategies for studying polyploid genomes. It is a one year project (09/2012 – 09/2013) funded by the University of Rennes 1. It is a joined project with CNRS/EcoBio lab and INRA/IGEPP lab in Rennes.

8.1.4. Partnership with IGDR

Participants: Dominique Lavenier, Claire Lemaitre, Pierre Peterlongo, Guillaume Rizk, Fabrice Legeai, Charles Deltel.

We collaborate with several teams of the Genomic and Development Institute of Rennes (IGDR) : Genetics of dog (detection of long non coding RNAs in collaboration with Thomas Derrien and Christophe Hitte) and Integrated Fonctional Genomics and Biomarkers (NGS analyses of glioblastoma cancer, project funded by INCa in collaboration with Marie de Tayrac and Jean Mosser).

8.1.5. Partnership with INRA

Participants: Dominique Lavenier, Claire Lemaitre, Pierre Peterlongo, Guillaume Rizk, Anaïs Gouin, Fabrice Legeai, François Moreews, Susete Alves Carvalho.

We have a strong and long term collaboration with biologists of INRA in Rennes : IGEPP and PEGASE units. This partnership concerns both service and research activities and is acted by the hosting of two engineers (F. Legeai, F. Moreews) and by the co-supervision of two non permanent engineers (A. Gouin, S. Alves Carvalho). In particular, the collaboration with the IGEPP team includes several research projects in which Genscale is formally a partner : an INRA project PEAPOL including an industrial partner, Biogemma, and an ANR project SPECIAPHID. These projects fund the non-permanent INRA members.

8.2. National Initiatives

8.2.1. ANR

8.2.1.1. MAPPI

Participants: Dominique Lavenier, Claire Lemaitre, Nicolas Maillet, Pierre Peterlongo.

The MAPPI project aims to develop new algorithms and Bioinformatics methods for processing high throughput genomic data. It is funded by ANR call COSINUS and coordinated by M. Raffinot (LIAFA, Paris VII) from Oct 2010 to Dec. 2013.

8.2.1.2. FATINTEGER

Participants: Dominique Lavenier, François Moreews.

The FatInteger project aims to identify some of the transcriptional key players of animal lipid metabolism plasticity, combining high throughput data with statistical approaches, bioinformatics and phylogenetic. It is funded by ANR call BLANC and coordinated by F. Gondret from 2012 to 2015.

8.2.1.3. SPECIAPHID

Participants: Anaïs Gouin, Fabrice Legeai, Claire Lemaitre.

The SPECIAPHID project aims to understand the adaptation and speciation of pea aphids by re-sequencing and comparing the genomes of numerous aphid individuals. Genscale's task, as associate partner, is to apply and develop new methods to detect variation between re-sequenced genomes, and in particular complex variants such as structural ones. It is funded by ANR call BLANC and coordinated by J-C Simon (Inra, Rennes) from January 2012 to Dec. 2014.

8.2.1.4. ADA-SPODO

Participants: Rumen Andonov, Dominique Lavenier, Fabrice Legeai, Claire Lemaitre, François Moreews, Pierre Peterlongo.

The ADA-SPODO project aims at identifying all sources of genetic variation between two strains of an insect pest : Lepidoptera Spodoptera frugiperda in order to correlate them with host-plant adaptation and speciation. Genscale's task is to develop new efficient methods to compare complete genomes along with their post-genomic and regulatory data. It is funded by ANR call BLANC and coordinated by E. d'Alençon (Inra, Montpellier) from October 2012 to Dec. 2015.

8.2.1.5. RAPSODYN

Participants: Dominique Lavenier, Claire Lemaitre, Pierre Peterlongo, Erwann Scaon.

RAPSODYN is a long term project funded by the IA French program (Investissement d'Avenir) for 7.5 years (07/2012-12/2019). The objective is the optimisation of the rapeseed oil content and yield under low nitrogen input. GenScale is involved in the bioinformatics workpackage to elaborate advanced tools dedicated to polymorphism.

8.2.1.6. COLIB'READ

Participants: Pierre Peterlongo, Claire Lemaitre, Dominique Lavenier, Fabrice Legeai, Guillaume Rizk.

The main goal of the Colib'Read project is to design new algorithms dedicated to the extraction of biological knowledge from raw data produced by High Throughput Sequencers (HTS). The project proposes an original way of extracting information from such data. Usually, a generic assembly (pre-treatment) is applied to the data, and then, in a second step, any information of interest is extracted. Our aim is to avoid this protocol that leads to a significant loss of information, or generates chimerical results because of the heuristics used in the assembly. Instead, the project will propose a set of innovative approaches for extracting information of biological interest from HTS data, with methods that bypass any costly and often inaccurate assembly phase, not requiring the availability of a reference genome. It is funded by ANR call BLANC and coordinated by P. Peterlongo from March 2013 to February 2016. <https://colibread.inria.fr/>

8.2.1.7. GATB

Participants: Dominique Lavenier, Erwan Drezen, Pierre Peterlongo, Claire Lemaitre, Guillaume Rizk.

GATB (Genome Assembly Tool Box) is a project that aims to provide algorithms and tools for genome assembly. The strength of these algorithms comes from the underlying structure that has a low memory footprint, which enables to assemble genomes on a simple desktop computer. The GATB project will provide several software components, such as low level libraries, binaries and pipelines providing a full spectrum of tools for genome assembly. It is a 2 years ANR project started in February 2013. <http://gatb.inria.fr>

8.2.2. Programs from research institutions

8.2.2.1. Mapsembler

Participants: Alexan Andrieux, Dominique Lavenier, Claire Lemaitre, Pierre Peterlongo.

The Mapsembler project aims at finalizing and to distributing the Mapsembler tool. It is funded by Inria ADT call (2012) and coordinated by P. Peterlongo from oct. 2012 to sept. 2014. <http://alcovna.genouest.org/mapsembler/>

8.2.2.2. Mastodons

Participants: Dominique Lavenier, Claire Lemaitre, Pierre Peterlongo.

This project, funded by the CNRS Big Data program in 2012 and 2013, aims do investigate the challenge brought by the processing of high throughput sequencing genomic data. It is coordinated by D. Lavenier from June 2012 to December 2013.

8.2.2.3. Barcoding de nouvelle génération

Participants: Dominique Lavenier, Claire Lemaitre, Pierre Peterlongo.

This project is a join initiative between Genscale and LECA (Laboratoire d'Ecologie Alpine in Grenoble). It aims at developping new algorithmic approaches for the species identification from low coverage NGS data. It is funded by a PEPS program at CNRS/Inria and coordinated by C. Lemaitre from Sept. 2012 to Dec. 2013.

8.2.2.4. Structuring of NGS for diagnostic purpose in cancer

Participants: Dominique Lavenier, Claire Lemaitre, Pierre Peterlongo.

This 18 months project is funded by the national institute of cancer (INCa). Genscale is involved in the optimization of bioinformatics workflows to detect variants in glioblastoma cancer.

8.2.3. Cooperations

8.2.3.1. Inria Bamboo Team

Participants: Claire Lemaitre, Pierre Peterlongo.

We maintain a long term collaboration with Inria Bamboo Team on the problems of finding biological information, such as variants, in NGS raw data.

8.2.3.2. LIGM, Paris

Participant: Pierre Peterlongo.

P. Peterlongo collaborates with the LIGM lab in Paris (UMR 8049), on problems of large NGS raw data indexation.

8.2.3.3. LIX

Participant: Antonio Mucherino.

A. Mucherino collaborates since 5 years with LIX, Ecole Polytechnique, in Palaiseau on the distance geometry problem. We reformulated the problem as a combinatorial optimization problem and we conceived an ad-hoc algorithm for the solution of this class of problems.

8.3. European Initiatives

8.3.1. Collaborations with Major European Organizations

Partner: CWI, University of Amsterdam, (Netherland)

Subject of cooperation: Optimization algorithms for protein structures alignments.

8.4. International Initiatives

8.4.1. Inria International Partners

8.4.1.1. Informal International Partners

Partner: IMECC, UNICAMP, Campinas-SP (Brazil)

Subject: distance geometry, bioinformatics.

Partner: COPPE, Federal University of Rio de Janeiro (Brazil)

Subject: distance geometry, bioinformatics.

Partner: Los Alamos National Laboratory (lanl), Los Alamos (USA)

Subjects: Combinatorial algorithms (shortest paths, graph partitioning, combinatorial optimization) and algorithm engineering (efficient implementation of combinatorial algorithms)

8.5. International Research Visitors

8.5.1. Visits of International Scientists

- Van-Hoa Nguyen from University of Angiang, Viet Nam, visited GenScale for 3 months (nov. 2012 - feb. 2013). The visit was funded by the French Mastodons program from CNRS to research focusing on bioinformatics big data problem.
- Fatima Sapundzhi and Boyana Garkova, PhD students from South-West University, Neofit Rilski, Blagoevgrad (Bulgaria), visited the team for one month in October 2013. The visit was funded by the bulgarian ministry and focused on ligand-protein interaction structure problems in collaboration with R. Andonov and M. Le Boudic-Jamin.

8.5.2. Visits to International Teams

- R. Andonov has been invited by the Information Sciences Group (CCS-3) from Los Alamos National Laboratory (LANL) for one month (15 July - 15 August 2013).

IBIS Project-Team

7. Partnerships and Cooperations

7.1. Regional initiatives

Project name	Identification structurelle et paramétrique des réseaux de régulation bactériens
Coordinator IBIS participants Type Web page	E. Cinquemani E. Cinquemani, J. Geiselmann, H. de Jong, D. Stefan Funding PhD grant, Cluster ISLE, Région Rhône-Alpes http://cluster-isle.grenoble-inp.fr/

Project name	Motilité ou adhésion : comment les entérobactéries choisissent entres ces deux états physiologiques déterminants pour la virulence
Coordinator IBIS participants Type	S. Lacour J. Demol, J. Geiselmann, S. Lacour, C. Pinel Grant, Cluster Infectiologie, Région Rhône-Alpes

Project name	Séminaire grenoblois des systèmes complexes
Coordinators IBIS participants Type Web page	S. Achard, O. François, A. Maignan, E. Prados, S. Rafai, D. Ropers D. Ropers Funding by Institut des Systèmes Complexes de Lyon (IXXI) http://www.ixxi.fr/?page_id=114&lang=fr

Project name	Séminaire de modélisation du vivant
Coordinators IBIS participants Type Web page	O. Gandrillon D. Ropers Funding by GdR BIM http://cgphimc.univ-lyon1.fr/CGphiMC/Semovi/Semovi.php

7.2. National initiatives

Project name	ColAge – Lifespan control in bacteria: Natural and engineering solutions
Coordinator IBIS participants Type Web page	H. Berry E. Cinquemani, J. Geiselmann, H. de Jong, S. Lacour, C. Pinel, D. Ropers Inria-Inserm Project Lab (2009-2013) http://colage.saclay.inria.fr

Project name	AlgeaInSilico: Prédire et optimiser la productivité des microalgues en fonction de leur milieu de croissance
Coordinator IBIS participants Type	O. Bernard H. de Jong Inria Project Lab (2013-)

Project name	GeMCo – Model reduction, experimental validation, and control for the gene expression machinery in <i>E. coli</i>
Coordinator IBIS participants Type Web page	M. Chaves E. Cinquemani, J. Geiselmann, C. Gomez Balderas-Barillot, E. Grac, H. de Jong, S. Lacour, C. Pinel, D. Ropers ANR Blanc (2010-2014) http://www-sop.inria.fr/members/Madalena.Chaves/ANR-GeMCo/main.html

Project name	RESET – Arrest and restart of the gene expression machinery in bacteria: from mathematical models to biotechnological applications
Coordinator IBIS participants Type Web page	H. de Jong E. Cinquemani, J. Geiselmann, C. Gomez Balderas-Barillot, E. Grac, H. de Jong, S. Lacour, Y. Markowicz, C. Pinel, D. Ropers Bioinformatics call, Investissements d’Avenir program (2012-2016) https://project.inria.fr/reset/

Project name	Fonction du système de régulation post-transcriptionnel CSR dans la dynamique de l’adaptation métabolique chez la bactérie modèle <i>Escherichia coli</i>
Coordinators IBIS participants Type Web page	M. Coccagn-Bousquet (Inra, LISBP), B. Enjalbert (INSA, LISBP), D. Ropers M. Morin, D. Ropers Contrat Jeune Scientifique Inra-Inria (2012-2016) http://www.inra.fr/les_hommes_et_les_femmes/rejoignez_nous/completer_sa_formation/le_recrutement_de_doctorants/cjs__1/inra_inria

7.3. International projects

Project name	French bioinformatics contribution to ICGC
Coordinator IBIS participants Type Web page	G. Thomas F. Rechenmann International Cancer Genome Consortium (ICGC) http://www.icgc.org/

The goal of ICGC (International Cancer Genome Consortium) is to obtain a comprehensive description of genomic, transcriptomic and epigenomic changes in 50 different cancer types. In France, INCa (French

National Cancer Institute) contributes to this project and focuses on two types of cancer. The main idea is to sequence the human genome of normal and tumoral cells of a large set of patients and to compare these genomic sequences to identify the mutations which may explain the development of the cancers. Bioinformatics is clearly involved in the management, the analysis and the visualization of the huge sets of data and results. Bioinformatics of the French contribution is carried out at Lyon, in the context of the Synergie Lyon Cancer Foundation. Until this year, François Rechenmann was part of the bioinformatics team and contributed to the organization of the data management and analysis workflow, under the leadership of prof. Gilles Thomas.

7.4. International collaborations

IBIS has strong collaborations with the group of Giancarlo Ferrari-Trecate at the Computer Engineering & Systems Science Department of the University of Pavia (Italy) and the group of John Lygeros at the Automatic Control Lab at ETH Zürich (Switzerland). This collaboration started with the FP6 project Hygeia, in which the above groups and IBIS (then HELIX) participated. Over the years, it has resulted in a dozen of co-authored papers and the co-supervision of a PhD thesis by Hidde de Jong and Giancarlo Ferrari-Trecate. Eugenio Cinquemani was a post-doctoral fellow at ETH in the framework of the Hygeia project, and joined the IBIS group as a research scientist in the fall of 2009. Andres Gonzales-Vargas, PhD student of Giancarlo Ferrari-Trecate, will spend six months in IBIS in 2014.

7.5. International research visitors

Invited professor Subject	Andreas Kremling (Technische Universität München) Modeling of carbon catabolite repression in <i>E. coli</i>
Invited professor Subject	Alberto Soria-López (Centro de Investigación y de Estudios Avanzados of Instituto Politécnico Nacional (IPN), Mexico) Development of an automatically-controlled system of parallel mini-bioreactors

M3DISIM Team

7. Partnerships and Cooperations

7.1. Regional Initiatives

The team is part of the Mechanics and Living Systems Initiative (**Opération Mécanique et Systèmes du Vivant**), a joint operation – focused on biomechanical modeling – between the LadHyx and LMS labs (CNRS and Ecole Polytechnique), and Inria.

7.2. European Initiatives

7.2.1. FP7 Projects

7.2.1.1. VPH-Share

Title: VPH-Share

Type: COOPERATION

Defi: Towards sustainable and personalised healthcare

Instrument: Integrated Project

Objectif: Virtual Physiological Human

Duration: March 2011 - February 2015

Coordinator: Univ. Sheffield (UK)

Other partners: Cyfronet (Cracow), University College London, Istituto Ortopedico Rizzoli (Bologna), NHS, IBM Israel, Univ. Auckland, Agència d'Informació, Avaluació i Qualitat en Salut (Barcelona), Biocomputing Competence Centre (Milano), Universitat Pompeu Fabra (Barcelona), Philips Research, TUE (Eindhoven), Sheffield Teaching Hospitals, Atos Origin (Madrid), the Open University (UK), Univ. Vienna, King's College London, Empirica (Bonn), Fundació Clínic (Barcelona), Univ. Amsterdam

See also: <http://vph-share.org/>

Abstract: VPH-Share aims at developing the organisational fabric (the infostructure) and integrate the optimised services to expose and share data and knowledge, to jointly develop multiscale models for the composition of new VPH workflows, and to facilitate collaborations within the VPH community. Within this project, the Macs team is in charge of developing some high-performance data assimilation software tools.

7.2.1.2. VP2HF

Title: Computer model derived indices for optimal patient-specific treatment selection and planning in Heart Failure

Type: COOPERATION

Defi: ICT for Health, Ageing Well, Inclusion and Governance

Instrument: Specific Targeted Research Project

Objectif: Virtual Physiological Human

Duration: October 2013 - September 2016

Coordinator: King's College London (UK)

Abstract: Heart failure (HF) is one of the major health issues in Europe affecting 6 million patients and growing substantially because of the ageing population and improving survival following myocardial infarction. The poor short to medium term prognosis of these patients means that, treatments such as cardiac re-synchronisation therapy and mitral valve repair can have substantial impact. However, these therapies, are ineffective in up to 50% of the treated patients and involve significant morbidity and substantial cost. The primary aim of VP2HF is to bring together image and data processing tools with statistical and integrated biophysical models mainly developed in previous VPH projects, into a single clinical workflow to improve therapy selection and treatment optimisation in HF.

MAGIQUE-3D Project-Team

8. Partnerships and Cooperations

8.1. Regional Initiatives

The PhD fellowship of Elodie Estecahandy is partially (50%) funded by the Conseil Régional d'Aquitaine.

The PhD fellowship of Vanessa Mattesi is partially (50%) funded by the Conseil Régional d'Aquitaine.

The Post-Doctoral fellowship of Juliette Chabassier is partially (50%) funded by the Conseil Général des Pyrénées Atlantiques.

The Post-Doctoral fellowship of Ángel Rodríguez Rozas is partially (50%) funded by the Conseil Régional d'Aquitaine.

8.2. National Initiatives

8.2.1. Depth Imaging Partnership

Magique-3D maintains active collaborations with Total. In the context of Depth Imaging, Magique-3D coordinates research activities dealing with the development of high-performance numerical methods for solving wave equations in complex media. This project involves 2 other Inria Team-Projects (Hiepac and Nachos) which have complementary skills in mathematics, computing and in geophysics. DIP is fully funded by Total by the way of an outline agreement with Inria .

Since its beginning (2009), eight PhD students have been funded and Magique 3D has hired six of them, one being shared with the project team Nachos (<http://www-sop.inria.fr/nachos/>). Moreover, several internships have been realized. 2013 was a particular year for the project because Total decided to extend DIP for five years. It has been necessary to update the legal framework of the project which explains that the second phase of DIP will officially begin in 2014. Nevertheless, in order to preserve the dynamic of the project, Magique-3D has hired an internship, Wilfredo Salazar, coming from the Engineering school INSA at Rouen.

8.2.2. Micro-local analysis of wave equations

The numerical solution of wave equations most often requires to truncate the propagation domain to define a computational domain limited by an artificial boundary. Magique-3D is very involved in the construction and mathematical validation of boundary conditions which are set on the artificial boundary. Different techniques can be used for the design of such conditions and Magique-3D maintains a collaboration with Prof. Olivier Lafitte from the University of Paris 13 on the mathematical analysis of the Dirichlet-to-Neumann (DtN) operator for acoustic waves. This issue is addressed by applying micro-local analysis which enables us to consider the full DtN operator in the whole space of frequencies.

8.2.3. Partnership with the department DMAE of ONERA

title: Modeling of multiperforated plates

Coordinator: Sébastien Tordeux

Other partners: Department DMAE of ONERA

Abstract: In the aeronautic industry, there is a need of numerical models for the design of turboreactors of new generation. Magique-3D is cooperating with the department DMAE of ONERA to develop acoustic models of multiperforated plates which is an important component of the turboreactors.

This project is interdisciplinary, since it involves the experimental expertise of Estelle Piot (acoustician engineer of ONERA working on acoustic bench), the competences in mathematical modeling of Magique 3D. In parallel to the obtention of new theoretical results we are jointly developing a new

numerical library based on the discontinuous Galerkin approximation which aims in interpreting experimental data.

This cooperation is formalized thanks to the common supervision of the PhD of Vincent Popie funded by ONERA and DGA and is a follow-up of the ANR APAM (2008-2011).

8.3. European Initiatives

8.3.1. FP7 Projects

8.3.1.1. HPC-GA

Title: High Performance Computing for Geophysics Applications

Type: PEOPLE

Instrument: International Research Staff Exchange Scheme (IRSES)

Duration: January 2012 - December 2014

Coordinator: Inria (France)

Others partners: BCAM (Basque Center of Applied Mathematics), Spain; BRGM (Bureau de Recherches Géologiques et Minières), France; ISTerre (Institut des Sciences de la Terre, France; UFRGS (Federal University of Rio Grande do Sul), Institute of Informatics, Brazil; UNAM (National Autonomous University of Mexico), Institute of Geophysics, Mexico;

See also: <https://project.inria.fr/HPC-GA/en>

Abstract: Simulating large-scale geophysics phenomenon represents, more than ever, a major concern for our society. Recent seismic activity worldwide has shown how crucial it is to enhance our understanding of the impact of earthquakes. Numerical modeling of seismic 3D waves obviously requires highly specific research efforts in geophysics and applied mathematics, leveraging a mix of various schemes such as spectral elements, high-order finite differences or finite elements.

But designing and porting geophysics applications on top of nowadays supercomputers also requires a strong expertise in parallel programming and the use of appropriate runtime systems able to efficiently deal with heterogeneous architectures featuring many-core nodes typically equipped with GPU accelerators. The HPC-GA project aims at evaluating the functionalities provided by current runtime systems in order to point out their limitations. It also aims at designing new methods and mechanisms for an efficient scheduling of processes/threads and a clever data distribution on such platforms.

The HPC-GA project is unique in gathering an international, multidisciplinary consortium of leading European and South American researchers featuring complementary expertise to face the challenge of designing high performance geophysics simulations for parallel architectures: UFRGS, Inria, BCAM and UNAM. Results of this project will be validated using data collected from real sensor networks. Results will be widely disseminated through high-quality publications, workshops and summer-schools.

Three members of MAGIQUE-3D (Julien Diaz, Victor Péron and Angel Rodríguez Rozas) participated to the second Workshop of HPC-GA in Bilbao on March 11th-15th, 2013, <http://www.bcamath.org/en/workshops/second-workshop-of-the-hpc-ga-project>.

Manuela Longoni de Castro, Assistant Professor at UFRGS, spent one month in MAGIQUE-3D in January 2013.

8.3.2. Collaborations in European Programs, except FP7

8.3.2.1. AKELARRE

Joint project with BCAM (Basque Center of Applied Mathematics) funded by the Conseil Régional d'Aquitaine and the Basque Government in the framework of the Aquitaine-Euskadi Call. Total Amount: 14 000 euros.

Program: Fonds commun de coopération Aquitaine/Euskadi

Project acronym: AKELARRE

Project title: Méthodes numériques innovantes et logiciels performants pour la simulation de la propagation des ondes électromagnétiques en milieux complexes

Duration: février 2011 - février 2013

Coordinator: Hélène Barucq

Other partners: BCAM (Basque Center of Applied Mathematics), Spain

Abstract: This project brings together complementary skills of two research teams which are respectively located in Pau and Bilbao. The main objective of this collaboration is to develop innovative numerical methods in the field of wave propagation and to implement powerful software for the simulation of electromagnetic waves in complex media. These waves play an important role in many industrial applications and the development of such software is of great interest for many industrial enterprises located in the region. Theoretical and practical issues are considered. In particular, we focus on the mathematical analysis of boundary conditions that play a crucial role for accurate numerical simulations of waves.

8.3.2.2. *Procope Inria - TU Berlin*

Joint project with the Matheon Research Center in Berlin funded by the European Union in the framework of the Procope 2012 Call. Total Amount: 2800 euros.

Program: PHC Procope 2012

Project acronym: Procope Inria - TU Berlin

Project title: Procope Inria - TU Berlin

Duration: January 2012 - December 2013

Coordinator: Sébastien Tordeux

Other partners: Matheon Research Center, TU Berlin, Germany

Abstract: This project aims in funding trips between Pau and Berlin. The young research group of Kersten Schmidt and Magique 3D are both specialist of the modeling and the simulation of the wave propagation phenomena. During this program we focus on the modeling of multiperforate plates which are present in the combustion chambers; on the derivation of absorbing boundary conditions for stratified media and on the development of precise numerical methods in the context of the Hardy problem.

In this framework several members of Magique 3D visited the Matheon Research Center in Berlin :

- Julien Diaz, May 7th to May 10th
- Victor Péron spent one week in Berlin in November
- Juliette Chabassier spent one month in Berlin

and several members of Matheon Research Center visited Magique 3D :

- Kersten Schmidt spent one week in Pau in November
- Robert Gruhlke spent one week in Pau in November
- Philipp Kliewe spent one week in Pau in November
- Dirk Klindworth spent one week in Pau in December
- Maxim Zeinaliyev spent two weeks in Pau in December

8.4. International Initiatives

8.4.1. Inria International Partners

8.4.1.1. MAGIC

Program: Inria International Partner

Title: Advance Modelling in Geophysics

Inria principal investigator: H el ene Barucq

International Partner (Institution - Laboratory - Researcher):

California State University at Northridge (United States) - Department of Mathematics -
Rabia Djellouli

The Associated Team MAGIC was created in January 2006 and renewed in January 2009. At the end of the program in December 2011, the two partners, MAGIQUE-3D and the California State University at Northridge (CSUN), decided to continue their collaboration and obtained the ‘‘Inria International Partner’’ label in 2013.

See also: <https://project.inria.fr/magic/>

The ultimate objective of this research collaboration is to develop efficient solution methodologies for solving inverse problems arising in various applications such as geophysical exploration, underwater acoustics, and electromagnetics. To this end, the research program will be based upon the following three pillars that are the key ingredients for successfully solving inverse obstacle problems: 1) The design of efficient methods for solving high-frequency wave problems. 2) The sensitivity analysis of the scattered field to the shape and parameters of heterogeneities/scatterers. 3) The construction of higher-order Absorbing Boundary Conditions.

 elodie  est echandy defended her PhD thesis, *Contribution   l’analyse math ematique et   la r esolution num erique d’un probl eme inverse de scattering  lasto-acoustique*, on September 19th 2013. She has been coadvised by H el ene Barucq and Rabia Djellouli in the framework of MAGIC.

Rabia Djellouli visited MAGIQUE-3D in September 2013.

8.4.2. Participation In other International Programs

8.4.2.1. HOSCAR

Program: Inria-CNPq

Title: High performance cOmputing and SCientific dAta management dRiven by highly demanding applications

Inria principal investigator: St ephane Lanteri (Nachos, Inria Sophia Antipolis-M editerran ee)

International Partners:

LNCC (Laborat rio Nacional de Computa o Cient fica), Brazil;

COPPE/UFRJ (Instituto Alberto Luiz Coimbra de P os-Gradua o e Pesquisa de Engenharia/Alberto Luiz Coimbra Institute for Graduate Studies and Research in Engineering, Universidade Federal do Rio de Janeiro), Brazil;

INF/UFRGS (Instituto de Inform tica, Universidade Federal do Rio Grande do Sul);

LIA/UFC (Laborat rios de Pesquisa em Ci ncia da Computa o Departamento de Computa o, Universidade Federal do Cear ).

Inria Teams :

NACHOS, Inria Sophia Antipolis - M editerran ee;

ZENITH, Inria Sophia Antipolis - M editerran ee;

MOAIS, Inria Grenoble - Rhone-Alpes;

HIEPACS, Inria Bordeaux - Sud-Ouest;

MOAIS, Inria Bordeaux - Sud-Ouest;

MAGIQUE 3D, Inria Bordeaux - Sud-Ouest;

Duration: 2012-2015

See also: <http://www-sop.inria.fr/hoscar/>

HOSCAR is a CNPq - Inria collaborative project between Brazilian and French researchers, in the field of computational sciences, also sponsored by the French Embassy in Brazil. It is coordinated by the team-project Nachos

The general objective of the project is to setup a multidisciplinary Brazil-France collaborative effort for taking full benefits of future high-performance massively parallel architectures. The targets are the very large-scale datasets and numerical simulations relevant to a selected set of applications in natural sciences: (i) resource prospection, (ii) reservoir simulation, (iii) ecological modeling, (iv) astronomy data management, and (v) simulation data management. The project involves computer scientists and numerical mathematicians divided in 3 fundamental research groups: (i) numerical schemes for PDE models, (ii) scientific data management, and (iii) high-performance software systems. Several Brazilian institutions are participating to the project among which: LNCC (Laboratório Nacional de Computação Científica), COPPE/UFRJ (Instituto Alberto Luiz Coimbra de Pós-Graduação e Pesquisa de Engenharia/Alberto Luiz Coimbra Institute for Graduate Studies and Research in Engineering, Universidade Federal do Rio de Janeiro), INF/UFRGS (Instituto de Informática, Universidade Federal do Rio Grande do Sul) and LIA/UFC (Laboratórios de Pesquisa em Ciência da Computação Departamento de Computação, Universidade Federal do Ceará). The French partners are research teams from several Inria research centers. MAGIQUE-3D is involved by the way of its research activities on finite element approximations which can be used for resource prospection and reservoir simulation. Several members of MAGIQUE-3D participated to the third workshop of the project in Bordeaux, Sep 2nd to 6th 2013 [69], [46], [60], [78]. In the framework of HOSCAR, Théophile Chaumont-Frelet who is a PhD student in Magique-3D, spent two weeks in August 2013 at the LNCC to initiate a collaboration with Prof. F. Valentin on the development of new finite element methods for the Helmholtz equation.

8.4.2.2. *GEO3D*

Program: Inria-Russia

Title: Models and numerical simulations in Geosciences: wave propagation in complex media

Inria principal investigator: Sébastien Tordeux

International Partner (Institution - Laboratory - Researcher):

Novosibirsk State University (Russia (Russian Federation)) - Institute of Numerical Mathematics and Mathematical Geophysics - Sébastien Tordeux

Duration: January 2012 - December 2014

See also: <http://uppa-inria.univ-pau.fr/m3d/ConfFR/participants.html>

GEO3D is a collaborative project between Magique 3D team-project (Inria Bordeaux Sud-Ouest) and the Institute of Numerical Mathematics and Mathematical Geophysics (Novosibirsk State University) and the Institute of Petroleum Geology and Geophysics, of in the context of geosciences.

We are mainly interested in the derivation of numerical methods (discontinuous Galerkin approximation, space-time refinement), the design of direct and inverse high performance solver, and the modeling of complex media.

More precisely, we are actually interested

1. in the computation of truncated Singular Value decomposition of very large matrix to analyze the inverse problem;
2. in the coupling of a discontinuous Galerkin method with a finite differences method for the direct problem;
3. in a spectral time stepping method for the direct problem;
4. in an algorithm to determine an impedance coefficient using indirect measurement.

Several researchers from the Institutes of Novosibirsk visited MAGIQUE-3D in 2013

- Serguey Kabanikhin spent one week in June 2013
- Maxim Shishlenin spent one month in June 2013 as invited Professor
- Vadim Lisitsa spent one month in September 2013
- Vladimir Tcheverda spent one month in September 2013

Several researchers from MAGIQUE-3D visited the Institute of Numerical Mathematics and Mathematical Geophysics in 2013

- Julien Diaz spent two weeks in February 2013
- Vanessa Mattesi spent three weeks in February 2013
- Sébastien Tordeux spent three weeks in February 2013
- Sébastien Tordeux spent two weeks in February 2013
- Vincent Popie spent two weeks in October 2013

8.5. International Research Visitors

8.5.1. Visits of International Scientists

- Patrick Dular (Université de Liège) spent two months MAGIQUE-3D between January 2013 and April 2013 as invited Professor.
- Manuela Longoni de Castro, Assistant Professor at UFRGS, spent one month in MAGIQUE-3D in January 2013.
- Serguey Kabanikhin spent one week in June 2013
- Maxim Shishlenin spent one month in June 2013 as invited Professor
- Vadim Lisitsa, Assistant Professor at Novossibirsk State University, spent one month in MAGIQUE-3D in September 2013.
- Vladimir Tcheverda, Professor at Novossibirsk State University, spent one month in MAGIQUE-3D in September 2013.

MAGNOME Project-Team

8. Partnerships and Cooperations

8.1. Regional Initiatives

8.1.1. Aquitaine Region “SAGESS” comparative genomics for wine starters.

This project is a collaboration between the company BioLaffort, specialized in the selection of industrial yeasts with distinct technological abilities, with the ISVV and MAGNOME. The goal is to use genome analysis to identify molecular markers responsible for different physiological capabilities, as a tool for selecting yeasts and bacteria for wine fermentation through efficient hybridization and selection strategies. This collaboration has obtained the INNOVIN label.

8.2. National Initiatives

8.2.1. ANR MYKIMUN.

Signal Transduction Associated with Numerous Domains (STAND) proteins play a central role in vegetative incompatibility (VI) in fungi. STAND proteins act as molecular switches, changing from closed inactive conformation to open active conformation upon binding of the proper ligand. Mykimun, coordinated by Mathieu Paoletti of the IBGC (Bordeaux), studies the postulated involvement of STAND proteins in heterospecific non self recognition (innate immune response).

In MYKIMUN we extend the notion of fungal immune receptors and immune reaction beyond the *P. anserina* NWD gene family. We develop *in silico* machine learning tools to identify new potential PRRs based on the expected characteristics of such genes, in *P. anserina* and beyond in additional sequenced fungal genomes. This should contribute to extend concept of a fungal immune system to the whole fungal branch of the eukaryote phylogenetic tree.

8.3. European Initiatives

8.3.1. FP7 Projects

A major objective of the “post-genome” era is to detect, quantify and characterise all relevant human proteins in tissues and fluids in health and disease. This effort requires a comprehensive, characterised and standardised collection of specific ligand binding reagents, including antibodies, the most widely used such reagents, as well as novel protein scaffolds and nucleic acid aptamers. Currently there is no pan-European platform to coordinate systematic development, resource management and quality control for these important reagents.

MAGNOME is an associate partner of the FP7 “Affinity Proteome” project coordinated by Prof. Mike Taussig of the Babraham Institute and Cambridge University. Within the consortium, we participate in defining community for data representation and exchange, and evaluate knowledge engineering tools for affinity proteomics data.

8.3.2. Collaborations with Major European Organizations

Prof. Mike Taussig: Babraham Institute & Cambridge University
Knowledge engineering for Affinity Proteomics
Henning Hermjakob: European Bioinformatics Institute
Standards and databases for molecular interactions

8.4. International Initiatives

8.4.1. Inria Associate Teams

MAGNOME participates in the CARNAGE associated team, coordinated by AMIB, with the Russian Academy of Sciences.

8.4.2. Inria International Partners

8.4.2.1. Declared Inria International Partners

AMAVI

Program: Inria International Partner

Title: Combinatorics and Algorithms for the Genomic sequences

Inria principal investigators: David Sherman

International Partner (Institution - Laboratory - Researcher):

Vavilov Institute of General Genetics (Russia (Russian Federation)) - Department of Computational Biology - Vsevolod Makeev

Duration: 2010 - present

VIGG and AMIB teams has a more than 12 years long collaboration on sequence analysis. The two groups aim at identifying DNA motifs for a functional annotation, with a special focus on conserved regulatory regions. In the current 3-years project CARNAGE, our collaboration, that includes Inria-team MAGNOME, is oriented towards new trends that arise from Next Generation Sequencing data. Combinatorial issues in genome assembly are addressed. RNA structure and interactions are also studied.

The toolkit is pattern matching algorithms and analytic combinatorics, leading to common software.

8.4.2.2. Informal International Partners

MAGNOME collaborates with Rodrigo Assar of the Universidad Andrés Bello, and Nicolás Loira and Alessandro Maass of the Center for Genomic Regulation, in Santiago de Chile (Chile).

8.4.3. Participation in other International Programs

MAGNOME and the VIGG of the Russian Academy of Sciences (RAS) in Moscow are partners in a project funded by the CNRS and the RAS entitle "Séquence profonde de organismes biotechnologiques : des régulateurs à l'adaptation".

8.5. International Research Visitors

8.5.1. Visits of International Scientists

Vsevolod MAKEEV November 8-22 2013

Artëm KASIANOV November 8-22 2013

8.5.1.1. Internships

Joaquin FERNANDEZ September-November 2013

MASAIE Project-Team

6. Partnerships and Cooperations

6.1. International Initiatives

6.1.1. Inria International Labs

MASAIE is the Inria EPI partner of GRIMCAPE (LIRIMA). It also has strong collaboration with M2IPE2S (LIRIMA). Two PhD students (Diaby and Diouf) are members of M2IPE2S.

G. Sallet has participated to "Journées du LIRIMA", Rabat, Morocco, September 17th-19th, 2013.

6.1.2. Participation In other International Programs

6.1.2.1. CAPES-COFECUB

MASAIE is the french correspondent in a cooperation program with Brazil. This project, funded by CAPES-COFECUB, "new methods in epidemiology and early detection of events" has begun in January 2011.

A Brazilian network has been built in 2011, and it is composed of

- FGV (Fundação Getulio Vargas) Rio de Janeiro. Principal investigator: Jair Koiller.
- UFF (Universidade Federal Fluminense) Rio de Janeiro. Principal investigator: Max Oliveira de Souza.
- UNICAMP (Universidade Estadual de Campinas) Campinas. Principal investigator: Hyun Mo Yang.
- Fondation Oswaldo Cruz (Fiocruz, Rio). Principal investigator: Claudia Codeço.
- IMPA Rio de Janeiro. Principal investigator: Jorge Zubelli.

6.1.2.2. PAES-UEMOA

A research project on Bilharzia was deposited November 2, 2012, by the universities of Ouagadougou and Gaston Berger of Saint-Louis, in the framework of PAES(projet d'appui à l'enseignement supérieur) of UEMOA (Union Economique et Monétaire de l'Afrique de l'Ouest). MASAIE is an important component of this network. This project has been accepted July, 1, 2012 and funded with 30 000 000 CFA (XOF) (≈ 45 000 euro).

The Phd thesis of Lena Tendeng and M. Diaby (MASAIE and UGB St Louis) are part of this project.

6.2. International Research Visitors

6.2.1. Visits of International Scientists

Jorge Zubelli, professor at IMPA, Rio de Janeiro, Brazil, december 2013. We started a collaboration on the analysis of PDE models for stage-structured intra-host models.

6.2.2. Visits to International Teams

In the framework of CAPES-COFECUB, G. Sallet has visited FGV and UFF (Rio de Janeiro) from March 2 to March 11, and from November 4 to November 16, 2013. A. Iggidr has visited FGV and UFF (Rio de Janeiro) and UNICAMP (Sao Paulo) from April 19 to May 12 and from October 22 to November 12, 2013.

MNEMOSYNE Team

7. Partnerships and Cooperations

7.1. National Initiatives

7.1.1. ANR

7.1.1.1. ANR project KEOPS

Participants: Frédéric Alexandre, Thierry Viéville.

We are responsible for this “ANR Internal White Project” involving Mnemosyne and Neuromathcomp Inria Project-Teams in France with the U. of Valparaiso, U. Tecnica Frederico Santa-Maria, and U. Chile. The project addresses the integration of non-standard behaviors of retinal neural sensors, observed in natural conditions, into neural coding models and their translation into real, highly non-linear, bio-engineering artificial solutions. This project is now a four year project until the end of 2014, it has been evaluated by the reviewers at the end of 2013. Results concerning the thalamus and the retina evoked in § 6.3 and § 6.4 have been obtained in this project. Furthermore, new collaboration tracks have been conducted, taking benefit of interdisciplinarity of this international collaboration, e.g. at the methodological level [1].

7.2. International Initiatives

7.2.1. Inria Associate Teams

7.2.1.1. Cortina, associate team with Chile

Participants: Frédéric Alexandre, Thierry Viéville.

The goal of this associate team that finished this year is to combine our complementary expertise, from experimental biology and mathematical models (U de Valparaiso and U Federico Santa-Maria) to computational neuroscience (Mnemosyne and Neuromathcomp Project-teams), in order to develop common tools for the analysis and formalization of neural coding and related sensory-motor loops. Recording and modeling spike trains from the retina neural network, an accessible part of the brain, is a difficult task that our partnership can address, what constitute an excellent and unique opportunity to work together sharing our experience and to focus in developing computational tools for methodological innovations.

7.2.2. Inria International Partners

7.2.2.1. Informal International Partners

We have informal relations with the Computational Cognitive Neuroscience (CCN) Lab, University of Colorado, Boulder, USA (Prof. Randall O’Reilly) concerning the computationally-based understanding of the neural circuits involved in affectively-driven decision making, including the basal ganglia (BG) and ventral and medial prefrontal cortex areas.

7.3. International Research Visitors

7.3.1. Visits of International Scientists

7.3.1.1. Invited Professor

Prof. Adrian Palacios, responsible for the chilean part of our associate team Cortina (*cf.* § 7.2) has been visiting Bordeaux one month in September 2013. He was also partly supported by the Labex BRAIN.

7.3.1.2. Internships

Meropi Topalidou

Subject: Touch and the Body

Date: from Mar 2013 until Sep 2013

Institution: Université Nationale Capodistrienne d'Athènes (Greece)

Román Gorojovsky

Subject: Hierarchical Associative Memories

Date: from Apr 2013 until Oct 2013

Institution: University of Buenos Aires (Argentina)

7.3.2. Visits to International Teams

From mid-july to end of August, Maxime Carrere, a newly-hired PhD student in the team, has visited the CCN lab in Boulder, USA (*cf.* § 7.2) for 6 weeks.

MODEMIC Project-Team

7. Partnerships and Cooperations

7.1. Regional Initiatives

7.1.1. Numev

Within the Labex Numev (Solutions Numériques, Matérielles et Modélisation pour L'Environnement et le Vivant [⁶]), the team is the coordinator since 2012 of a working group on Modeling and numerical probabilities for ecology and biology with the team EPS of I3M (Univ. Montpellier 2) [⁷].

7.1.2. LBE

An new interlab seminar about the modeling of bioprocesses has been launched in July 2013 under the responsibility of J. Harmand, involving Biocore and Modemic Inria project-teams [⁸].

7.2. National Initiatives

7.2.1. ANR project “DISCO”

DISCO (Multi-scale modeling bioDiversity Structure COupling in biofilms) is a project funded by the ANR SYSCOMM since the end of 2009, that ended in May 2013. Modemic has been the coordinator and other partners were Irstea LISC (Clermont-Ferrand), Irstea HBAN (Antony), Inra LBE (Narbonne) and CNRS/UMPC LPMTc (Paris VI). The objectives were to develop and study computational and mathematical models of biofilm dynamics, taking into account the biodiversity (distribution of bacteria species) and the spatial structure. The project had a strong multi-disciplinary dimension, gathering specialists of IBM study and reduction techniques, mathematical analysis of ecosystems modeling, multi-scale modeling of complex structures and dynamics, wastewater engineering and biodiversity measurements through DNA fingerprints, and solid waste biodegradation and microscopic biofilm structure imaging. During the project, several kinds of models (individual-based up to deterministic continuous) have been developed and confronted to experimental data at both micro and macroscopic scales. For the closing of the projet, the team has organized a one day meeting in Paris, combining a project restitution and an international workshop [⁹].

7.2.2. RNSC project “MnMs”

This year, a partial support of the continuation of the ANR DISCO has been funded for two years by the RNSC (National Network on Complex Systems). The MnMs (Numerical Models for Microbial ecosystems) project [¹⁰] aims at studying how to articulate existing models (discrete, continuous, deterministic, stochastic...) in a multi-scale framework with interactions between various scales. The team is the coordinator and the other partners are Irstea LISC (Clermont-Ferrand) and CNRS/UMPC LPMTc (Paris VI).

We organized a joint seminar with the project DyLeRBio of the RNSC (M. Desroches, Sisyph/Mycenae projet-team) in Montpellier (September 30, October 1-2 2013) [¹¹].

⁶<http://www.lirmm.fr/numev>

⁷<http://www-sop.inria.fr/members/Fabien.Campillo/gt-modelisation/>

⁸<https://sites.google.com/site/journeesthematiquesdulbe/home>

⁹<https://sites.google.com/site/anrdisco/>

¹⁰<http://www-sop.inria.fr/members/Fabien.Campillo/mnms/>

¹¹<http://www-sop.inria.fr/members/Fabien.Campillo/projects/mnms/>

7.2.3. Intra-MEM program project “ENOC”

Since 2012, the team is the coordinator of the ENOC project with the LBE lab (Inra Narbonne) [12], funded the by Inra meta-program MEM (metagenomics of microbial ecosystems). This two-years project proposes a multidisciplinary approach shared by microbial ecologists and mathematicians for the reverse modeling of metagenomic data for microbial resource management. The final objective is to develop a generic approach for predicting ecosystem performance from an unknown inoculum.

7.2.4. Intra-CEPIA project “New perspectives for the MSCF”

A new project submitted to the Inra Dept. CEPIA, entitled “New perspectives for the Multi-Stage Continuous Fermentor (MSCF): Study of fermentations with disturbances, and development of a control law”, in which the Montpellier Units SPO and Mistea are involved has been accepted in 2013 and will last 2 years. It is the continuation of the work made within the CAFE project (see Section 7.4) about the control of a wine fermentation process. The goal of the project is to study the fermentations with addition nitrogen. From the control point of view, we will study the control of both the sugar concentration and the CO_2 production rate in each of the 4 reactors of a MSCF.

7.2.5. CNRS-PEPS project “ASYDE”

The team participates to the CNRS PEPS “ASYDE” (Analyse de systèmes de digesteurs biologiques) launched in 2013 for two years, with the objective to develop tools for the analysis and reduction of the models (flat systems, Lyapunov functions, delayed equations...) in microbial ecology. The project is coordinated by the L2S (CNRS/Supélec, Gif-sur-Yvette), with Modemic, LBE (Inra Narbonne) and MIA (Inra Jouy) as partners.

7.2.6. Inria Project Lab “Algae in Silico”

Modemic is a partner of the proposal of the Inria Project Lab “Algae in Silico” launched by Biocore Inria project-team.

7.3. European Initiatives

7.3.1. FP7 Projects

Program: Food, Agriculture and Fisheries, and Biotechnology (Theme 2)

Project acronym: CAFE

Project title: Computer-Aided Food processes for control Engineering

Duration: 2009-2013

Coordinator: CESAME, UCL (Louvain-la-Neuve, Belgium)

Other partners: Altra, BIV SA, C-Tech Innovation, Irstea, Consejo Superior de Investigaciones Cientificas (CSIC), Wageningen Univ. and Research centre, Institut des Sciences et Industries du Vivant et de l’Environnement Agro Paris Tech, Inra, Povltavske Mlekarny AS, Psutec SPRL, Societa di Progettazione Elettronica e Software S.C.R.L. SPES, Telstar Technologies SLU, The Univ. of Manchester, Univ. Degli Studi di Roma Tor Vergata, X-Flow BV.

Abstract: This is a Large collaborative project, whose objective is to provide new paradigms for the smart control of food processes, on the basis of four typical processes in the areas of bio-conversion, separation, preservation and structuring (resp. wine making, micro-filtration of food beverages, freeze-drying of lactic acid bacteria and ice cream crystallization). The novelty of the project lies in the capacity of combining PAT (Process Analytic Technology) and sensing devices with models and simulation. The team works on the control of multi-stage bioreactors (for wine making) and the regulation of ice quality (ice cream crystallization).

Web-site: <http://www.cafe-project.org/>

The CAFE project ended in March 2013 (see deliverables [66], [67], [68]). An industrial conference has been organized by the consortium in February 2013 at Irstea (Antony, France). During the conference, which representatives of several industries in food processing attended, a live demonstration of the designed control law has been performed.

¹²<https://sites.google.com/site/enocprojetreversemodelling/>

7.4. International Initiatives

7.4.1. Inria International Partners

7.4.1.1. Declared Inria International Partners

From 2010 to 2012, the Inria associated-team Dymecos (DYnamical Microbial and Environmental eCOSystems) has associated the team with three main partners in Chile: UMR CNRS CMM (Santiago), Math. Dept. of UTFSM (Valparaiso) and EIB-PUCV (Valparaiso). A continuation of this associated-team has been submitted for 2014. Within the Inria CIRIC Center in Chile, the team has co-supervised in 2013 the postdoctoral stay of M. Sebbah (part-time in Chile, part-time in France).

7.4.1.2. Informal International Partners

The team has a long term collaboration with Prof. D. Dochain from CESAME (Univ. Louvain-la-Neuve).

7.4.2. Inria International Labs

Lirima STIC-Mada [¹³] since 2010 (Madagascar). The purpose of the project was to develop land use dynamical models corresponding to plots located on the edge of the forest corridor linking the two national parks of Ranomafana and Andringitra in Madagascar. We use both Markov and semi-Markov models to infer the land-use dynamics. The main contribution was the co-advising of a PhD student, Angelo Raheiririna who defended his thesis in August 2013. This work is done in collaboration with IRD in Madagascar.

Lirima NuWat (Numerics for water treatment research) [¹⁴] 2013-... (Tlemcen, Algeria and Gamma Team/UMR Mistea). NuWat focuses on the numerical Modeling and simulation of microbial ecosystems and their application in biotechnology with a focus on solutions considered as promising for countries of the Maghreb, for instance in waste-water treatment systems and its reuse in agriculture under semi-arid climates. NuWat handles the two following related topics: (1) the elaboration of numerical hybrid models for simulation of bacterial ecosystems combining discrete models (for small size populations) and continuous models (for large size populations, substrate and environment); (2) the systematic numerical and software development for biotechnology process control.

CIRIC-Chile. The future of our collaboration with Chile within the BIONATURE line is not entirely in our hands and relies much on CIRIC's policy regarding fundamental research. Anyway we shall try to continue our fruitful collaboration in modeling and optimal control within the CIRIC project, and focus more on transfer applications.

7.4.3. Participation In other International Programs

7.4.3.1. TREASURE (Treatment and Sustainable Reuse of Effluents in semiarid climates)

Program: **Euromediterranean 3+3**

Title: Treatment and Sustainable Reuse of Effluents in semiarid climates

Inria principal investigator: Modemic (J. Harmand),

Partners: Centre de Biotechnologie de Sfax, Department of environmental engineering (Tunisia), Ecole Nationale des Ingénieurs de Tunis, Dept. de Mathématiques (Tunisia), Institut National de la Recherche Agronomique, Dept. EA, MICA et MIA (France), National Research Center, Water Pollution Control (Egypt), Univ. of Patras, Process Control Laboratory (Greece), Univ. of Tlemcen, Automatic control (Algeria), Univ. of santiago de compostella, Environmental engineering (Spain) Université Cadi Ayyad de Marrakech, Faculté des Sciences de Semlalia, Dépt. de Mathématiques (Morocco), Centre National de Recherche sur l'Eau et l'Energie, Université Française d'Egypte (Egypt)

Duration: Jan 2012 - Dec 2015

¹³<http://www.Lirima.uninet.cm/index.php/recherche/equipes-de-recherche/stic-mada>

¹⁴<https://project.inria.fr/nuwat/>

Abstract: The TREASURE network aims at integrating knowledge on the modeling, the control and the optimization of biological systems for the treatment and reuse of wastewater in countries submitted to semi-arid climates under both socio-economical and agronomic constraints within the actual context of global changes. A special focus of the actual project concerns the integration of technical skills together with socio-economical and agronomic studies for the integrated solutions developed within the network to be evaluated and tested in practice in the partner's countries and, as possible as it may be within the context of the actual research network, valorizing these proposed technologies with the help of industrial on site in partners from South.

Web-site: <https://project.inria.fr/treasure>

7.4.3.2. CIB (Centre Interfacultaire Bernoulli)

A very old collaboration of Inria with ecologists (the COREV network presently animated by R. Arditi) initiated (at the beginning of the 90s) by J-L. Gouzé and C. Lobry within the framework of Comore Inria project-team, pursued then by Mere and Comore raised very recently an important success: the half-year "Mathematics and computer sciences in theoretical ecology" which we co-organize with R. Arditi (associated with D. de Angelis and L. Ginzburg) at the Federal Polytechnical School of Lausanne (Centre Interfacultaire Bernoulli). The organization of this half-year (in July-December 2014) and the preparation of the acts will mobilize a great part of our activity for the coming two years. It should gather around sixty specialists during a half-dozen workshops. If additional funds are obtained from other sponsors we hope to welcome for the totality of the semester half a dozen post-doc.

7.5. International Research Visitors

Imme Van Den Berg (Univ. of Évora, Portugal) from Oct. 2013 until Feb. 2014: Construction, analysis and simulation of population dynamics models.

Nihel Ben Amar (ENIT, Tunis, Tunisia) from September 2013 to October 2013: Bioprocess modeling.

Boumédiène Benyahia (Univ. Tlemcen, Algeria) from January 2013 to October 2013: Bioprocess modelling.

Abdoudramane Guiro (Univ. Ougadougou, Burkina Fasso) from October 2013 to December 2013: Construction, analysis and simulation of dynamical models of populations.

7.5.1. Visits to International Teams

Coralie Fritsch as obtained a grant in the context of the Agreenium program [¹⁵] to visit Pr. Otso Ovaskainen's mathematical biology group (Univ. of Helsinki) from September to December 2013.

¹⁵<http://www.agreenium.org>

MOISE Project-Team

8. Partnerships and Cooperations

8.1. Regional Initiatives

- M. Nodet is responsible for the workpackage "numerical modelling" within the regional project (Région Rhône-Alpes) "**Envirhonalp**" <http://www.envirhonalp.fr>.
- M. Nodet is involved in E. Maitre MSTIC project MENTOL about Optimal Transport.
- A. Rousseau leads the working group *Couplage Fluide/Vivant* in Montpellier for the study of coupled systems (fluid dynamics and life sciences) in nearshore regions. This research is funded by the Labex NUMEV in Montpellier.
- Clémentine Prieur is a member of the project "Soutien à l'Excellence et à l'Innovation Grenoble INP" MEPIERA (Méthodologies innovantes Pour l'Ingénierie de l'Eau et des Risques Associés) led by A.- C. Favre (LTHE).

8.1.1. Collaborations with Various Regional Research Teams

- LGGE, MEOM team : [6.3.2](#) ,[6.2.1](#) ,[6.3.2](#) ,[6.3.6](#) , [6.3.5](#) , [6.1.2](#) .
- LGGE Grenoble, Edge team (C. Ritz, O. Gagliardini, F. Gillet-Chaulet, G. Durand), see paragraphs [6.2.2](#) and [6.2.3](#) .
- LTHE, A.C. Favre: hydrological risk assessment.
- LTHE, Thierry Lebel, Théo Vischel: tracking of mesoscale convective systems,
- LTHE, MISTIS, LJK: PEPS (CNRS, PRES Grenoble) project AGREE on multivariate risk assessment. The project was funded in 2013 and led by M. Clausel (LJK).
- LTHE, MISTIS, LJK: AGIR project. Clémentine Prieur obtained the funding for a thesis on risk assessment.
- Building energy (G2ELab, Mathilde Grandjacques, Benoît Delinchant). : [6.4.1](#) ,[6.5](#)
- Univ. Lyon 1 collaboration with V. Maume-Deschamps and S. Loisel.

8.2. National Initiatives

8.2.1. Interactions with other Inria Project-Teams or Actions

Participants	Inria Project-Team	Research topic	Link
F. Lemarié	POMDAPI	Coupling methods	6.1.1
A. Rousseau	TOSCA	Stochastic Downscaling Method	5.4
A. Rousseau	MODEMIC	Bioremediation of natural resources	6.10
C.Prieur, P. Tencaliec	MISTIS	hydrological risk assessment	6.6
C. Helbert, C.Prieur, A. Vidard, N. Papadakis	STEEP	Calibration and sensitivity analysis for LUTI models	6.9
A. Vidard M. Nodet F.X. Le Dimet	CLIME, FLUMINANCE	Image assimilation	6.3.2
A. Vidard, M. Nodet, E.Kazantsev	TROPICS	Ocean Adjoint Modelling	6.2.1 , 6.3.6
L.Debreu,	CLIME, FLUMINANCE	Multiscale data assimilation	6.2.1
C.Prieur, L. Viry	GRAAL	Grid deployment for the study of West African Monsoon	6.4

8.2.2. Collaborations with other Research Teams in France

Participants	Research Team	Research topic	Link
L. Debreu, F. Lemarié	IFREMER (Brest), LOCEAN (Paris)	Ocean modelling, Ocean-atmosphere coupling	6.1.2 , 6.1.1
F. Lemarié	CNRM (Toulouse)	Ocean-atmosphere coupling	6.1.1
A. Rousseau	Institut de Mathématiques et de Modélisation de Montpellier (I3M)	Modelling and simulation of coastal flows	6.1
A. Rousseau	Laboratoire de Météorologie Dynamique (Ecole Polytechnique)	Stochastic Downscaling Method	5.4
E.Blayo, A.Rousseau, F. Lemarié	LAMFA (Amiens), LAGA (Paris 13)	Coupling methods	6.1.1 , 6.1.1
A. Rousseau	IFREMER (Sète), UMR Ecosym (Montpellier)	Coupling fluids and life sciences	6.10
C. Prieur	IMT Toulouse, IFP Rueil, EDF, CEA Cadarache	Sensitivity analysis	6.4.1
C. Prieur	ISFA Lyon 1, Université de Bourgogne, CNAM	Multivariate risk indicators	6.6
C. Prieur	IMT Toulouse, Caracas	non parametric estimation for hypoelectic diffusions	6.7
A. Vidard	Centre Européen de Recherche et de Formation Avancée en Calcul Scientifique (Toulouse), Mercator-Océan (Toulouse), Laboratoire de Physique des Océans (Brest),	Ocean Data Assimilation	6.2.1
A. Vidard	LOCEAN (Paris)	Ocean Adjoint Modelling	6.2.1
A. Vidard	LPO (Brest), CERFACS	Ocean data assimilation	6.2.1
B.Lemieux	LSCE (Laboratoire des Sciences de l'Environnement et du Climat)	DatIce tool	5.3

8.2.3. Other National Initiatives:

- A. Vidard leads a group of projects gathering multiple partners in France and UK on the topic "Variational Data Assimilation for the NEMO/OPA9 Ocean Model", see [6.2.1](#) .
- C. Prieur chairs GdR MASCOT NUM, in which are also involved M. Nodet, E. Blayo, A. Rousseau, C. Helbert, L. Viry, A. Janon, S. Nanty, L. Gilquin and G. Chastaing. <http://www.gdr-mascotnum.fr/doku.php>
- M. Nodet is PI of the project "Méthodes inverses en glaciologie" supported by INSU-LEFE.
- A. Rousseau is PI of the project COCOA "Couplages Côtes, Océan, Atmosphère" supported by INSU-LEFE.
- F. Lemarié leads a group of projects gathering multiple partners in France on the topics « ocean-atmosphere coupling » and « numerical analysis of time schemes in ocean models » (funded by CNRS-INSU LEFE).

- E.Kazantsev, E.Blayo, F. Lemarié participate in the project "PACO - Vers une meilleure paramétrisation de la côte et des conditions limites dans les modèles d'océan" supported by LEFE-GMMC and LEFE-MANU .
- M. Nodet is involved in GDR Calcul and GDR Ondes.
- E. Blayo is the chair of the CNRS-INSU research program on mathematical and numerical methods for ocean and atmosphere LEFE-MANU. <http://www.insu.cnrs.fr/co/lefe>
- L. Debreu is the coordinator of the national group COMODO (Numerical Models in Oceanography)

8.2.4. ANR

- A 4-year ANR contract: ANR COSTA-BRAVA (Complex Spatio-Temporal Dynamics Analysis by Reduced Models and Sensitivity Analysis)http://www.math.univ-toulouse.fr/COSTA_BRAVA/index.html
- A 4-year ANR contract: ANR ADAGe (Adjoint ice flow models for Data Assimilation in Glaciology).
- A 4-year ANR contract: ANR Geo-FLUIDS (Fluid flows analysis and simulation from image sequences: application to the study of geophysical flows, see paragraph 6.3.2) .
- A 4-year ANR contract: ANR TOMMI (Transport Optimal et Modèles Multiphysiques de l'Image), see paragraphs 6.3.3 ,6.3.2 .
- A 4 year ANR contract (2011-2015): ANR COMODO (Communauté de Modélisation Océanographique) on the thematic "Numerical Methods in Ocean Modelling". (coordinator L. Debreu) 6.1.2
- A 3.5 year ANR contract: ANR CITiES (numerical models project selected in 2012). http://steep.inrialpes.fr/?page_id=46

8.3. European Initiatives

8.3.1. FP7 Projects

8.3.1.1. ERA-CLIM2

Type: COOPERATION

Instrument: Specific Targeted Research Project

Program: Collaborative project FP7-SPACE-2013-1

Project acronym: ERA-CLIM2

Project title: European Reanalysis of the Global Climate System

Duration: 01/2014 - 12/2016

Coordinator: Dick Dee (ECMWF, Europe)

Other partners: Met Office (UK), EUMETSAT (Europe), Univ Bern (CH), Univ. Vienne (AT), FFCUL (PT), RIHMI-WDC (RU), Mercator-Océan (FR), Météo-France (FR), DWD (DE), CER-FACS (FR), CMCC (IT), FMI (FI), Univ. Pacifico (CL), Univ. Reading (UK), Univ. Versailles St Quentin en Yvelines (FR)

Inria contact: Arthur Vidard

8.3.2. Collaborations with Major European Organizations

Partner: European Centre for Medium Range Weather Forecast. Reading (UK)

World leading Numerical Weather Centre, that include an ocean analysis section in order to provide ocean initial condition fo the coupled ocean atmosphere forecast. They play a significant role in the NEMOVAR project in which we are also partner.

Partner: Met Office (U.K) National British Numerical Weather and Oceanographic service. Exeter (UK).

We do have a strong collaboration with their ocean initialization team through both our NEMO, NEMO-ASSIM and NEMOVAR activities. They also are our partner in the NEMOVAR consortium.

Partner: Marine Hydrographic Institute, National Ac.Sci. Ukraine, Sevastopol.

We have a long term collaboration about data assimilation with the Black Sea. This collaboration is getting to a new level with their plan to adopt NEMO and NEMOVAR for their operational forecasting system. On our side, we will benefit from their expertise on the Black Sea dynamics, that is an excellent test case for our developments and methods.

Partner: GDR-E CONEDP

Subject: Control of Partial Differential Equations.

Partner: University of Reading, Department of Meteorology, Department of Mathematics

Subject: Data assimilation for geophysical systems.

8.4. International Initiatives

8.4.1. Inria International Labs

- A. Rousseau spent 2 weeks in Santiago in April 2013 and started a collaboration with Inria Chile.

8.4.2. Participation In other International Programs

- C. Prieur collaborates with Antonio Galves (University Sao Paulo) and Jose R. Leon (UCV, Central University of Caracas). She is a member of a USP-COFECUB project on the study of stochastic models with variable length memory (2010-2013) with University of Sao Paulo.
- C. Prieur is leader of a project ECOS Nord with Venezuela (2012-2015).
- F.-X. Le Dimet collaborates with the Institute of Mechanics of the Vietnamese Academy of Sciences Ha Noi, and with the Institute of Numerical Mathematics of the Russian Academy of Sciences.
- F. Lemarié collaborates with A.F. Shchepetkin and J.C. McWilliams from the University of California at Los Angeles (UCLA).

8.5. International Research Visitors

8.5.1. Visits of International Scientists

- Angie Pineda (invited 6 weeks in 2013 by C. Prieur through the ECOS Nord project),
- Jose R. León (invited 2 weeks in 2013 by C. Prieur through the ECOS Nord project).
- Victor Shutyaev, Institute of Numerical Mathematics, Russian Academy of Sciences, Moscow (invited for 4 weeks by F.-X. Le Dimet, see 6.4.2 , 6.4.3)
- Igor Gejadze, University of Strathclyde, Glasgow, UK (invited for 4 week by F.-X. Le Dimet, see 6.4.2)
- Nancy Nichols, University of Reading, invited for 1 week by A. Vidard and M. Nodet

8.5.2. Visits to International Teams

- F.-X. Le Dimet was invited to the Florida State University for 6 weeks in May 2013 and to the Institute of Numerical Mathematics Moscow for 2 weeks in June 2013

MORPHEME Project-Team

6. Partnerships and Cooperations

6.1. Regional Initiatives

- We started a collaboration with the team TIRO (Transporteurs en Imagerie et Radiothérapie en Oncologie), CEA/UNS/Centre Antoine Lacassagne, Nice, concerning the detection of tumorous cells in kidney histopathology (see Fig. 17). Although the images have a very high resolution, the problem is extremely difficult due to the similarity between different type of cells.

A coarse-to-fine approach seems perfectly adapted since the acquisitions are performed at several resolutions. Typically, six resolutions are available (see Table 1). However, contrarily to what is usually done, we do not plan to develop a unique approach, to apply it to the coarser resolution, and to use the corresponding result projected onto the following resolution as the initialization of the next step. Our idea is to think of which approach to take at each resolution level, and to gradually improve the detection confidence from “this broad area might contain tumorous cells” to “with high confidence, this small, finely delineated region is a tumorous cell”. For example, we might start with histogram analysis or simple thresholding methods on the coarser resolution. Then, texture analysis could be performed in intermediate resolutions. Finally, fine radiometric and shape analyses could be done on the full resolution image to achieve object-level detection.

- We have a collaboration with the Laboratoire d’Océanographie de Villefranche (LOV), CNRS/Université Pierre et Marie Curie, concerning automatic classification of zooplankton organisms for an embedded system called UVP for Underwater Vision Profiler (see Section 4.12).
- We have a collaboration with IPMC (H. Barelli) on vesicles tracking for characterizing cell membrane properties (see Section 4.7).

Table 1. Typical resolutions of the acquisitions in kidney histopathology.

	Full res.	Res. 1	Res. 2	Res. 3	Res. 4	Low res.
Width (rounded)	95 000	25 000	6000	1500	370	90
Height (rounded)	70 000	18 000	4500	1100	275	70
1-D downsampling factor	1	4	16	64	256	1024

6.2. National Initiatives

6.2.1. LABEX SIGNALIFE

The MORPHEME team is member of the SIGNALIFE Laboratory of Excellence.

6.2.2. ANR DIAMOND

Participants: Laure Blanc-Féraud [PI], Saima Ben Hadj.

In collaboration with the Pasteur Institute (Jean-Christophe Olivo Marin) , the MIPS laboratory of Université de Haute Alsace (Alain Dieterlen, Bruno Colicchio) , the LIGM of Université Paris-Est (Jean-Christophe Pesquet, Caroline Chaux, Hugues Talbot), and INRA Sophia-Antipolis (Gilbert Engler). Details on the ([website](#))

6.2.3. ANR MOTIMO

Participants: Laure Blanc-Féraud, Xavier Descombes, Eric Debreuve, Huei Fang Yang, Ana Rita Lopes Simoes.

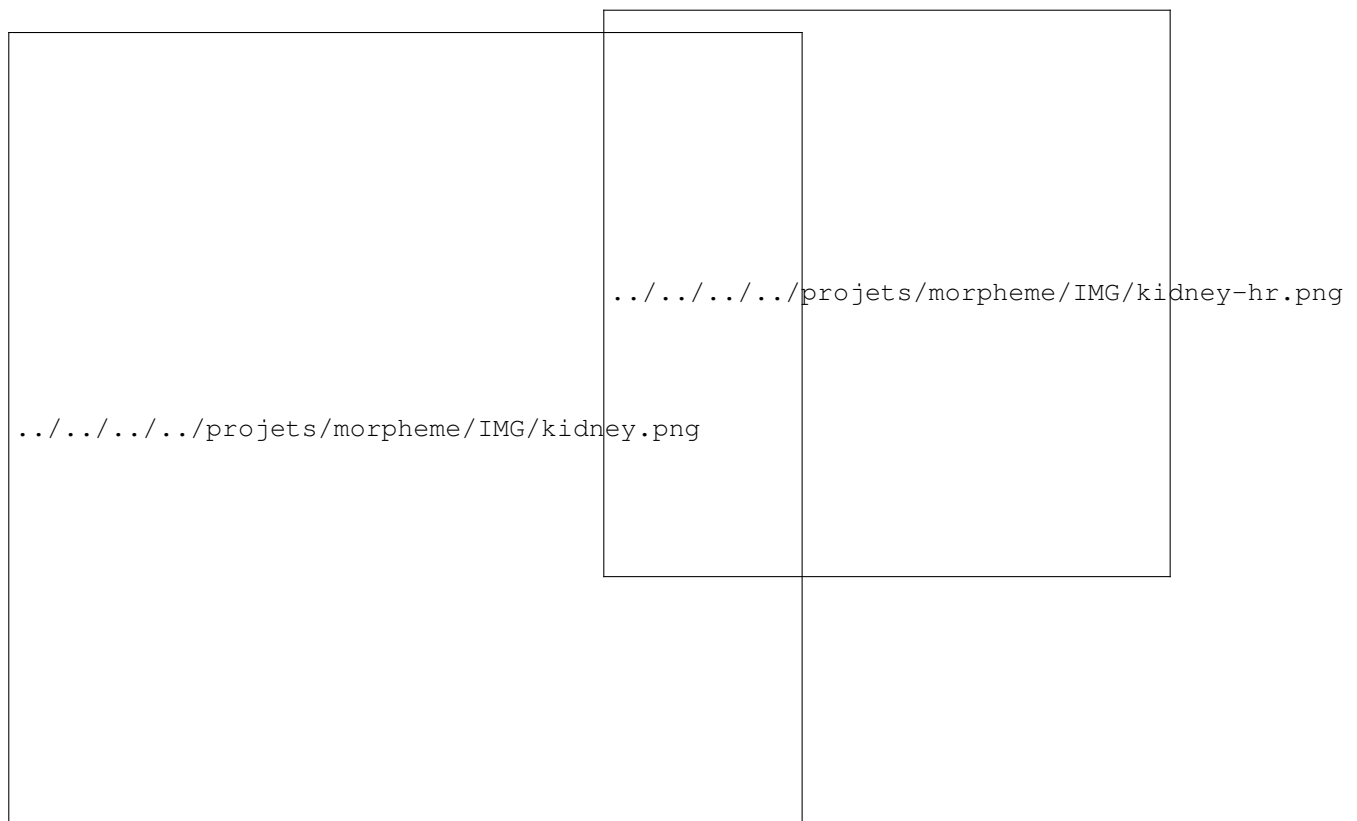


Figure 17. An example of image acquired for kidney histopathology. Left: low resolution; Right: intermediate resolution.

In collaboration with Institut de Mathématiques de Toulouse, INRA, Institut de Mécanique des Fluides de Toulouse, Laboratoire J-A Dieudonné, et IMV Technologies (PME). Details on the ([website](#))

6.2.4. ANR POXADRONO

Participants: Florence Besse [PI], Xavier Descombes, Laure Blanc-Féraud.

The young researcher ANR project POXADRONO is in collaboration with Caroline Medioni, Hélène Bruckert, Giovanni Marchetti, Charlène Perrois and Lucile Palin from iBV. It aims at studying ARN regulation in the control of growth and axonal guidance by using a combination of live-imaging, quantitative analysis of images, bio-informatic analysis and genetic screening.

6.2.5. Inria Large-scale initiative Morphogenetics

Participants: Grégoire Malandain, Xavier Descombes, Gaël Michelin.

This action gathers the expertise of three Inria research teams (Virtual Plants, Morpheme, and Evasion) and other groups (RDP (ENS-CNRS-INRA, Lyon), RFD (CEA-INRA-CNRS, Grenoble)) and aimed at understanding how shape and architecture in plants are controlled by genes during development. To do so, we will study the spatio-temporal relationship between genetic regulation and plant shape utilizing recently developed imaging techniques together with molecular genetics and computational modelling. Rather than concentrating on the molecular networks, the project will study plant development across scales. In this context we will focus on the Arabidopsis flower, currently one of the best-characterised plant systems.

6.2.6. PEPH 1

Participants: Laure Blanc-Féraud, Xavier Descombes [PI], Alejandro Mottini.

This project aims at studying graphs in biological context (axons, vascular networks ...). In collaboration with Institut de Mécanique des Fluides de Toulouse, CerCo (Toulouse) .

6.2.7. PEPH 2

Participants: Laure Blanc-Féraud [PI], Xavier Descombes, Eric Debreuve.

In collaboration with Institut de Mathématiques de Toulouse, INRA, Institut de Mécanique des Fluides de Toulouse, Laboratoire J-A Dieudonné, et IMV Technologies (PME).

6.3. International Research Visitors

6.3.1. Visits of International Scientists

- Evgueny Pechersky from IITP Moscow (Russian Academy of Science) was invited one week in december.

6.3.1.1. Internships

- Vladimir Gutov : Master BioComp, UNS, Curves and Trees classification using SVM. Supervisors: E. Debreuve, X. Descombes.
- Gael Michelin : ENSEEIHT, Planar structures detection and tracking in biological images. Supervisor: Grégoire Malandain.
- Emmanuel Soubies : INSA Toulouse, Numerical methods for 3D biological structures reconstruction in fluorescent microscopy. Supervisors: L. Blanc-Féraud, Gilles Aubert.
- Nektaria Pappa : Master BioComp, UNS, Lobule detection from confocal microscopy images. Supervisor X. Descombes (with F. Plouraboué from IMFT)
- Anirudh Chakravarthi : Master BioComp, UNS, Dendrites detection from confocal microscopy images. Supervisor X. Descombes (with M. Studer from iBV).

6.3.2. Visits to International Teams

- Xavier has visited the Bristol University during one week in december. He was a Benjamin Maeker invited professor.

NEUROMATHCOMP Project-Team

6. Partnerships and Cooperations

6.1. National Initiatives

6.1.1. ANR

6.1.1.1. KEOPS

See section “International Initiatives” below.

6.2. European Initiatives

6.2.1. FP7 Projects

6.2.1.1. BRAINSCALES

Title: BrainScaleS: Brain-inspired multiscale computation in neuromorphic hybrid systems

Type: COOPERATION (ICT)

Defi: Brain-inspired multiscale computation in neuromorphic hybrid systems

Instrument: Integrated Project (IP)

Objectif: FET proactive 8: Brain Inspired ICT

Duration: January 2011 - December 2014

Coordinator: Universitaet Ruprecht- Karls Heidelberg (Germany)

Other Partners: Nederlandse Akademie van Wetenschappen, Amsterdam; Universitetet For Miljo Og Biovitenskap, Aas; Universitat Pompeu Fabra, Barcelona; University of Cambridge; Debreceni Egyetem, Debrecen; Technische Universität Dresden; CNRS-UNIC, Gif-sur- Yvette; CNRS-INCM, Marseille; CNRS-ISM, Marseille; TUG, Graz; Ruprecht-Karls-Universität Heidelberg; Forschungszentrum Jülich GmbH, Jülich; EPFL LCN, Lausanne; EPFL- BBP, Lausanne; The University Of Manchester, Manchester; KTH, Stockholm; Universität Zürich.

See also <http://brainscales.kip.uni-heidelberg.de/>

Inria contact: Olivier Faugeras

Abstract: The BrainScaleS project aims at understanding function and interaction of multiple spatial and temporal scales in brain information processing. The fundamentally new approach of BrainScaleS lies in the in-vivo biological experimentation and computational analysis. Spatial scales range from individual neurons over larger neuron populations to entire functional brain areas. Temporal scales range from milliseconds relevant for event based plasticity mechanisms to hours or days relevant for learning and development. In the project generic theoretical principles will be extracted to enable an artificial synthesis of cortical-like cognitive skills. Both, numerical simulations on petaflop supercomputers and a fundamentally different non-von Neumann hardware architecture will be employed for this purpose. Neurobiological data from the early perceptual visual and somatosensory systems will be combined with data from specifically targeted higher cortical areas. Functional databases as well as novel project-specific experimental tools and protocols will be developed and used. New theoretical concepts and methods will be developed for understanding the computational role of the complex multi-scale dynamics of neural systems in-vivo. Innovative in-vivo experiments will be carried out to guide this analytical understanding. Multiscale architectures will be synthesized into a non-von Neumann computing device realised in custom designed electronic hardware. The proposed Hybrid Multiscale Computing Facility (HMF) combines microscopic neuromorphic physical model circuits with numerically calculated mesoscopic and macroscopic functional units

and a virtual environment providing sensory, decision-making and motor interfaces. The project also plans to employ petaflop supercomputing to obtain new insights into the specific properties of the different hardware architectures. A set of demonstration experiments will link multiscale analysis of biological systems with functionally and architecturally equivalent synthetic systems and offer the possibility for quantitative statements on the validity of theories bridging multiple scales. The demonstration experiments will also explore non-von Neumann computing outside the realm of brain-science. BrainScaleS will establish close links with the EU Brain-i-Nets and the Blue Brain project at the EPFL Lausanne. The consortium consists of a core group of 10 partners with 13 individual groups. Together with other projects and groups the BrainScaleS consortium plans to make important contributions to the preparation of a FET flagship project. This project will address the understanding and exploitation of information processing in the human brain as one of the major intellectual challenges of humanity with vast potential applications.

This project started on January 1st, 2011 and is funded for four years.

6.2.1.2. MATHEMACS

Title: Mathematics of Multilevel Anticipatory Complex Systems

Type: Collaborative project (generic) (FP7-ICT)

Defi: develop a mathematical theory of complex multilevel systems and their dynamics.

Instrument: Integrated Project (IP)

Duration: October 2012 - September 2015

Coordinator: Fatihcan Atay, Max Planck Institute for Mathematics in the Sciences, Leipzig (Germany)

Other Partners: Max Planck Institute for Mathematics in the Sciences (Leipzig, Germany), Universität Bielefeld (Germany), Chalmers University of Technology (Gothenburg, Sweden), Ca'Foscari University of Venice (Italy), Università Politecnica delle Marche (Ancona, Italy).

See also: <http://www.mathemac.eu/description.html>

Inria contact: Olivier Faugeras

Abstract: The MATHEMACS project aims to develop a mathematical theory of complex multi-level systems and their dynamics. This is done through a general formulation based on the mathematical tools of information and dynamical systems theories. To ensure that the theoretical framework is at the same time practically applicable, three key application areas are represented within the project, namely neurobiology, human communication, and economics. These areas not only provide some of the best-known epitomes of complex multi-level systems, but also constitute a challenging test bed for validating the generality of the theory since they span a vast range of spatial and temporal scales. Furthermore, they have an important common aspect; namely, their complexity and self-organizational character is partly due to the anticipatory and predictive actions of their constituent units. The MATHEMACS project contends that the concepts of anticipation and prediction are particularly relevant for multi-level systems since they often involve different levels. Thus, as a further unique feature, the project includes the mathematical representation and modeling of anticipation in its agenda for understanding complex multi-level systems.

This project started on October 1st, 2012 and is funded for four years.

6.2.1.3. RENVISION

Type: COOPERATION, FP7 FET (Future Emerging technology) proactive program: Neuro-Bio-Inspired Systems Call 9 Objective 9.11

Defi: Retina-inspired ENcoding for advanced VISION tasks (RENVISION)

Instrument: Specific Targeted Research Project

Duration: March 2013 - February 2016

Coordinator: Vittorio Murino, PAVIS, IIT (Italy)

Partner: PAVIS, IIT (Italy), NBT, IIT (Italy), NAPH, IIT (Italy), The Institute of Neuroscience, Newcastle University (UK), Institute for Adaptive and Neural Computation, The University of Edinburgh (UK), Neuromathcomp project-team, Inria (France)

Inria contact: Pierre Kornprobst

Abstract: The retina is a sophisticated distributed processing unit of the central nervous system encoding visual stimuli in a highly parallel, adaptive and computationally efficient way. Recent studies show that rather than being a simple spatiotemporal filter that encodes visual information, the retina performs sophisticated non-linear computations extracting specific spatio-temporal stimulus features in a highly selective manner (e.g. motion selectivity). Understanding the neurobiological principles beyond retinal functionality is essential to develop successful artificial computer vision architectures.

RENVISION's goal is, therefore, twofold:

- To achieve a comprehensive understanding of how the retina encodes visual information through the different cellular layers;
- To use such insights to develop a retina-inspired computational approach to high-level computer vision tasks.

To this aim, exploiting the recent advances in high-resolution light microscopy 3D imaging and high-density multielectrode array technologies, RENVISION will be in an unprecedented position to investigate pan-retinal signal processing at high spatio-temporal resolution, integrating these two technologies in a novel experimental setup. This will allow for simultaneous recording from the entire population of ganglion cells and functional imaging of inner retinal layers at near-cellular resolution, combined with 3D structural imaging of the whole inner retina. The combined analysis of these complex datasets will require the development of novel multimodal analysis methods.

Resting on these neuroscientific and computational grounds, RENVISION will generate new knowledge on retinal processing. It will provide advanced pattern recognition and machine learning technologies to ICTs by shedding a new light on how the output of retinal processing (natural or modelled) allows solving complex vision tasks such as automated scene categorization and human action recognition.

6.2.1.4. HBP

Type: COOPERATION, FET Flagship' project

Defi: Understanding the brain

Instrument: FET Flagship' project

Duration: October 2013 - March 2016

Coordinator: EPFL (Switzerland)

Partner: see <http://www.humanbrainproject.eu>.

Inria contact: Olivier Faugeras

Abstract: The Human Brain Project (HBP) is supported by the European Union as a 'FET Flagship' project and the 86 institutions involved will receive one billion euro in funding over ten years. HBP should lay the technical foundations for a new model of ICT-based brain research, driving integration between data and knowledge from different disciplines, and catalysing a community effort to achieve a new understanding of the brain, new treatments for brain disease and new brain-like computing technologies. <http://www.humanbrainproject.eu>

6.2.1.5. NERVI

Program: ERC IDEAS

Project acronym: NerVi

Project title: From single neurons to visual perception

Coordinator: Olivier Faugeras

Duration: January 2009 - December 2013

Abstract: The project is to develop a formal model of information representation and processing in the part of the neocortex that is mostly concerned with visual information. This model will open new horizons in a well-principled way in the fields of artificial and biological vision as well as in computational neuroscience. Specifically the goal is to develop a universally accepted formal framework for describing complex, distributed and hierarchical processes capable of processing seamlessly a continuous flow of images. This framework features notably computational units operating at several spatiotemporal scales on stochastic data arising from natural images. Mean-field theory and stochastic calculus are used to harness the fundamental stochastic nature of the data, functional analysis and bifurcation theory to map the complexity of the behaviours of these assemblies of units. In the absence of such foundations, the development of an understanding of visual information processing in man and machines could be greatly hindered. Although the proposal addresses fundamental problems, its goal is to serve as the basis for ground-breaking future computational development for managing visual data and as a theoretical framework for a scientific understanding of biological vision.

6.2.1.6. FACETS-ITN

Title: FACETS-ITN

Instrument: Initial Training Network (ITN)

Duration: September 2009 - August 2013

Coordinator: Universität Heidelberg- Ruprecht-Karls (Germany)

Inria contact: O. Faugeras

See also <http://facets.kip.uni-heidelberg.de/ITN/index.html>

This 'Marie-Curie Initial Training Network' (funded by the EU) involves 15 groups at European Research Universities, Research Centers and Industrial Partners in 6 countries. Website: <http://facets.kip.uni-heidelberg.de/ITN/index.html>

6.3. International Initiatives

6.3.1. Inria Associate Teams

6.3.1.1. CORTINA

Title: Retina neural network coding

Inria principal investigator: Bruno CESSAC

International Partner (Institution - Laboratory - Researcher):

Technical University Federico Santa Maria, Valparaíso (Chile) - Electronics Engineering Department - Bruno CESSAC

Duration: 2011 - 2013

See also: <http://cortex.loria.fr/Projects/Cortina>

Much progress has been made in the last decades in understanding the basic organization and function of the nervous system in general. Contributions to this end have come from various domains including computational neuroscience and numerical science of the information in general. The goal of this associate team is to combine our complementary expertise, from experimental biology and mathematical models (U de Valparaiso and U Federico Santa-Maria) to computational neuroscience (CORTEX and NEUROMATHCOMP), in order to develop numerical tools for the study and characterization of neural coding and related sensory-motor loops. Recording and modeling spike trains from the retina neural network, an accessible part of the brain, is a difficult task that our partnership

can address, what constitute an excellent and unique opportunity to work together sharing our experience and to focus in developing computational tools for methodological innovations. To understand how the neural spike coding from natural image sequences works we are addressing the following issues: How visual signals are coded at earlier steps in the case of natural vision? What are their functions? What are the computational coding principles explaining (in artificial or biological system) the statistical properties of natural images? We wish to advance our actual knowledge in natural and artificial visual signals processing and apply it to the field of education; to foster better capacities for learning and memory; sensory prosthesis design, to will help unpaired sensory persons to sense the world and physical rehabilitation, among others. In the context of the cooperation between the Inria and Chile, we propose to develop new neural decoding algorithms that are transverse to several field and applications.

6.3.2. Inria International Partners

6.3.2.1. Declared Inria International Partners

Paul Bressloff, Professor of applied mathematics at the University of Utah (USA) specialising in mathematical neuroscience, has been selected for an Inria International Chair. He will be visiting the Sophia-Antipolis Méditerranée research center two months every year for five years, starting in 2014.

6.3.3. Participation In other International Programs

6.3.3.1. ANR KEOPS

Type: Algorithms for modeling the visual system: From natural vision to numerical applications.

Principal Investigator: Thierry Viéville (Mnemosyne)

International partner:

- Institution: University of Valparaiso (Chile)
- Laboratory: Centro Interdisciplinario de Neurociencia de Valparaiso
- Researcher: Adrian PALACIOS

International partner:

- Institution: UTFSM Valparaiso (Chile)
- Laboratory: Direccion General de Investigacion y Postgrado de Valparaiso
- Researcher: Maria-Jose ESCOBAR

Duration: 2011 - 2013

See also: <http://cortex.loria.fr/Research/Keops>

Abstract: KEOpS attempts to study and model the non-standard behavior of retinal (ganglion cells) sensors observed in natural scenarios. KEOpS also attempts to incorporate the resulting models into real engineering applications as new dynamical early-visual modules. The retina, an accessible part of the brain, is a unique model for studying the neural coding principles for natural scenarios. A recent study proposes that some visual functions (e.g. movement, orientation, anticipatory temporal prediction, contrast), thought to be the exclusive duty of higher brain centers, are actually carried at the retina level. The anatomical and physiological segregation of visual scenes into spatial, temporal and chromatic channels begins at the retina through the action of local neural networks. However, how the precise articulation of this neural network contributes to local solutions and global perception necessary to resolve natural task remains in general a mystery. KEOpS thus attempts to study the complexity of retinal ganglion cells (the output to the brain) behaviors observed in natural scenarios and to apply this result to artificial visual systems. We revisit both the retinal neural coding information sent to the brain, and at the same time, the development of new engineering applications inspired by the understanding of such neural encoding mechanisms. We develop an innovative formalism that takes the real (natural) complexity of retinal responses into account. We also develop new dynamical early-visual modules necessary to solve visual problems task.

6.4. International Research Visitors

6.4.1. Visits of International Scientists

- Alexander Cerquera, Universidad Antonio Nariño, Facultad de Ingeniería Electrónica y Biomédica, Colombia, 25-29/03/2013.
- Antonio Galves, Statistics Department. Instituto de Matemática e Estatística · Universidade de São Paulo. 25-27/06/2013.
- Eva Loecherbach, Maths department, Cergy University. 25-27/06/2013.

6.4.1.1. Internships

- Gaia Lombardi, M2 Internship, March-August 2013.

NEUROSYS Team

7. Partnerships and Cooperations

7.1. Regional Initiatives

In the *Contrat de Projet État Région (CPER) Action Modeling, Simulation and Interaction* (2009-2014), we are contributing to the axis *Situed Informatic* through the project CoBras for controlling a jaco robotic arm using EEG. Contact in Neurosys is Laurent Bougrain.

7.2. National Initiatives

7.2.1. ANR

We participate in the project *Keops: Algorithms for modeling the visual system: From natural vision to numerical applications* (2011-2014).

A recent description in the retina of non-standard ganglion cells types, beside a complex repertoire of standard ganglion cells, responses in front of natural stimulus and conveys important questions about the real, early processing capacity of the retina. This leads to revisit both the neural coding of the information the eye is sending to the brain, and also sheds light to engineering applications from the understanding of such encoding, as detailed in the sequel. At the modeling level, retinal cells are mainly formalized using a LN (Linear spatio-temporal filtering followed by a static Non-linear transduction), while an important fraction of non-standard cells response cannot be represented in such a model class. This is a challenge to develop an innovative formalism that takes such complex behaviors into account, with such immediate applications as new dynamical early-visual modules. Proposing new innovative bioinspired formalisms in order to perform dynamical visuo-perceptual tasks adapted to natural environment is a main goal of this project, with a special focus to scenes including complex visual motion interacting with light.

The project is a cooperation between the University of Nice (France), the University of Valparaiso (Chile), the Pontifical Catholic University of Chile in Santiago de Chile, the Inria teams NeuroMathComp, Mnemosyne, Cortex and Neurosys.

7.2.2. Others

- Inria Technological development action (ADT): OpenViBE-NT
This is a two-year multi-site project (2012–2014) to develop OpenViBE further on several fronts such as usability, new algorithms and scope of applicability. Teams of the ADT are Hybrid(Rennes), Athena (Sophia), Potioc (Bordeaux) and Neurosys. Coordinator is Laurent Bougrain.
- Multidisciplinary Exploratory Project (PEPS 2013) Bio-Maths-Info (BMI): *Characterising the laminar profile of motor cortical oscillatory synchronization during visuomotor behavior with new analysis tools.*

Oscillations are omnipresent in the brain, but their function is still disputed. In motor cortex, beta and gamma oscillations are often observed, but their proposed roles in sensorimotor behavior are largely overlapping. While much is known on the laminar distribution of oscillations in sensory areas, the very sparse data on the laminar profile of motor cortical oscillations largely limits their functional interpretations. The 2-years project studies the layer specificity of monkey motor cortical oscillations and oscillatory interactions between M1 and PMd during visuomotor behavior. Extending conventional tools, such as coherency analysis, Neurosys develops a new method to quantify short-lasting partial amplitude and phase synchronization in single-trial data, based on wavelets, exploiting the predefined vicinity of contacts on the laminar probes. The application of this new method to the data recorded in Marseille will reveal instantaneous amplitude and phase synchronization between cortical layers and between the brain areas *M1* and *PMd*, providing novel insights into the functional roles of beta and gamma oscillations in visuomotor behavior. The experimental partner at the *Institut de Neurosciences de la Timone* in Marseille is Bjork Kilavik, the contact in Neurosys is Axel Hutt.

7.3. European Initiatives

7.3.1. FP7 Projects

The ITN-project *Neural Engineering Transformative Technologies (NETT)* (2012-2016) is a Europe-wide consortium of 18 universities, research institutes and private companies which together hosts 17 PhD students and 3 postdoctoral researchers over the next 4 years. Neural Engineering brings together engineering, physics, neuroscience and mathematics to design and develop brain-computer interface systems, cognitive computers and neural prosthetics. Neurosys will host a PhD-student for three months in winter 2014/2015. Contact is Axel Hutt.

7.3.2. Collaborations in European Programs, except FP7

Program: ERC Starting Grant

Project acronym: MATHANA

Project title: Mathematical Modeling of Anaesthesia

Duration: January 2011 – December 2015

Coordinator: Axel Hutt

Abstract: MATHANA aims to study mathematically spatially extended neural systems and reveal their spatio-temporal dynamics during general anaesthesia.

7.4. International Initiatives

7.4.1. Informal International Partners

- We collaborate with Jamie Sleight (University of Auckland, New Zealand), who provides us with experimental EEG-data obtained in humans during anaesthesia (A. Hutt).
- In the collaboration with Flavio Frohlich (University of North Carolina - Chapel Hill), we receive experimental data measured intracranially in ferrets and analyse them on spectral properties (A. Hutt).
- The collaboration with Matthias Munk (Max Planck Institute for Biological Cybernetics in Tuebingen) lasts for over 10 years now and provides us with experimental Local Field Potentials measured during a visuomotor task of monkeys (A. Hutt).
- The collaboration with Linghai Zhang (Lehigh University, USA) on the mathematical analysis of neural field equations led to a publication in 2013 [6] (A.Hutt).
- In the collaboration with Jeremy Lefebvre (University in Geneva), we have been working out together a novel stochastic center manifold analysis method for delayed differential equations leading to new insights into the effects of additive noise close to bifurcation points (A. Hutt).
- The collaboration with Marina Palazova and Torsten Schubert (Humboldt University Berlin) on priming effects of subliminal visual stimuli has led to a publication in 2013 [8] (A. Hutt).
- The collaboration with Peter beim Graben (Humboldt University Berlin) on recurrence data analysis stimulated us to intensify our work on meta-stable states in neural systems (A. Hutt).
- An Inria Internship proposal has been submitted on topics that will involve Pr. Motoharu Yoshida at the Ruhr University Bochum, Germany, to study the role of persistent firing neurons in memory and more specifically in neural network synchronization. M. Yoshida provides us with biological data that we combine with simulations to test hypotheses on memory formation (L. Buhry).
- We also collaborate with Pr. John Rinzel (New York University, USA) and Pr. LieJune Shiau (University of Houston, Texas, USA) on more theoretical approaches concerning the role intrinsic neuronal dynamics in network synchronization and brain oscillations (L. Buhry).

7.5. International Research Visitors

7.5.1. Visits of International Scientists

We have hosted the visiting professors Peter beim Graben (Humboldt University Berlin, September–October) and Jamie Sleight (September–October) to join forces in our common project on the analysis of multivariate EEG-data obtained during anaesthesia.

7.5.2. Visits to International Teams

Pedro Garcia Rodriguez works on stochastic transitions in neural systems and he has visited the group of Prof. Schimansky-Geier at Humboldt University Berlin in December for one week to start a future collaboration.

NUMED Project-Team

6. Partnerships and Cooperations

6.1. National Initiatives

6.1.1. ANR

Vincent Calvez is head of on ingoing ANR contract on cell mobility.

6.1.2. Competitivity Clusters

Vincent Calvez organized a special semester on mathematical biology within Lyon mathematical in spring 2013. and computer science LABEX Milion.

6.2. European Initiatives

6.2.1. FP7 Projects

6.2.1.1. DDMoRE

Member: Benjamin Ribba.

PARIETAL Project-Team

7. Partnerships and Cooperations

7.1. Regional Initiatives

7.1.1. Digiteo/DIM

7.1.1.1. HIDINIM Digiteo project

Participants: Bertrand Thirion [Correspondant], Virgile Fritsch.

High-dimensional Neuroimaging– Statistical Models of Brain Variability observed in Neuroimaging

This is a joint project with Select project team and with SUPELEC Sciences des Systèmes (E3S), Département Signaux & Systèmes Électroniques (A. Tennenhaus), 2010-2013.

Statistical inference in a group of subjects is fundamental to draw valid neuroscientific conclusions that generalize to the whole population, based on a finite number of experimental observations. Crucially, this generalization holds under the hypothesis that the population-level distribution of effects is estimated accurately. However, there is growing evidence that standard models, based on Gaussian distributions, do not fit well empirical data in neuroimaging studies.

In particular, Hidinim is motivated by the analysis of new databases hosted and analyzed at Neurospin that contain neuroimaging data from hundreds of subjects, in addition to genetic and behavioral data. We propose to investigate the statistical structure of large populations observed in neuroimaging. In particular, we investigate the use of region-level averages of brain activity, that we plan to co-analyse with genetic and behavioral information, in order to understand the sources of the observed variability. This entails a series of modeling problems that we address in this project: *i*) Distribution normality assessment and variables covariance estimation, *ii*) model selection for mixture models and *iii*) setting of classification models for heterogeneous data, in particular for mixed continuous/discrete distributions.

7.1.1.2. ICOGEN Digiteo project

Participants: Bertrand Thirion [Correspondant], Benoit Da Mota.

ICOGEN : Intensive Computing for Genetic-Neuroimaging studies

Project supported by a Digiteo grant in collaboration with Inria's KerData Team, MSR-Inria joint centre, Supélec Engineer School, Imagen project and CEA/Neurospin, 2012-2014.

In this project, we design and deploy some computational tools to perform neuroimaging-genetics association studies at a large scale.

Unveiling the relationships between genetic variability and brain structure and function is one of the main challenges in neuroscience, which can be partly addressed through the information conveyed by high-throughput genotyping on the one hand, and neuroimaging data on the other hand. Finding statistical associations between these different variables is important in order to find relevant biomarkers for various brain diseases and improve patient handling. Due to the huge size of the datasets involved and the requirement for tight bounds on statistical significance, such statistical analysis are particularly demanding and cannot be performed easily at a large scale with standard software and computational tools. In ICOGEN, we design and deploy some computational tools to perform neuroimaging-genetics association studies at a large scale. We implement and assess on real data the use of novel statistical methodologies and run the statistical analysis on various architectures (grids, clouds), in a unified environment.

7.1.1.3. SUBSAMPLE Digiteo chair

Participants: Bertrand Thirion [Correspondant], Gaël Varoquaux, Alexandre Abraham.

Parietal is associated with this Digiteo Chair by Dimitris Samaras, in which we will address the probabilistic structure learning of salient brain states (PhD thesis of Alexandre Abraham, 2012-2015).

Cognitive tasks systematically involve several brain regions, and exploratory approaches are generally necessary given the lack of knowledge of the complex mechanisms that are observed. The goal of the project is to understand the neurobiological mechanisms that are involved in complex neuro-psychological disorders. A crucial and poorly understood component in this regard refers to the interaction patterns between different regions in the brain. In this project we will develop machine learning methods to capture and study complex functional network characteristics. We hypothesize that these characteristics not only offer insights into brain function but also can be used as concise features that can be used instead of the full dataset for tasks like classification of healthy versus diseased populations or for clustering subjects that might exhibit similarities in brain function. In general, the amount of correlation between distant brain regions may be a more reliable feature than the region-based signals to discriminate between two populations e.g. in schizophrenia. For such exploratory methods to be successful, close interaction with neuroscientists is necessary, as the salience of the features depends on the population and the observed effects of psychopathology. For this aim we propose to develop a number of important methodological advances in the context of prediction of treatment outcomes for drug addicted populations, i.e. for relapse prediction.

7.1.1.4. MMoVNI Digiteo project

Participants: Bertrand Thirion [Correspondant], Pierre Fillard, Viviana Siless, Stéphanie Allassonnière, Hao Xu.

This is a joint project with CMAP <http://www.cmapx.polytechnique.fr/~allassonniere/>, 2010-2013.

Modeling and understanding brain structure is a great challenge, given the anatomical and functional complexity of the brain. In addition to this, there is a large variability of these characteristics among the population. To give a possible answer to these issues, medical imaging researchers proposed to construct a template image. Most of the time, these analysis only focus on one category of signals (called modality), in particular, the anatomical one was the main focus of research these past years. Moreover, these techniques are often dedicated to a particular problem and raise the question of their mathematical foundations. The MMoVNI project aims at building atlases based on multi-modal images (anatomy, diffusion and functional) data bases for given populations. An atlas is not only a template image but also a set of admissible deformations which characterize the observed population of images. The estimation of these atlases will be based on a new generation of deformation and template estimation procedures that build an explicit statistical generative model of the observed data. Moreover, they make it possible to infer all the relevant variables (parameters of the atlases) thanks to stochastic algorithms. Lastly, this modeling allows also to prove the convergence of both the estimator and the algorithms which provides a theoretical guarantee to the results. The models will first be proposed independently for each modality and then merged together to take into account, in a correlated way, the anatomy, the local connectivity through the cortical fibers and the functional response to a given cognitive task. This model will then be generalized to enable the non-supervised clustering of a population. This leads therefore to a finer representation of the population and a better comparison for classification purposes for example. The Neurospin center, partner of this project, will allow us to have access to databases of images of high-quality and high-resolution for the three modalities: anatomical, diffusion and functional imaging. This project is expected to contribute to making neuroimaging a more reliable tool for understanding inter-subject differences, which will eventually benefit to the understanding and diagnosis of various brain diseases like Alzheimer's disease, autism or schizophrenia.

7.2. National Initiatives

7.2.1. ANR

7.2.1.1. BrainPedia project

Participants: Bertrand Thirion [Correspondant], Gaël Varoquaux, Yannick Schwartz, Virgile Fritsch.

BrainPedia is an ANR JCJC (2011-2015) which addresses the following question: Neuroimaging produces huge amounts of complex data that are used to better understand the relations between brain structure and function. While the acquisition and analysis of this data is getting standardized in some aspects, the neuroimaging community is still largely missing appropriate tools to store and organize the knowledge related to the data. Taking advantage of common coordinate systems to represent the results of group studies, coordinate-based meta-analysis approaches associated with repositories of neuroimaging publications provide a crude solution to this problem, that does not yield reliable outputs and loses most of the data-related information. In this project, we propose to tackle the problem in a statistically rigorous framework, thus providing usable information to drive neuroscientific knowledge and questions.

7.2.1.2. IRMgroup project

Participants: Bertrand Thirion [Correspondant], Alexandre Gramfort, Michael Eickenberg.

This is a joint project with Polytechnique/CMAP <http://www.cmap.polytechnique.fr/>: Stéphanie Allasonnière and Stéphane Mallat (2010-2013).

Much of the visual cortex is organized into visual field maps, which means that nearby neurons have receptive fields at nearby locations in the image. The introduction of functional magnetic resonance imaging (fMRI) has made it possible to identify visual field maps in human cortex, the most important one being the medial occipital cortex (V1,V2,V3). It is also possible to relate directly the activity of simple cells to an fMRI activation pattern and Parietal developed some of the most effective methods. However, the simple cell model is not sufficient to account for high-level information on visual scenes, which requires the introduction of specific semantic features. While the brain regions related to semantic information processing are now well understood, little is known on the flow of visual information processing between the primary visual cortex and the specialized regions in the infero-temporal cortex. A central issue is to better understand the behavior of intermediate cortex layers.

Our proposition is to use our mathematical approach to formulate explicitly some generative model of information processing, such as those that characterize complex cells in the visual cortex, and then to identify the brain substrate of the corresponding processing units from fMRI data. While fMRI resolution is still too coarse for a very detailed mapping of detailed cortical functional organization, we conjecture that some of the functional mechanisms that characterize biological vision processes can be captured through fMRI; in parallel we will push the fMRI resolution to increase our chance to obtain a detailed mapping of visual cortical regions.

7.2.1.3. Nicconnect project

Participants: Bertrand Thirion, Gaël Varoquaux [Correspondant], Alexandre Abraham.

- **Context:** The NiConnect project (2012-2016) arises from an increasing need of medical imaging tools to diagnose efficiently brain pathologies, such as neuro-degenerative and psychiatric diseases or lesions related to stroke. Brain imaging provides a non-invasive and widespread probe of various features of brain organization, that are then used to make an accurate diagnosis, assess brain rehabilitation, or make a prognostic on the chance of recovery of a patient. Among different measures extracted from brain imaging, functional connectivity is particularly attractive, as it readily probes the integrity of brain networks, considered as providing the most complete view on brain functional organization.
- **Challenges:** To turn methods research into popular tool widely usable by non specialists, the NiConnect project puts specific emphasis on producing high-quality open-source software. NiConnect addresses the many data analysis tasks that extract relevant information from resting-state fMRI datasets. Specifically, the scientific difficulties are *i*) conducting proper validation of the models and tools, and *ii*) providing statistically controlled information to neuroscientists or medical doctors. More importantly, these procedures should be robust enough to perform analysis on limited quality data, as acquiring data on diseased populations is challenging and artifacts can hardly be controlled in clinical settings.

- **Outcome of the project:** In the scope of computer science and statistics, NiConnect pushes forward algorithms and statistical models for brain functional connectivity. In particular, we are investigating structured and multi-task graphical models to learn high-dimensional multi-subject brain connectivity models, as well as spatially-informed sparse decompositions for segmenting structured from brain imaging. With regards to neuroimaging methods development, NiConnect provides systematic comparisons and evaluations of connectivity biomarkers and a software library embedding best-performing state-of-the-art approaches. Finally, with regards to medical applications, the NiConnect project also plays a support role in on going medical studies and clinical trials on neurodegenerative diseases.
- **Consortium**
 - Parietal Inria research team: applied mathematics and computer science to model the brain from MRI
 - LIF INSERM research team: medical image data analysis and modeling for clinical applications
 - CATI center: medical image processing center for large scale brain imaging studies
 - Henri-Mondor hospital neurosurgery and neuroradiology: clinical teams conducting research on treatments for neurodegenerative diseases, in particular Huntington and Parkinson diseases
 - Logilab: consulting in scientific computing

7.3. European Initiatives

7.3.1. HBP

Type: COOPERATION

Instrument: Collaborative Project with Coordination and Support Action

Objectif: NC

Duration: October 2013 - March 2016

Coordinator: EPFL, Lausanne

Partner: 86 partners, <https://www.humanbrainproject.eu/fr/discover/the-community/partners?jsessionid=10vokilfkjcyhhgmfxu609p40>

Inria contact: Olivier Faugeras

Abstract:

Understanding the human brain is one of the greatest challenges facing 21st century science. If we can rise to the challenge, we can gain profound insights into what makes us human, develop new treatments for brain disease and build revolutionary new computing technologies. Today, for the first time, modern ICT has brought these goals within sight.

Convergence of ICT and Biology The convergence between biology and ICT has reached a point at which it can turn the goal of understanding the human brain into a reality. This realisation motivates the Human Brain Project – an EU Flagship initiative in which over 80 partners will work together to realise a new "ICT-accelerated" vision for brain research and its applications.

One of the major obstacles to understanding the human brain is the fragmentation of brain research and the data it produces. Our most urgent need is thus a concerted international effort that uses emerging emerging ICT technologies to integrate this data in a unified picture of the brain as a single multi-level system.

Research Areas The HBP will make fundamental contributions to neuroscience, to medicine and to future computing technology.

In *neuroscience*, the project will use neuroinformatics and brain simulation to collect and integrate experimental data, identifying and filling gaps in our knowledge, and prioritising future experiments.

In *medicine*, the HBP will use medical informatics to identify biological signatures of brain disease, allowing diagnosis at an early stage, before the disease has done irreversible damage, and enabling personalized treatment, adapted to the needs of individual patients. Better diagnosis, combined with disease and drug simulation, will accelerate the discovery of new treatments, drastically lowering the cost of drug discovery.

In *computing*, new techniques of interactive supercomputing, driven by the needs of brain simulation, will impact a vast range of industries. Devices and systems, modelled after the brain, will overcome fundamental limits on the energy-efficiency, reliability and programmability of current technologies, clearing the road for systems with brain-like intelligence.

The Future of Brain Research

Applying ICT to brain research and its applications promises huge economic and social benefits. But to realise these benefits, the technology needs to be made accessible to scientists – in the form of research platforms they can use for basic and clinical research, drug discovery and technology development. As a foundation for this effort, the HBP will build an integrated system of ICT-based research platforms, building and operating the platforms will require a clear vision, strong, flexible leadership, long-term investment in research and engineering, and a strategy that leverages the diversity and strength of European research. It will also require continuous dialogue with civil society, creating consensus and ensuring the project has a strong grounding in ethical standards.

The Human Brain Project will last ten years and will consist of a ramp-up phase and a partially overlapping operational phase.

7.4. International Initiatives

7.4.1. Inria Associate Teams

Title: Analysis of structural MR and DTI in neonates

Inria principal investigator: Pierre Fillard

International Partner:

Institution: University of Southern California (United States)

Laboratory: Image Lab at Children Hospital at Los Angeles

Researcher: Natasha Lepore

International Partner:

Institution: University of Pennsylvania (United States)

Laboratory: Penn Image Computing and Science Laboratory

Researcher: Caroline Brun

Duration: 2011 - 2013

See also: <http://www.capneonates.org/>

While survival is possible at increasingly lower gestational ages at birth, premature babies are at higher risk of developing mental disorders or learning disabilities than babies born at term. A precise identification of the developmental differences between premature and control neonates is consequently of utmost importance. Nowadays, the continuously improving quality and availability of MR systems makes it possible to precisely determine, characterize and compare brain structures such as cortical regions, or white matter fiber bundles. The objective of this project is to understand the developmental differences of premature versus normal neonates, using structural and diffusion MRI. This work will consist in identifying, characterizing and meticulously studying the brain structures that are different between the two groups. To do so, we propose to join forces between the

Parietal team at Inria and the University of Southern California. Parietal has a recognized expertise in medical image registration and in statistical analyses of groups of individuals. USC has a broad knowledge in MR image processing. In particular, the Children's Hospital at Los Angeles (CHLA), which is part of USC, is in the process of collecting a unique database of several hundreds of premature and normal neonates MR scans. This joint collaboration is consequently a unique chance of addressing key questions pertaining to neonatal and premature development. It will make it possible to elaborate new tools to analyze neonate MR images while tremendously increasing our knowledge of neuroanatomy at such an early stage in life.

7.4.2. Inria International Labs

Parietal has taken part to the program Inria@SiliconValley, and had a 18-months post-doc funded to work on the comparison of anatomical and functional connectivity (18 months, 2011-2013):

In this project, we build probabilistic models that relates quantitatively the observations in anatomical and functional connectivity. For instance given a set of brain regions, the level of functional integration might be predicted by the anatomical connectivity measurement derived from the fibers in a given population of subjects. More generally, we seek to extract latent factors explaining both connectivity measures across the population. Such models require specifically that a generative model is proposed to explain the observations in either domain, so that a meaningful and testable link is built between the two modalities. The inference problem can then be formulated as learning the coupling parameters that are necessary to model the association between modalities, and tested e.g. by assessing the ability of the learned model to generalize to new subjects. The aim is then to provide the mathematical and algorithmic tools necessary to build a standardized model of brain connectivity informed by both modalities, associated with confidence intervals to take into account between subject variability. Such an atlas is a long-term project, that requires adequate validation on high-resolution data, but it is tightly linked to this project.

7.5. International Research Visitors

7.5.1. Visits of International Scientists

7.5.1.1. Internships

Felipe Yanez made a three months internship (January-March 2013), funded by Inria Chile and Conycit. His research topic was *Improving the fit of functional MRI data through the use of sparse linear models*.

7.5.1.2. Other visitors

Danilo Bzdok (Forschungszentrum Jülich, institute of neuroscience and medicine) visited Parietal in September 2013, to develop collaborations on the use of machine learning techniques to model behavioral variables and find data-driven characterization of brain diseases.

7.5.2. Visits to International Teams

- Yannick Schwartz spent one month in University of Texas at Austin, in Poldrack's lab <http://www.poldracklab.org/>. This stay was an opportunity to improve our understanding of the main challenges in functional brain imaging modalities.
- Philippe Ciuciu spent two months in the Paul Sabatier University (Toulouse, France), as part of the CIMI labex, where he runs a collaboration on compressed sensing for MRI.

POMDAPI Project-Team

6. Partnerships and Cooperations

6.1. National Initiatives

ANR GEOPOR: “Geometrical approach for porous media flows: theory and numerics”, with LJLL (Université de Paris 6).

ANR MANIF: “Mathematical and numerical issues in first-principle molecular simulation”, with Ceramics (École Nationale des Ponts et Chaussées), and LJLL (Université de Paris 6).

ARC Geofrac: (*Action de Recherche Coopérative*, Inria) “Large-scale computation of flow in complex 3D geological fractured porous media” with Inria project-teams Sage and Gamma3. From 2011.

C2S@Exa (Computer and Computational Sciences at Exascale) is an Inria Project Lab (IPL). This national initiative aims at the development of numerical modeling methodologies that fully exploit the processing capabilities of modern massively parallel architectures in the context of a number of selected applications related to important scientific and technological challenges for the quality and the security of life in our society. This project supports in particular the PhD of N. Birgler (supervised by J. Jaffré) which is part of an Inria-Andra collaboration.

Projet P: Project P is a four-year research project funded by the French FUI (*Fonds Unique Interministériel*) that started in 2011. Project P aims at supporting the model-driven engineering of high-integrity embedded real-time systems by providing an open code generation framework. The contribution of project-team Pomdapi is in the domain of language translation and block-schema modelisation semantics. This project supports the work of C. Franchini (under the supervision of P. Weis).

6.2. European Initiatives

6.2.1. FP7 Projects

Program: ERC Czech Republic

Project acronym: MORE

Project title: Implicitly constituted material models: from theory through model reduction to efficient numerical methods

Duration: September, 2012–August, 2017

Coordinator: Josef Málek, Charles University in Prague

Other partners: Charles University in Prague, Czech Republic; Institute of Mathematics, Academy of Sciences of the Czech Republic, Czech Republic; Oxford Centre for Nonlinear Partial Differential Equations, United Kingdom

www: <http://more.karlin.mff.cuni.cz/>

6.3. International Initiatives

Pomdapi is associated with LIRNE-Équipe d’Ingénierie Mathématiques, Université Ibn Tofaïl (Kenitra, Morocco) (PHC Volubilis) in the project “Techniques multi-échelles adaptatives pour la résolution des problèmes d’écoulement et de transport en milieux poreux hétérogènes”. From 2010.

Pomdapi is part of the EuroMediterranean 3+3 program with the project HYDRINV (Direct and inverse problems in subsurface flow and transport). Besides Inria institutions participating in this project are: Universitat Politècnica de Catalunya (Barcelona, Spain), Universidad de Sevilla (Spain), École Mohamedia d’Ingénieurs (Rabat, Morocco), Université Ibn Tofaïl (Kenitra, Morocco), University Centre of Khemis Miliana (Algeria), École Nationale d’Ingénieurs de Tunis (Tunisia). From 2012.

6.4. International Research Visitors

6.4.1. Visits of International Scientists

Laïla Amir, professor at FSTG in Marrakech, Morocco, was invited for one week.

H. Ben Ameer, professor at IPEST and member of the ENIT-Lamsin laboratory, Tunis, Tunisia, was invited for three months.

Lamia Guellouz, associate professor at Ecole Nationale d'Ingénieurs de Tunis, Tunisia, was invited for two weeks.

Z. Mghazli, professor at university Ibn Tofaïl, Kenitra, Morocco, was invited for one week.

6.4.2. Internships

E. Ahmed, from École Nationale d'Ingénieurs de Tunis (Tunisia), has visited Pomdapi for nine months on the subject *Modélisation d'écoulements diphasiques dans un milieu poreux fracturé*.

F. Cheikh, from École Nationale d'Ingénieurs de Tunis (Tunisia), has visited pomdapi for six months on the subject *Identification de failles dans un milieu poreux par une méthode d'indicateurs*.

M. H. Riahi, from École Nationale d'Ingénieurs de Tunis (Tunisia), has visited Pomdapi for six months on the subject *Identification de paramètres hydrogéologiques dans un milieu poreux*.

6.4.3. Visits to International Teams

M. Vohralík has visited from March 29th till May 15th Charles University in Prague, Czech Republic, Departement of Numerical Analysis (collaboration on the project MORE, teaching a Master 2nd year course).

Popix Team

8. Partnerships and Cooperations

8.1. European Initiatives

8.1.1. FP7 Projects

The Drug Disease Model Resources (DDMoRe) consortium will build and maintain a universally applicable, open source, model-based framework, intended as the gold standard for future collaborative drug and disease modeling and simulation.

The DDMoRe project is supported by the Innovative Medicines Initiative (IMI), a large-scale public-private partnership between the European Union and the pharmaceutical industry association EFPIA.

Marc Lavielle is leader of WP6: "New tools for Model Based Drug Development".

DDMoRe website: <http://www.ddmore.eu>

Duration: 2010 - 2015

Project members: Uppsala Universitet, Sweden; University of Navarra, Spain; Universiteit Leiden, Netherlands; Université Paris Diderot, France; Università degli Studi di Pavia, Italy; UCB Pharma, Belgium; Simcyp, UK; Pfizer, UK; Optimata, Israel; Novo Nordisk, Denmark; Novartis, Switzerland; Merck Serono, Switzerland; Mango Business Solutions, UK; Lixoft, France; Interface Europe, Belgium; Institut de Recherches Internationales Servier, France; Inria, France; GlaxoSmithKline Research and Development, UK; Freie Universität Berlin, Germany; F. Hoffmann - La Roche, Switzerland; EMBL - European Bioinformatics Institute, UK; Eli Lilly, UK; Cyprotex Discovery, UK; Consiglio Nazionale delle Ricerche, Italy; AstraZeneca, Sweden.

REO Project-Team

7. Partnerships and Cooperations

7.1. National Initiatives

7.1.1. ANR

7.1.1.1. ANR Project “M3RS”

Participants: Laurent Boudin, Muriel Boulakia, Céline Grandmont [Principal Investigator], Irène Vignon-Clementel.

Period: 2008-2013.

This project, coordinated by C. Grandmont, aims at studying mathematical and numerical issues raised by the modeling of the lungs.

7.1.1.2. ANR Project “Epsilon”

Participant: Marina Vidrascu [local coordinator].

Period: 2009-2013

This project, coordinated by Jean-Jacques Marigo (LMS-Ecole polytechnique) aims to study Domain decomposition and multi-scale computations of singularities in mechanical structures.

7.1.1.3. ANR Project “EXIFSI”

Participants: Benoit Fabrèges, Miguel Ángel Fernández Varela [Principal Investigator], Mikel Landajuela Larma, Marina Vidrascu.

Period: 2012-2016

The aim of this project, coordinated by Miguel Àngel Fernández Varela, is to study mathematically and numerically new numerical methods for incompressible fluid-structure interaction.

7.1.1.4. ANR Project “CARDIOXCOMP”

Participants: Muriel Boulakia, Jean-Frédéric Gerbeau [Principal Investigator], Fabien Raphel.

Period: 2013-2013.

This project, coordinated by Jean-Frédéric Gerbeau, is carried out in the framework of a joint laboratory (“LabCom” call of ANR) with the software company NOTOCORD. The focus is the mathematical modeling of a device measuring the electrical activity of cardiomyocytes. The overall objective of CardioXcomp is to enrich NOTOCORD’s software with modelling and simulation solutions and provide to pharmacology research a completely new set incorporating state of the art signal processing and numerical simulation.

7.1.1.5. ANR Project “iFLOW”

Participants: Chloé Audebert, Jean-Frédéric Gerbeau, Irène Vignon-Clementel [co-Principal Investigator].

Period: 2013-2017.

This ANR-tecsan, co-managed by Eric Vibert (Paul Brousse Hospital) and Irene Vignon-Clementel, aims at developing an Intraoperative Fluorescent Liver Optimization Workflow to better understand the relationship between architecture, perfusion and function in hepatectomy.

7.2. European Initiatives

7.2.1. FP7 Projects

7.2.1.1. REVAMMAD

Type: PEOPLE

Instrument: Marie Curie Initial Training Network

Duration: April 2013 - March 2017

Coordinator: Andrew Hunter, University of Lincoln (UK)

Partners: See the [web site](#)

Inria contact: J-F Gerbeau

Abstract: **REVAMMAD** is a European Union project aimed at combatting some of the EU's most prevalent chronic medical conditions using retinal imaging. The project aims to train a new generation of interdisciplinary scientists for the academic, clinical and industrial sectors, and to trigger a new wave of biomedical interventions. The role of REO team within this consortium is to propose a mathematical model and a simulation tool for the retina hemodynamics.

7.3. International Initiatives

7.3.1. Inria Associate Teams

Participants: Grégory Arbia, Miguel Ángel Fernández Varela, Jean-Frédéric Gerbeau, Céline Grandmont, Jessica Oakes, Irène Vignon-Clementel [coordinator].

Period: 2008-2013

CARDIO: The aim of this project is to foster the collaboration between the Cardiovascular Biomechanics Research Laboratory (CVBRL) of C.A. Taylor (Stanford University, USA) and colleagues such as Dr. Feinstein, and the project-team REO, through research on cardiovascular and respiratory related topics (boundary conditions for complex flow, patient-specific modeling of congenital heart disease, image-based fluid solid interaction, postprocessing of numerical simulations). The associated team has been extended to other partners: team-project MACS at Inria, the Marsden group at University of California in San Diego and the and the Shadden group at University of California in Berkeley.. CA Figueroa is now at KCL, UK.

7.3.2. Trans-Atlantic Network of Excellence for Cardiovascular Research

Participants: Grégory Arbia, Jean-Frédéric Gerbeau, Irène Vignon-Clementel [correspondant].

Period: 2010-2015

This network, funded by the Leducq fondation, is working on the multi-scale modeling of single ventricle hearts for clinical decision support ³.

7.3.3. German BMBF national project Lungsys II

Participant: Irène Vignon-Clementel.

Period: 2012-2015 "Systems Biology of Lung Cancer "Dynamic Properties of Early Spread and Therapeutic Options". In collaboration with Dirk Drasdo EPI Bang, Inria & Paris 6 UPMC

7.4. International Research Visitors

7.4.1. Internships

- Stephanie Lindsey, PhD student at Cornell University, Aug 2013 - February 2014

³<http://modelingventricle.clemson.edu/home>

SAGE Project-Team

8. Partnerships and Cooperations

8.1. Regional Initiatives

8.1.1. Brittany council: FRACINI project

Participants: Jean-Raynald de Dreuzy, Jocelyne Erhel, Géraldine Pichot.

Contract with Brittany council

Duration: one year from December 2013.

Title: European initiative towards models and numerical methods for simulations in fractured-porous geological media.

Coordination: Géraldine Pichot.

Partners: Geosciences Rennes.

Web page: <http://www.irisa.fr/sage/>

Abstract: FRACINI is an initiative funded by the Région Bretagne. It aims at gathering researchers from the European community working on models and numerical methods for simulations in fractured-porous media. Two international workshops will be organized in 2014. The overall objective of these workshops is to end up with a submission of a proposal in response to the Future and Emerging Technology (FET) call of H2020 Funding.

8.2. National Initiatives

8.2.1. ANR-MN: H2MNO4 project

Participants: Édouard Canot, Jocelyne Erhel, Grégoire Lecourt, Aurélien Le Gentil, Lionel Lenôtre, Géraldine Pichot, Souhila Sabit.

Contract with ANR, program Modèles Numériques

Duration: four years from November 2012.

Title: Original Optimized Object Oriented Numerical Model for Heterogeneous Hydrogeology.

Coordination: Jocelyne Erhel and Géraldine Pichot, with Fabienne Cuyolla.

Partners: Geosciences Rennes, University of Poitiers, University of Lyon 1, Andra, Itasca.

International collaborations: University of San Diego (USA), UPC, Barcelona (Spain)

Web page: <http://h2mno4.inria.fr/>

Abstract: The project H2MNO4 develops numerical models for reactive transport in heterogeneous media. It defines six mathematical and computational challenges and three applications for environmental problems with societal impact (see 6.3, 5.1.1).

8.2.2. Inria Project Lab: HEMERA project

Participants: Jocelyne Erhel, Géraldine Pichot.

Title: Hemera - developing large scale parallel and distributed experiments

Duration: September 2010 - July 2014

Coordination: C. Perez, Avalon team.

Partners: 22 Inria teams.

Webpage: <http://www.grid5000.fr/mediawiki/index.php/Hemera>

Abstract: Hemera is an Inria Project Lab, started in 2010, that aims at demonstrating ambitious up-scaling techniques for large scale distributed computing by carrying out several dimensioning experiments on the Grid'5000 infrastructure, at animating the scientific community around Grid'5000 and at enlarging the Grid'5000 community by helping newcomers to make use of Grid'5000.

The team Sage is the leader of the Scientific Challenge Hydro: Multi-parametric intensive stochastic simulations for hydrogeology. The objective is to run multiparametric large scale simulations (see 6.3).

8.2.3. Inria Project Lab: C2S@EXA project

Participants: Édouard Canot, Thomas Dufaud, Jocelyne Erhel, Géraldine Pichot, Souhila Sabit.

Title: C2S@EXA - Computer and Computational Sciences at Exascale

Duration: from January 2012.

Coordination: S. Lanteri, Nachos team.

Partners: Inria teams working on HPC; external partners: ANDRA and CEA.

Webpage: http://www-sop.inria.fr/c2s_at_exa/

Abstract: The C2S@Exa Inria Project Lab is concerned with the development of numerical modeling methodologies that fully exploit the processing capabilities of modern massively parallel architectures in the context of a number of selected applications related to important scientific and technological challenges for the quality and the security of life in our society (see 6.1 , 6.3 , 6.4). The team participated in several workshops.

8.2.4. Inria Technological development actions: H2OGilde project

Participants: Jocelyne Erhel, Aurélien Le Gentil, Grégoire Lecourt, Géraldine Pichot.

Title: H2OGilde - Graphical User Interface and Library Development for H2OLab platform

Duration: October 2011 - October 2013.

Coordination: J. Erhel and G. Pichot.

Partner: Charles Deltel, SED Inria Rennes

Webpage: <http://www.irisa.fr/sage/>

Abstract: The project H2OGilde aims at developing an interface for the platform H2OLab and at designing software libraries with a large academic diffusion (see 5.1.1 , 5.1.5 , 5.1.4).

8.2.5. Inria Collaborative Research Action: GEOFRAC project

Participants: Thomas Dufaud, Jocelyne Erhel, Géraldine Pichot.

Title: GEOFRAC

Duration: June 2011-June 2013.

Coordinator: J. Erhel and G. Pichot.

Partners: Pomdapi and Gamma3 Inria teams, Géosciences Rennes.

Webpage: <http://www.irisa.fr/sage/geofrac/>

Abstract: In the last twenty years, the interest of geological fractured rocks has been renewed by a variety of energy-related applications, such as carbonate oil reservoirs, geothermic energy production, geological storage of high level nuclear waste, geological sequestration of CO₂. Fractures are highly permeable pathways within a less pervious but more porous medium generally called matrix. The discrete modeling of fractures faces at least two challenging numerical issues. First, the fracture and matrix phases have very different hydraulic properties. Permeability is at least two orders of magnitude larger in the fractures than in the matrix. Second, the fracture structure complexity yield intricate geometrical configurations difficult to mesh. We propose to address these limitations by developing new numerical methods (see 6.4 , 5.1.1).

8.2.6. GENCI: project on advanced linear solvers

Participants: Édouard Canot, Jocelyne Erhel, Grégoire Lecourt, Lionel Lenôtre, Géraldine Pichot.

Title: Scalabilité de méthodes numériques pour l'hydrogéologie

Duration: 2012

Coordination: J. Erhel and G. Pichot.

Webpage: <http://www.genci.fr/>

Abstract: To run large scale simulations, we defined a project, based on the software H2OLab, SBM, PALMTREE and GRT3D. We obtained and used computing time on machines located at GENCI supercomputing centers. (see 6.1 , 6.3).

8.2.7. GNR MOMAS: project on reactive transport

Participants: Jocelyne Erhel, Souhila Sabit.

Webpage: <https://www.ljll.math.upmc.fr/cances/gdrmomas/>

The working group MOMAS includes many partners from CNRS, Inria, universities, CEA, ANDRA, EDF and BRGM. It covers many subjects related to mathematical modeling and numerical simulations for nuclear waste disposal problems (see 6.3 , 6.4). The team participated in workshops.

8.3. European Initiatives

8.3.1. FP7: EXA2CT project

Title: EXascale Algorithms and Advanced Computational Techniques

Instrument: Specific Targeted Research Project

Duration: September 2013 - August 2016

Coordinator: S. Ashby, IMEC, Belgium

Partners: 10 partners

Inria contact: Luc Giraud

Web page: <https://projects.imec.be/exa2ct/>

Abstract: The goal of this project is to develop novel algorithms and programming models to tackle what will otherwise be a series of major obstacles to using a crucial component of many scientific codes at exascale, namely solvers and their constituents. The results of this work will be combined in running programs that demonstrate the application-targeted use of these algorithms and programming models in the form of proto-applications.

8.3.2. Collaborations with Major European Organizations

UPC: Universitat Politècnica de Catalunya-UPC, Institute of Environmental Assessment and Water Research (Spain)

numerical simulations in hydrogeology, reactive transport in heterogeneous media, upscaling, scientific software platform (see 5.1.1 , 6.3.1 , 6.4).

UFZ: Helmholtz Centre for Environmental Research-UFZ, Hydrogeology group (Germany)

numerical simulations in hydrogeology, flow in porous fractured media, scientific software platform

HPCLab: University of Patras, High Performance Information Systems Laboratory (Greece)

cooperation with B. Philippe in writing a book, and in common research on low rank approximations of matrix functions.

ERCIM: working group on numerical algorithms, high performance computing.

8.4. International Initiatives

8.4.1. Informal International Partners

University of Kent (USA)

Krylov methods

University of Purdue (USA)

High Performance Scientific Computing

University of San Diego (USA)

Hydrogeology

8.4.2. LIRIMA laboratory: momappli team (Cameroon)

Participant: Bernard Philippe.

Program: Laboratoire International de Recherche en Informatique et Mathématiques Appliquées

Title: Modélisation Mathématique et Applications

Inria principal investigator: Bernard Philippe

International Partner (Institution - Laboratory - Researcher): University of Yaounde, Cameroon - Norbert Noutchequeme

Duration: 2010-2013

See also: <http://www.lirima.uninet.cm/index.php/recherche/equipes-de-recherche/momappli>

Abstract: The team deals with high performance scientific computing, with a focus on reliable tools for localizing eigenvalues of large sparse matrices (see 6.1.4).

8.4.3. LIRIMA laboratory: EPIC team (Tunisia)

Participants: Amine Abdelmoula, Jocelyne Erhel, Sinda Khalfallah, Bernard Philippe.

Program: Laboratoire International de Recherche en Informatique et Mathématiques Appliquées

Title: Problèmes Inverses et Contrôle

Inria principal investigator: Houssem Haddar, Defi team

International Partner (Institution - Laboratory - Researcher): ENIT, University of Tunis, Tunisia - LAMSIN - Amel ben Abda

Duration: 2011-2013

See also: <http://www.lirima.uninet.cm/index.php/recherche/equipes-de-recherche/epic>

Abstract: The team deals with nonlinear and inverse problems.

8.4.4. Joint Laboratory for Petascale Computing (USA)

Participant: Jocelyne Erhel.

Program: Joint Laboratory for Petascale Computing

Inria principal investigator: Franck Cappello and Laura Grigori, Grand Large team

International Partner (Institution - Laboratory - Researcher): University of Illinois at Urbana-Champaign, USA - Marc Snir and Bill Gropp

Duration: 2011-2013

See also: <http://jointlab.ncsa.illinois.edu/>

Abstract: The team works on deflation methods and their integration into the software PETSc (see 6.1.1); the team works also on domain decomposition methods (see 6.4.2).

8.4.5. CEDRE program: MODNUM project (Lebanon)

Participants: Édouard Canot, Jocelyne Erhel, Bernard Philippe.

Program: CEDRE Lebanon

Title: Modélisation numérique pour des applications libanaises

Inria principal investigator: Jocelyne Erhel and Bernard Philippe

International Partner (Institution - Laboratory - Researcher): American University of Beirut (Lebanon)

Duration: Jan 2012 - Dec 2013

Abstract: the project deals with numerical parallel algorithms and with applications to archaeology.

8.4.6. *ECOS Sud (Argentina): ARPHYMAT project*

Participant: Édouard Canot.

Program: COFECUB

Title: Processus de formation et transformation de structures de combustion archéologique

Inria principal investigator: Édouard CANOT

International Partner (Institution - Laboratory - Researcher): University of Buenos Aires (Argentina)

Duration: Jan 2012 - Dec 2014

Abstract: the project concerns numerical simulations of prehistoric fires and comparison with archaeological data in South America.

8.4.7. *Inria Euromediterranean: HYDRINV project*

Participants: Édouard Canot, Jocelyne Erhel, Sinda Khalfallah, Bernard Philippe.

Program: **Euromediterranean 3+3**

Title: Direct and inverse problems in subsurface flow and transport

Coordination: H. ben Ameer, ENIT, Tunisia and J. Jaffré, Inria, Paris

Inria-Rennes principal investigator: Jocelyne Erhel

International Partners (Institution - Laboratory - Researcher):

Université Ibn Tofail - Faculté des Sciences de Kénitra (Morocco) - Laboratoire Interdisciplinaire en Ressources Naturelles et en Environnement - Zoubida Mghazli

Ecole Nationale d'Ingénieurs de Tunis (Tunisia) - Laboratoire de Modélisation en Hydraulique et Environnement - Rachida Bouhlila

Universidad de Sevilla (Spain) - Department Ecuaciones Diferenciales y Análisis Numérico - Tomas Chacon Rebollo

Universitat Politècnica de Catalunya (Spain) - Department of Geotechnical Engineering and Geo-Sciences - Xavier Sànchez Vila

University Centre of KHEMIS MILIANA (Algeria) - Laboratoire de l'Energie et des Systèmes Intelligents - Mohammed Hachama

Ecole Mohammadia d'Ingénieurs (Morocco) - LERMA - Rajae Aboulaich

Ecole Nationale d'Ingénieurs de Tunis (Tunisia) - Laboratoire de Modélisation Mathématique et Numérique dans les Sciences de l'Ingénieur - Hend Ben Ameer

Duration: Jan 2012 - Dec 2015

The management of water resources is a problem of great importance in all countries, and is particularly acute around the Mediterranean sea. The goal is to find a reasonable balance between these resources and demand while preserving the quality of water. Towards this goal it is essential to understand and simulate flow and transport in the subsurface. The science corresponding to this topic is hydrogeology. Since models become more and more complicated and quantitative answers must be given, numerical modeling become more and more sophisticated and mathematicians must also be involved. This project brings together hydrogeologists and mathematicians from France, Spain, Algeria, Morocco and Tunisia in order to develop, analyze, and validate numerical methods for several problems arising from modeling flow and transport in the subsurface. The emphasis is put on direct nonlinear problems (air-water flow, density driven flow related to salinization, transport with chemistry) and on inverse problems.

8.4.8. Joint supervision of M. Oumouni's PhD (Morocco)

Participants: Jocelyne Erhel, Mestapha Oumouni.

Program: International joint supervision of PhD agreement

Title: Méthodes numériques et leur analyse pour la résolution des équations de l'écoulement et de transport en milieux poreux hétérogènes et aléatoires

Inria principal investigator: Jocelyne Erhel

International Partner (Institution - Laboratory - Researcher): University Ibn Tofail - Faculté des Sciences de Kénitra (Morocco) - Zoubida Mghazli

Duration: Jan 2009 - June 2013

Abstract: see 6.3.3 .

8.4.9. Joint supervision of A. Abdelmoula's PhD (Tunisia)

Participants: Amine Abdelmoula, Bernard Philippe.

Program: International joint supervision of PhD agreement

Title: Résolution de problèmes inverses en géodésie physique

Inria principal investigator: Bernard Philippe

International Partner (Institution - Laboratory - Researcher): Ecole Nationale d'Ingénieurs de Tunis - LAMSIN (Tunisia) - Maher Moakher

Duration: 2005 - 2013

Abstract: The objective is to compute a set of point-mass which generate an a priori given gravitational field (see 8.4.7 , 8.4.3).

8.4.10. Joint supervision of S. Khalfallah's PhD (Tunisia)

Participants: Jocelyne Erhel, Sinda Khalfallah.

Program: International joint supervision of PhD agreement

Title: Contribution à l'analyse mathématique et numérique de quelques problèmes issus de l'hydrogéologie

Inria principal investigator: Jocelyne Erhel

International Partner (Institution - Laboratory - Researcher): Ecole Nationale d'Ingénieurs de Tunis - LAMSIN (Tunisia) - Amel ben Abda

Duration: 2010 - 2014

Abstract: The objective is to solve data completion problems applied to hydrogeology (see 8.4.7 , 8.4.3).

8.5. International Research Visitors

8.5.1. Visits of International Scientists

- Emmanuel Kamgnia, University of Yaoundé, 2 months, March-April 2013
- Nabil Nassif, American University of Beirut, 3 weeks, July 2013, November 2013, December 2013
- Stratis Gallopoulos, University of Patras, 1 week, August 2013
- Ahmed Sameh, University of Purdue, 1 week, August 2013
- Mohamad Muhieddine, Libanese University, 2 weeks, June 2013
- Lamia Guellouz, University of Tunis, 1 week, December 2013

8.5.2. Internships (Joint supervision of Ph-D students)

- Louis-Bernard Nguenang, University of Yaoundé, 4.5 months, March-July 2013

- Mestapha Oumouni, University of Kenitra, 3 months, March-June 2013
- Marwen ben Refifa, University of Tunis, 3 months, April-July 2013
- Salwa Mansour, Lebanese University, 7 months, Feb-Aug 2013

8.5.3. Visits to International Teams

- Édouard Canot, ENIT Tunis, Tunisia, 1 week, February 2013 (project HYDRINV)
- Jocelyne Erhel and Géraldine Pichot, UPC Barcelona, Spain, 1 week, April 2013 (project H2MNO4)
- Édouard Canot and Salwa Mansour and Bernard Philippe, Beirut, Lebanon, 1 week, May 2013 (project MODNUM)
- Édouard Canot, ANCBA Buenos Aires, Argentina, 2 weeks, November 2013 (project ARPHY-MAT)
- Bernard Philippe, Yaoundé, Cameroon, 1 week, December 2013 (project MOMAPPLI)

SERPICO Project-Team

8. Partnerships and Cooperations

8.1. Regional Initiatives

8.1.1. RTR SISCom project

Participant: Charles Kervrann.

In this project, we developed new statistical restoration algorithms for fluorescence and electron imaging and PSF (point-spread function) and CTF (contrast transfer function) correction, respectively. An integrated highly focused approach combining the efforts of three teams in image processing (Serpico), in-vivo light microscopy (IGDR-CeDRE) and cryo-electron tomography (IGDR-TIPs) has been studied to produce novel computational strategies for biological imaging.

Funding: RTR Syscom, European University of Brittany (UEB): 12 months

Partners: UMR 6290 – IGDR (Institut de Génétique et Développement de Rennes)

8.2. National Initiatives

8.2.1. Quaero project

Participants: Charles Kervrann, Patrick Bouthemey, Denis Fortun, Pierre Allain, Thibault Geffroy.

Quaero is a European collaborative research and development program with the goal of developing multimedia and multi-lingual indexing and management tools for professional and public applications. SERPICO team participates in the Work Package 9 on Video Processing (WP9) of QUAERO Core Technology Cluster Project (CTC). Within WP9, former Vista project-team led three tasks: “Motion Recognition”, “Object Tracking” and “Event Recognition”. Since October 2010, SERPICO has conducted activities in object tracking and indexing for video-microscopy analysis (Denis Fortun PhD grant) and Thibault Geffroy (Master 1 INSA Rouen).

Funding: Quaero (no. Inria Alloc 3184), duration: 60 months

Partners: 24 academic and industrial partners led by Technicolor

8.2.2. ANR GreenSwimmers project

Participant: Charles Kervrann.

Biofilms are composed of spatially organized microorganisms (possibly including pathogens) embedded in an extracellular polymeric matrix. A direct time-lapse confocal microscopic technique was recently developed to enable the real-time visualization of biocide activity within the biofilm. It can provide information on the dynamics of biocide action in the biofilm and the spatial heterogeneity of bacteria-related susceptibilities that are crucial for a better understanding of biofilm resistance mechanisms. The approach is here to characterize the spatial and temporal exploration of the biofilm by microorganisms.

In this project, SERPICO develop methods and software for the computation of mean velocity as well as other descriptors of swimmers bacteria dynamics inside biofilm image sequences. We investigate spatio-temporal features and descriptors for comparison, classification, indexing and retrieval.

Funding: ANR, duration: 24 months

Partners: INRA, AgroParisTech, Naturatech company

8.2.3. France-BioImaging project

Participants: Charles Kervrann, Patrick Bouthemey, Tristan Lecorgne, Tinaherinantenaina Rakotoarivelo, Thierry Pécot.

The goal of the project is to build a distributed coordinated French infrastructure for photonic and electronic cellular bioimaging dedicated to innovation, training and technology transfer. High computing capacities are needed to exhaustively analyse image flows. We address the following problems: i/ exhaustive analysis of bioimaging data sets; ii/ deciphering of key steps of biological mechanisms at organ, tissular, cellular and molecular levels through the systematic use of time-lapse 3D microscopy and image processing methods; iii/ storage and indexing of extracted and associated data and metadata through an intelligent data management system. SERPICO is co-head of the IPDM (Image Processing and Data Management) node of the FBI network composed of 6 nodes.

Funding: Investissement d’Avenir - Infrastructures Nationales en Biologie et Santé (2011-2016)

Partners: CNRS, Institut Jacques Monod, Institut Pasteur, Institut Curie, ENS Ulm, Ecole Polytechnique, INRA, INSERM

8.3. European Initiatives

8.3.1. Collaborations with Major European Organizations

ESFRI Euro-BioImaging initiative: SERPICO participates in the ESFRI Euro-BioImaging project, one of the four new biomedical science projects in the roadmap of the European Strategic Forum on Research Infrastructures (ESFRI). The mission of Euro-BioImaging is to provide access, service and training to state-of-the-art imaging technologies and foster the cooperation and networking at the national and European level including multidisciplinary scientists, industry regional, national and European authorities. (3-year Preparatory Phase / start: December 2010). SERPICO also participates in the French counterpart, the so-called “France-BioImaging” (FBI) network which gathers several outstanding cellular imaging centers (microscopy, spectroscopy, probe engineering and signal processing) as described in Section 8.2.3 .

8.4. International Research Visitors

8.4.1. Visits to International Teams

- Collaboration with Harvard Medical School (Boston, MA), Prof. G. Danuser, on object tracking in video-microscopy (P. Roudot’s visit in 2012-2013, 3 months, Inria & CNRS grant).
- Collaboration with University of California - San Francisco (USA), J. Sedat and D. Agard, on image denoising in cryo-electron microscopy.

SHACRA Project-Team

8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. *Sofa, ADT*

SOFA Large Scale Development Initiative (ADT) : the SOFA project (Simulation Open Framework Architecture) is an international, multi-institution, collaborative initiative, aimed at developing a flexible and open source framework for interactive simulations. This will eventually establish new grounds for a widely usable standard system for long-term research and product prototyping, ultimately shared by academic and industrial sites. The SOFA project involves 3 Inria teams, SHACRA, IMAGINE and ASCLEPIOS. The development program of the ADT started in 2007.

8.1.2. *ANR Acoustic*

The main objective of this project is to develop an innovative strategy based on models for helping decision-making process during surgical planning in Deep Brain Stimulation. Models will rely on different levels involved in the decision-making process; namely multimodal images, information, and knowledge. Two types of models will be made available to the surgeon: patient specific models and generic models. The project will develop methods for 1) building these models and 2) automatically computing optimal electrodes trajectories from these models taking into account possible simulated deformations occurring during surgery. The project belongs to the multidisciplinary domain of computer-assisted surgery (CAS). Computer assisted surgery aims at helping the surgeon with methods, tools, data, and information all along the surgical workflow. More specifically, the project addresses surgical planning and surgical simulation in Image Guided Surgery. It is related to the exponentially growing surgical treatment of Deep Brain Stimulation (DBS), originally developed in France by Pr. Benabid (Grenoble Hospital). The key challenges for this research project are 1) to identify, extract, gather, and make available the information and knowledge required by the surgeon for targeting deep brain structures for stimulation and 2) to realistically simulate the possible trajectories.

8.1.3. *IHU, Strasbourg*

Our team has been selected to be part of the IHU of Strasbourg. This new institute, for which funding (67M€) has just been announced, is a very strong innovative project of research dedicated to future surgery of the abdomen. It will be dedicated to minimally invasive therapies, guided by image and simulation. Based on interdisciplinary expertise of academic partners and strong industry partnerships, the IHU aims at involving several specialized groups for doing research and developments towards hybrid surgery (gesture of the surgeon and simulation-based guidance). Our group and SOFA have a important place in the project. Since September 2011 a part of our team is located within the IHU, to develop a number of activities in close collaboration with clinicians.

8.1.4. *ANR IDeaS*

IDeaS is a project targeted at per-operative guidance for interventional radiology procedures. Our main goal is to provide effective solutions for the two main drawbacks of interventional radiology procedures, namely: reduce radiation exposure and provide a fully 3D and interactive visual feedback during the procedure. To do so, our project relies on an original combination of computer vision algorithms and interactive physics-based medical simulation. Computer vision algorithms extract relevant information (like the actual projected shape of the guide-wire at any given time) from X-ray images, allowing adjusting the simulation to real data. Conversely, computer-based simulation is used as a sophisticated and trustful predictor for an improved initialization of computer vision tracking algorithms. Many outcomes may be expected both in scientific and clinical aspects. On the scientific side, we believe a better understanding of how real data and

simulation should be merged and confronted must lead, as a natural by-product, to image-based figures of merit to actually validate computer-based simulation outputs against real and dynamic data. A more accurate identification of the factors limiting the realism of simulation should follow with a rebound impact on the quality of the simulation itself. An actual integration of a mechanical model into the loop will improve the tracking. We firmly believe mechanical constraints can supplement the image data such that dynamic single view reconstruction of the interventional devices will be possible. On the clinical side, using the prediction capabilities of the simulation may decrease the need for X-ray images at high rates, thus leading to lower exposure to radiations for the patients and surgical staff. Finally, the output of the simulation is the 3D shape of the tool (e.g. guide-wire or catheter), but not only. Additional information may be visualized, for instance pressure of the catheter on the arterial wall, to prevent vessel wall perforations, or reduce stress on the arterial wall to prevent spasm. More generally, richer information on the live procedure may help surgeons to reduce malpractice or medical errors.

8.2. European Initiatives

8.2.1. FP7 Projects

8.2.1.1. RASimAs

Type: COOPERATION

Defi: NA

Instrument: Specific Targeted Research Project

Objectif: NC

Duration: nov 2012 - oct 2015

Coordinator: RHEINISCH-WESTFAELISCHE TECHNISCHE HOCHSCHULE (RWTH), Aachen, Germany

Partner: UNIVERSITAETS KLINIKUM AACHEN, Germany // RHEINISCH-WESTFAELISCHE TECHNISCHE HOCHSCHULE, Germany // BANGOR UNIVERSITY, United Kingdom // UNIVERSITY COLLEGE CORK, NATIONAL UNIVERSITY OF IRELAND, CORK, Ireland // UNIVERSIDAD REY JUAN CARLOS, Spain // FOUNDATION FOR RESEARCH AND TECHNOLOGY HELLAS, Greece // ZILINSKA UNIVERZITA V ZILINE, Slovakia // KATHOLIEKE UNIVERSITEIT LEUVEN, Belgium // SINTEF Norway, SENSEGRAPHICS, Sweden

Inria contact: Stéphane Cotin

Abstract: Regional anaesthesia has been used increasingly during the past four decades. This is addressed to the perceived advantages of reduced postoperative pain, earlier mobility, shorter hospital stay, and significantly lower costs. Current training methods for teaching regional anaesthesia include cadavers, video teaching, ultrasound guidance, and simple virtual patient modeling. These techniques have limited capabilities and do not consider individual anatomy. The goal of this project is to increase the application, the effectiveness and the success rates of RA and furthermore the diffusion of the method through the development VPH models for anaesthesia. The goal of the SHACRA team is to provide the computational infrastructure for the physics-based simulation and to propose new methods for patient-specific modeling and simulation of soft tissues and their interaction with the needle, including its effect on nerve physiology.

8.3. International Initiatives

8.3.1. Participation In other International Programs

Jeremie Dequidt has been a member of the Inria delegation at the India-France Technology Summit <http://indiafrancesummit.org/>. During a technology showcase, he presented SOFA and various medical simulators. He also was part of a roundtable about biotechnologies.

8.4. International Research Visitors

8.4.1. Visits to International Teams

Christian Duriez has been invited during one week (last week of October) by the JRL team in AIST Tsukuba Japan, to work with Pr. Eiichi Yoshida on using real-time simulation for the control of robotic tasks with deformable objects.

SISYPHE Project-Team

8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. ANR project *EBONSI: Extended Block-Oriented Nonlinear System Identification*

Participants: Boyi Ni, Michel Sorine, Qinghua Zhang.

The main idea of block-oriented nonlinear system identification is to model complex systems with interconnected simple blocks. Such models cover many industrial applications and are simple enough for theoretic studies. In EBONSI we extend classical block-oriented nonlinear models to new model structures motivated by applications, and relax some traditional restrictions on experimental conditions. This international project is jointly funded by the French ANR and the Chinese National Natural Science Foundation (NSFC) from 2011 to 2014. The partners are SISYPHE (project leader), the Centre de Recherche en Automatique de Nancy (CRAN), and the Laboratory of Industrial Process Monitoring and Optimization of Peking University.

8.1.2. ANR project *0DEFECT: On-board fault diagnosis for wired networks*

Participants: Mohamed Oumri, Michel Sorine, Qinghua Zhang.

Due to the increasing number of electric and electronic equipments in automotive vehicles, the reliability of electric connections is becoming more and more important. The project 0DEFECT aims at developing tools for on-board diagnosis of failures in electric wire connections in automotive systems. The project is funded by Agence Nationale de la Recherche (ANR) from 2009 to Jan 2013. The partners are CEA LIST (project leader), Renault Trucks, Freescale, PSA, Delphi, Supelec LGEP and Inria.

8.1.3. ANR project *SODDA: Soft Defects Diagnosis in wired networks*

Participants: Michel Sorine, Qinghua Zhang.

The need for detection, localization and characterization of defects in a cable network has led to the ANR projects SEEDS followed by 0-DEFECT in the automotive domain, INSCAN for cables along railways. These projects provide the foundations of diagnosis methods for cables – with a proof of feasibility in the case of hard defects (short-circuit, open circuit) - and some theoretical results on the associated inverse problems in the case of soft faults. They also made it possible to identify their limits. One of the principal limits of these methods, based on the principles of reflectometry, is the difficulty of detecting soft defects. If it was possible to detect and locate precisely these defects, that would help for preventive maintenance or prognosis. The objective of SODDA is to study the signatures of the soft defects, by combining theory and experiment, and to design and test innovative methods adapted to these signatures which are very difficult to detect. The project is run by an academic consortium, in close connection with an industrial board, responsible for keeping the work in realistic and relevant use cases. The Inria teams involved are POEMS and Sisyphé.

8.1.4. ANR project *EPOQ2: Estimation Problems for Quantum & Quantumlike systems*

Participants: Mazyar Mirrahimi, Pierre Rouchon, Michel Sorine.

The project **EPOQ2** is an ANR “Young researcher” project led by Mazyar Mirrahimi (Sisyphé). Its goal is to address a class of inverse problems arising from either the emerging application domain of “quantum engineering” or from some classical applications where a natural quantization lead to quantum-like systems, as it is the case in particular for inverse scattering for transmission lines. This research is in collaboration with the Pierre Aigrain laboratory at ENS Paris, Michel Devoret and Rob Schoelkopf at Yale University and Pierre Rouchon from Ecole Nationale Supérieure des Mines de Paris.

8.1.5. Inria Large Scale Initiative Action REGATE

REGATE (REgulation of the GonAdoTropE axis) has been a 4-year Large Scale Initiative Action funded by Inria in May 2009 dedicated to the modeling, simulation and control of the gonadotrope axis. The action is coordinated by Frédérique Clément. The Inria participants to this action are researchers of 2 Inria research teams, Contraintes and Sisyphe. There are also participants from INRA, Université Libre de Bruxelles (Unité de Chronobiologie théorique), Université Paris 6 (Laboratoire Jacques-Louis Lions) and the Florida State University.

The **closing meeting** of REGATE has hold this year on April 9th. Beyond its academic achievements (see more details on the publication page of the website), REGATE has played a significant role on the national level, in the constitution of the transversal research group “Integrative and translational approaches of human and animal reproduction” (GdR REPRO), that was initiated by ITMO (Multi OrganizationThematic Institute)) BCDE (Cell Biology, Development and Evolution).

8.2. European Initiatives

8.2.1. Collaborations in European Programs, except FP7

MODRIO: Model Driven Physical Systems Operation. This ITEA 2 (Information Technology for European Advancement) project is joined by partners from Austria, Belgium, Finland, France, Germany, Italy and Sweden. See the complete list on the MODRIO page of the **ITEA 2 call 6** website. The involved Inria project-teams are PARKAS, S4 and SISYPHE. It is coordinated by EDF, France.

To meet the evermore stringent safety and environmental regulations for power plants and transportation vehicles, system operators need new techniques to improve system diagnosis and operation. Open standards are necessary for different teams to cooperate by sharing compatible information and data. The objective of the MODRIO project is to extend modeling and simulation tools based on open standards from system design to system diagnosis and operation.

ERNSI: European Research Network System Identification. The SISYPHE project-team is involved in the activities of the European Research Network on System Identification (ERNSI) federating major European research teams on system identification. See the website of **ERNSI**. Funded as a SCIENCE project (1992 - 1995), HCM Project (1993-1996), TMR Project (1998 - 2003), this network, currently coordinated by Bo Wahlberg, Automatic Control, KTH, Stockholm, is still very active.

Partners: KTH (Sweden), Inria (France), TUD (Technische Universität Darmstadt), TUW (Vienna University of Technology), UCAM-DENG (University of Cambridge), ELEC (Vrije Universiteit Brussel), ULIN (Sweden), UNIPD (Italy).

8.3. International Initiatives

8.3.1. Inria International Partners

8.3.1.1. Declared Inria International Partners

Collaborations in Neuroscience & Neuroendocrinology:

- Boston University: joint publications [87], [92] (with John Burke, Tasso Kaper and Mark Kramer).
- University of Sevilla (Spain): joint publications [43] (with Emilio Freire and Enrique Ponce), participation in PhD examination boards (Mathieu Desroches).
- Joint publications with individual collaborators: Thomas Stiehl (IWR Heidelberg) [39] ; David Avitabile (School of Mathematical Sciences, University of Nottingham) [83] and Serafim Rodrigues (Centre for Robotics and Neural Systems, Plymouth University) [83], [7].
- Florida State University: joint work on GnRH decoding, with Richard Bertram and Joël Tabak, in the framework of the doctoral committee of Patrick Fletcher.

Collaborations in Quantum engineering:

The collaborations with the teams of Michel Devoret and Robert Schoelkopf, enforced through a two-year sabbatical visit of Mazyar Mirrahimi at Yale university, have led to a set of contributions ranging from the theoretical analysis and performance optimization of ongoing experiments on weak quantum measurements [47] and preparation of non-classical field states through single photon Kerr effect [49] to the design of new experiments on single qubit cooling by reservoir engineering techniques [46] and development of new quantum gates allowing the transfer of quantum information from a superconducting qubit to a cavity mode [111].

Collaborations in Classical engineering:

Long-term collaboration of Qinghua Zhang with Lennart Ljung (Linköping University, Sweden) and Peter Lindskog (NIRA Dynamics, Sweden) that led to the development of the System Identification ToolBox (SITB) is one of the main Matlab toolboxes commercialized by The Mathworks and several papers.

8.4. International Research Visitors

8.4.1. Visits of International Scientists

Koen TIELS, Vrije Universiteit Brussel, Department of Fundamental Electricity and Instrumentation, from the group of Johan SCHOUKENS, has visited us during October 2013.

8.4.2. Visits to International Teams

Mazyar Mirrahimi spent four months in the Qnantronics Laboratory of Michel Devoret and in the Rob Schoelkopf Lab at Yale University.

STEPP Team

8. Partnerships and Cooperations

8.1. Regional Initiatives

In 2012, we started an informal collaboration with Serge Fenet from the University of Lyon (LIRIS lab), which among others accompanied Brindusa Smaranda's MSc thesis. In 2013, a project we submitted to the IXXI Complex Systems Institute of the Rhône-Alps region, together with the CERAG lab, was accepted. The project is about modeling and data mining applied to territorial ecology.

8.2. National Initiatives

8.2.1. ANR

CITiES (*Calibrage et validation de modèles Transport - usagE des Sols*)

Program: "Modèles Numériques" 2012, ANR

Duration: 2013 – 2016

Coordinator: Emmanuel Prados (STEPP)

Other partners: LET, IDDRI, IRTES-SET ("Systemes and Transports" lab of Univ. of Tech. of Belfort-Montbéliard), IFSTTAR-DEST Paris (formerly INRETS), LVMT ("*Laboratoire Ville Mobilité Transport*", Marne la Vallée), VINCI (Pirandello Ingenierie, Paris), IAU Île-De-France (Urban Agency of Paris), AURG (Urban Agency of Grenoble), MOISE (Inria project-team)

Abstract: Calibration and validation of transport and land use models.

8.2.2. FRB (*Fondation pour la Recherche sur la Biodiversité*)

ESNET (Futures of ecosystem services networks for the Grenoble region)

Program: "Modeling and Scenarios of Biodiversity" flagship program, Fondation pour la Recherche sur la Biodiversité (FRB). This project is funded by ONEMA (*Office National de l'Eau et des Milieux Aquatiques*).

Duration: 2013 – 2016

Coordinator: Sandra Lavorel (LECA)

Other partners: EDDEN (UPMF/CNRS), IRSTEA Grenoble (formerly CEMAGREF), PACTE (UJF/CNRS), ERIC (Lyon 2/CNRS)

Abstract: This project explores alternative futures of ecosystem services under combined scenarios of land-use and climate change for the Grenoble urban area in the French Alps. In this project, STEEP works in particular on the modeling of the land use and land cover changes, and to a smaller extent on the interaction of these changes with some specific services.

8.3. International Initiatives

8.3.1. Participation In other International Programs

TRACER (*TRANUS, analyse de la calibration et des erreurs, retours sur Grenoble et Caracas*)

Program: Ecos-NORD

Duration: 2012 – 2014

Coordinator: Mathieu Saujot (IDDRI)

Other partners: University of Caracas (Venezuela)

8.4. International Research Visitors

8.4.1. Visits of International Scientists

In July 2013, we received a one week visit by Professor Tomás de la Barra (University of Caracas and Modelistica) and by Dr. Brian Morton (University of North Carolina), the two leading experts of the TRANUS model (de la Barra developed the model). We organized a 3-day training course on the TRANUS model around these visits, with attendees from various labs in France and Belgium as well as an extended visit to the urban planning agency of the Grenoble region.

8.4.2. Internships

Participant: Thomas Capelle.

Subject: Calibration of the TRANUS land use module

Date: from Apr 2013 until Aug 2013

Institution: Universidad de Chile, Santiago

Participant: Lara Antonela Colombo.

Subject: Optimization based formulation of local material flow assessment

Date: from Mar 2013 until Aug 2013

Institution: Universidad Nacional de Rosario (Argentina)

Participant: Martin Crespo.

Subject: Parameter optimization algorithm for a Transport/land use model via adjoint method.

Date: from Jul 2012 until Jan 2013

Institution: Universidad Nacional de Rosario (Argentina)

Participant: Laurent Gilquin.

Subject: Sensitivity analysis of TRANUS

Date: from Mar 2013 until Aug 2013

Institution: ENS Lyon

Participant: Jakub Krzywda.

Subject: Data mining for ecological accounting and material flow analysis

Date: from Mar 2013 until Aug 2013

Institution: Poznan University of Technology (Poland)

Participant: Brindusa Smaranda.

Subject: Data mining for ecological accounting and material flow analysis

Date: from Mar 2013 until Aug 2013

Institution: Erasmus Mundus on Data Mining Knowledge Management (Lyon and Barcelona)

Participant: Pablo Virgolini.

Subject: Optimization based formulation of local material flow assessment

Date: from Mar 2013 until Aug 2013

Institution: Universidad Nacional de Rosario (Argentina)

VIRTUAL PLANTS Project-Team

6. Partnerships and Cooperations

6.1. Regional Initiatives

6.1.1. *OpenAlea*

Participants: Christophe Pradal, Christophe Godin, Christian Fournier [INRA, LEPSE].

Funding: Agropolis foundation (Contractors for Virtual Plants: CIRAD and Inria from 2009 to 2013)

The aim of this project is to foster the development and the national and international diffusion of the platform OpenAlea. This opensource platform provides an easy-to-use environment for plant modelers through a visual programming interface to efficiently use and combine models or computational methods from different scientific fields in order to represent, analyze and simulate complex plant systems at different scales, from meristems to plant canopy. Work comprises the development of standard data structures, deployment tools, documentation, training, software engineering, user interface, interfaces with other platform, ...

6.1.2. *Agropolis computational plant seminar*

Participants: Yann Guédon, Thierry Fourcaud [CIRAD, AMAP], Christine Granier [INRA, LEPSE], Soazig Guyomarc'h [Montpellier 2 University, DIADE], Laurent Laplaze [IRD, DIADE].

Funding: Agropolis foundation (Contractor for Virtual Plants: CIRAD. From 2013 to 2016)

In the context of the creation of a world-level pole on plant science in the region Languedoc-Roussillon, we created a monthly seminar on plant modeling and its applications. The seminar is organized by Yann Guédon, Thierry Fourcaud (CIRAD, AMAP), Christine Granier (INRA, LESPE), Soazig Guyomarc'h (Montpellier 2 University, DIADE) and Laurent Laplaze (IRD, DIADE) with the support of Agropolis International and Agropolis Foundation.

6.1.3. *Fruit3D*

Participants: Mik Cieslak, Frédéric Boudon, Christophe Godin, Nadia Bertin [PSH, Avignon].

Funding: Agropolis foundation (Contractor for Virtual Plants: INRA, from 2009 to 2012)

The project gathers the competences of plant modelers, physicists and ecophysicists for developing a virtual tomato model. The model contains the geometrical description of a growing fruit, physical and biological laws involved in tissue differentiation and cell growth, physiological models (for sugar and hormone transfers) and mechanical model. Magnetic Resonance Imaging (MRI) techniques are used to provide an in vivo validation of the model by non invasive measurements.

Partners: PSH, INRA, Avignon; LCVN, IES, Université Sud de France, Montpellier.

6.1.4. *Rhizopolis*

Participants: Frédéric Boudon, Christophe Godin, Yann Guédon, Christophe Pradal.

Funding: Agropolis foundation (Contractor for Virtual Plants: INRA, from 2011 to 2013)

Rhizopolis is a multidisciplinary project on the biology and ecology of the plant root that addresses the broad roles of this organ in mineral nutrient and water acquisition. The consortium addresses central issues such as the coupling of membrane transport activity and structure-function relationships in roots and root symbioses, the integration of root-soil interactions in the rhizosphere at the whole root system level, and the development of key tools for imaging root development. Virtual Plants is mainly involved in the development of a software for automatically reconstructing root systems from 2D images.

Partners: DAR Team, UMR AGAP, UMR BPMC and UMR LEPSE (Montpellier).

6.1.5. *RhizoScanHT*

Participants: Julien Diener, Frédéric Boudon, Christophe Godin, Yann Guédon, Christophe Pradal.

Funding: Labex Numev (Contractor for Virtual Plants: UM2, from 2013 to 2014)

In this project, we extend the pipeline of 2D root system reconstruction developed in the project RhizoPolis to deal with high-throughput data. For this we develop the project in two directions: i) make the pipeline software components more robust to various acquisition conditions and root system complexities ii) use techniques coming from the big data community to upscale the indexing and reconstruction methods.

Partners: Zenith Inria Project Team, UMR AGAP, UMR BPMC and UMR LEPSE (Montpellier).

6.2. National Initiatives

6.2.1. ANR

6.2.1.1. *Morpholeaf*

Participants: Christophe Godin, Maryam Aliee.

Funding: ANR (Contractor for Virtual Plants: Inria, From 2011 to 2014)

The goal of this project is to apply a systems biology approach combining biological investigation and modeling on leaf margin development to elucidate how gene networks and hormone signalling are translated into specific growth patterns and generate complex shapes. This project brings together three groups that have complementary expertises in biology, image analysis and modeling to provide new insights into the mechanisms of leaf margin development. We will specifically determine the dynamics of CUC/miR164A/auxin activities during leaf development and their interrelations, establish the contributions of cell proliferation and cell expansion to leaf serration and leaf shape and address the contribution of auxin and CUC2 to differential growth and hence to leaf serration and leaf shape.

Partners: RDP ENS-Lyon; INRA Versailles.

6.2.1.2. *HydroRoot*

Participants: Mikaël Lucas [IRD], Christophe Pradal, Christophe Godin, Christophe Maurel [BPMP].

Funding: ANR (Contractor for Virtual Plants: Cirad, From 2012 to 2014)

The HydroRoot project proposes a unique combination of approaches in the model plant *Arabidopsis thaliana* to enhance our fundamental knowledge of root water transport. Accurate biophysical measurements and mathematical modeling are used, in support of reverse and quantitative genetics approaches, to produce an integrated view of root hydraulics. The HydroRoot project will address as yet unknown facets of root water transport. It will lead to an integrated view of root hydraulics that considers both tissue hydraulics and root architecture and explains how these components are controlled at the molecular level by physiological and/or environmental cues. Because of its strong physiological and genetic background, this research may also directly impact on breeding programs, for production of crops with optimised water usage and stress responses.

6.2.2. Other national grants

6.2.2.1. *OpenAlea 2.0*

Participants: Julien Coste, Christophe Pradal, Christophe Godin, Didier Parigot [Inria, Zenith].

Funding: Inria ADT (Contractors for Virtual Plants: Inria from 2012 to 2014)

The goal of this project is to develop an integrated multi-paradigm software environment for plant modeling. This environment will allow the user to draw, model, program or combine models interactively. In a first step, the component architecture of OpenAlea1 .0 will be extended to dynamically add plugin application. In a second step, we move to a decentralized architecture, capable of distributing simulations in the cloud and share virtual experiments on the web. Finally, the modeling environment to be adapted to run in a web browser using HTML5 and WebGL technology

Partners: EPI Zenith

6.2.2.2. MARS-ALT

Participants: Guillaume Baty, Christophe Pradal, Christophe Godin.

Funding: Inria ADT (Contractors for Virtual Plants: Inria from 2012 to 2014)

The goal of this project is to integrate in a single software platform all the software tools and algorithms that have been developed in various projects about meristem modeling in our teams. More precisely, we aim at building 3D models of meristem development at cellular resolution based on images obtained with confocal or multiphoton microscopy. This set of components will be used by biologists and modelers making it possible to build such meristem structures, to explore and to program them. This platform is embedded in the OpenAlea framework and is based on the imaging components of the platform MedInria.

Partners: EPI Asclepios, RDP ENS-Lyon/INRA, PHIV CIRAD

6.2.2.3. Echap

Participants: Christophe Pradal, Christian Fournier, Corinne Robert [INRA, EGC].

Funding: ONEMA (Contractor for Virtual Plants: INRA, From 2012 to 2014)

The objective of the ECHAP project is to reduce the frequency of treatments and the doses of pesticides applied on crops by taking advantage of natural mechanisms of disease escape related to crop architecture and by optimizing interception of pesticides by plant canopies. It focuses on the development of an integrative, yet modular, modeling tool on the OpenAlea platform that couples wheat architectural development, the interception and fate of fungicides and the dynamics of a pathogen. Various scenarios combining climate x architecture x fungicide treatment will be simulated to identify and propose efficient strategies of pesticide applications.

Partners: UMR EGC (Paris-Grignon), UMR LEPSE (Montpellier), ARVALIS (Institut du végétal, France), ALTEIRA (Research Institute for the Green World, The Netherlands), ADAS Intitute (UK), CNRS, and IRSTEA.

6.2.2.4. Morphogenetics

Participants: Christophe Godin, Frédéric Boudon, Christophe Pradal, Etienne Farcot, Yann Guédon.

Funding: Inria Project Lab (From 2011 to 2015)

Morphogenetics is an Inria transversal project gathering 3 Inria teams and two Inra teams. It aimed at understanding how flower shape and architecture are controlled by genes during development. Using quantitative live-imaging analysis at cellular resolution we will determine how specific gene functions affect both growth patterns and the expression of other key regulators. The results generated from these experiments will be integrated in a specially designed database (3D Atlas) and used as direct input to new predictive computational models for morphogenesis and gene regulation. Model predictions will then be further tested through subsequent rounds of experimental perturbation and analysis. A particular emphasis will be put on the modeling of mechanics in tissues for which different approaches will be developed.

Partners: ENS-Lyon; Imagine Inria Team (Grenoble); Morpheme Inria Team (Sophia-Antipolis).

6.2.2.5. Rose

Participants: Christophe Godin, Frédéric Boudon, Christophe Pradal.

Funding: INRA - Projet de Pari Scientifique (From 2012 to 2014)

In this project we want to quantify and understand how sugars interfere with hormonal signals (auxin, cytokinins) to regulate lateral bud outgrowth of aerial stems of roses. Experiments will be made on Rose stems to test different levels of sugar conditions and hormonal concentrations on bud outgrowth. An extension of the recently published hormonal model of apical dominance will be made to take into account the role of carbon as a signaling molecule.

Partners: UMR SAGAH, Angers

6.3. European Initiatives

6.3.1. Collaborations in European Programs, except FP7

- **iSAM** (Funding: European EraSybio+ Programme). This project aims at improving our knowledge of shoot apical meristem, and more specifically the combined action of auxin and cytokinin, using a systems biology approach. It is part of a wider program, the ERASysBio initiative, a consortium of European funding bodies, ministries and project management agencies. Four partners are involved in iSAM: the group of J. Murray will focus on mutants of cell cycle regulation, the group of Y. Helariutta is specialized in several aspects of cytokinin regulation, while the group of J. Traas in Lyon provides input regarding auxin regulation and transport, and Virtual Plants is in charge of the modeling aspects, in synergy with the three other groups.

6.4. International Initiatives

6.4.1. Inria International Partners

6.4.1.1. Informal International Partners

There is currently a very active connection with the group of Malcolm Bennett, at the Centre for Plant Integrative Biology (CPIB) in Nottingham, UK. The CPIB invests in the development of OpenAlea at the tissue level. This collaboration is expressed recently through several publication, e.g. [22].

An important collaboration with the Unit Hortsys of CIRAD et the Reunion island and in particular Frédéric Normand has been established for a number of year. The topic of the collaboration is the study of the phenology of mango tree. Three members of the team have been visiting our collaborators during the years.

6.5. International Research Visitors

6.5.1. Visits of International Scientists

The team received several visitors from foreign research groups in 2013:

- Farah Ben Naoum, from Sidi Bel Abbes University, Algeria, visited the team last summer for 1 month.
- Katarina Smolenova, from University of Göttingen, Germany, visited the team last fall for 2 weeks.
- Jianming Guo, from Canberra, Australia, visited the team for 5 weeks.
- Xavier Sirault, from Canberra, Australia, visited the team last spring for 2 days.
- John Fozard, from University of Nottingham, visited the team for 2 days.

6.5.1.1. Internships

- Eugenio Espinosa, from Universidad de México (UNAM), visited the team last spring for 6 month.

6.5.2. Visits to International Teams

During the year, Frédéric Boudon, Pierre Fernique and Jean Baptiste Durand visited Fred Normand of the UR Hortsys at the CIRAD La Réunion in April and November respectively.

VISAGES Project-Team

8. Partnerships and Cooperations

8.1. Regional Initiatives

8.1.1. Biogenouest

The VisAGeS team and the Neurinfo platform integrated the Biogenouest "Groupement d'Intérêt Scientifique (GIS)" in 2012.

Biogenouest is a Western France life science and environment core facility network. Research programmes are undertaken in the fields of Marine biology, Agriculture/Food-processing, Human health, and Bioinformatics. Set up in keeping with the inter-regional principle of complementarity, Biogenouest coordinates over twenty technological core facilities in both the Brittany and Pays de la Loire regions.

8.1.2. COREC projects

COREC is the "COmité de REcherche Clinique" of the University Hospital of Rennes. This comity proposes an annual project funding in the limit of 30k€ per project. In 2012, the Neurinfo platform as an incitative action for clinical research project emergence accompanied the COREC call by financially supporting the imaging part of the projects up to 50 MRI hours, ie 30k€. Two projects were selected by the COREC. The MALTA project led by radiologist Jean-Christophe Ferré will compare the ability of functional BOLD MRI and perfusion ASL MRI to detect language areas in patients with brain tumor.

8.1.3. Projet CRITT Santé Bretagne : AfaCorVis3D

Participants: Elise Bannier, Isabelle Corouge, Christian Barillot.

duration: 12 months from November 2011

A research project in fMRI involving 3D visual stimulation was performed to try and differentiate areas activated by 2D versus 3D visualisation, whether static or dynamic. The task was evaluated on 10 volunteers in the context of the Master Research Project of Guillaume Koch. Areas activated specifically by 3D visualisation were extracted.

8.1.4. Défis Scientifiques Emergents - Université de Rennes I

Participants: Aurore Esquevin, Isabelle Corouge, Elise Bannier, Jean-Christophe Ferré, Christian Barillot, Jean-Yves Gauvrit.

duration: 22 months from March 2012 (end: December 31, 2013)

The ASLDEM project was partially funded the University of Rennes 1 "Défis Scientifiques Emergents" grant (7000 euros).

8.1.5. Fondation de l'Avenir - Depression, suicide and fMRI

Participants: Elise Bannier, Isabelle Corouge, Jean-Christophe Ferré, Christian Barillot.

duration: 12 months from November 2012

In collaboration with EA 4712 "Comportement et Noyaux Gris Centraux" of the University of Rennes I, a complementary funding (20 000€) was obtained to support an ongoing fMRI research project on emotions, impulsivity and suicide. The study protocol and the fMRI task was finalized. Inclusions will start early 2013.

8.1.6. Fondation de l'Avenir - Stroke, rehabilitation and fMRI

Participants: Elise Bannier, Isabelle Bonan, Isabelle Corouge, Jean-Christophe Ferré, Christian Barillot, Jean-Yves Gauvrit.

duration: 12 months from November 2012

A complementary funding (20 000€) was obtained to support a new research project on rehabilitation of stroke patients. The fMRI protocol was setup, the task developed and validation on volunteers is ongoing. Patient inclusions will start in spring 2013.

8.1.7. *Fondation Planiol*

Participants: Elise Bannier, H el ene Raoult, Jean-Yves Gauvrit.

duration: 12 months from November 2012

In the context of a neurovascular imaging research study, funding (13500€) was obtained to perform a phantom study on test objects representing carotid stenosis, with a circulating flow. This project will be performed as part of a collaboration with Dr Cavaro M enard - Angers (LISA), Dr Langevin - Compi egne (UTC) and Pr Saint Jalmes - PRISM (UR1).

8.2. National Initiatives

8.2.1. ANR

8.2.1.1. ANR "Neurological and Psychiatric diseases" NUCLEIPARK

Participants: Christian Barillot, Sylvain Prima, Juan Francisco Garamendi Bragado.

NucleiPark project: In the context of the ANR-09-MNPS-016 Nucleipark project we develop a pipeline for detecting shape changes in Parkinson and Paralysis Supranuclear Progressive (PSP) diseases. The pipeline is based on the previous work of Benoit Comb es et al. [58]. The pipeline was first validated on controlled synthetic data. For Parkinson disease, a total of 16 patients and 11 healthy controls were evaluated. The structures analyzed were: PPN, GPe, GPi, Caudate, Putamen, SN, STN, RN. Differences (uncorrected $P < 0.001$) were found in the right putamen and caudate structures. And slight difference (uncorrected $P < 0.05$) in the right GPe. No significant correlation was found in PPN, GPi, SN, STN, and RN structures. In the case of PSP disease, a total of 10 patients and 11 healthy controls were evaluated. The structures analyzed were: PPN, GPe, GPi, Caudate, Putamen, SN, STN, RN. Differences (uncorrected $P < 0.001$) were found in the left caudate structure. No significant correlation was found in PPN, GPe, GPi, Putamen, SN, STN, and RN structures.

In the context of this project, we propose a statistical data analysis pipeline that uses the apparent diffusion coefficient (ADC) as biomarker. The ADC is computed considering the diffusion weighted signal as a scalar field on a 5-D manifold. This consideration allows to keep the information about direction of the ADC. We have tested the proposed pipeline on synthetic dataset with promising results. Other contributions were the implementation and minimization, in the 5-D non-euclidean space, of the total variation (in its dual formulation) inpainting problem as interpolation method used in the statistical pipeline.

8.2.1.2. ANR Cosinus VIP

Participants: Fang Cao, Olivier Commowick, Christian Barillot.

VIP is collaborative project supported by ANR "Conception and Simulation"; it was accepted in 2009 (around 1 million euros). VIP aims at building a computing environment enabling multi-modality, multi-organ and dynamic (4D) medical image simulation, using GRID infrastructure. The goal is to integrate proven simulation software of the four main imaging modalities (MRI, US, PET and X-Ray/CT), and to cope interoperability challenges among simulators. The partners are CREATIS in Lyon (main contractor, Principal Investigator: Tristan Glatard), UNS-I3S in Nice, CEA-LETI in Grenoble and MAAT-G Maat G, a spanish company. The role of VISAGES in this project concerns primarily Task 1.1 and Task 3.3, focusing respectively on ontologies development and application to multiple sclerosis images simulation. This grant serves as support for the positions of Olivier Luong (PhD student) and Germain Forestier (post-doc).

8.2.1.3. AINSI Inria joint project

Participants: Christian Barillot, Isabelle Corouge, Pierre Maurel, Jean-Christophe Ferr e, Elise Bannier, Camille Maumet.

We have been involved in a 2-year Inria ARC project AINSI (<http://thalie.ujf-grenoble.fr/ainsi>). AINSI stands for “Modeles statistiques pour l’Assimilation d’Informations de Neuroimagerie fonctionnelle et de perfusion cerebrale”. The goal is to propose an innovative statistically well-based solution to the joint determination of neural activity and brain vascularization by combining BOLD contrast images obtained in functional MRI and quantitative parametric images (Arterial Spin Labelling: ASL). The partners involved are the Mistiss project from Inria in Grenoble (Lead F. Forbes) and Parietal in Saclay, the INSERM Unit U594 (Grenoble Institute of Neuroscience) and the LNAO laboratory from CEA NeuroSpin.

8.2.1.4. TRANSLATE-MS-REPAIR

Participants: Fang Cao, Laurence Catanese, Olivier Commowick, Isabelle Corouge, Jean-Christophe Ferré, Elise Bannier, Gilles Edan, Christian Barillot.

It is now commonly admitted that MS is not only an inflammatory disease but a neurodegenerative disease as well. This project is devoted to show that the olesoxime molecule is not only neuroprotective, but it has the ability to promote the maturation of oligodendrocyte progenitor cells (OPCs) into myelinating oligodendrocytes. However, before considering a large-scale clinical trial to assess efficacy. An important aspect is that to date, no treatment for neuroprotection / remyelination has reached the stage of clinical proof of concept that aims Trophos company who is leading this project. It appears that the best criteria for assessing neuroprotective/remyelinating effect of the drug candidate, are MRI criteria. However, these imaging criteria have not yet been validated for use in multicentre trials - so we will also check the feasibility of such measures under this condition. In addition to Trophos company, the partners of this project are AP-HM/CNRSCEMEREM-CRMBM, CHU Rennes, CHU Reims, and Inria-VISAGES.

8.2.2. Competitvity Clusters

8.2.2.1. The HEMISFER Project

Participants: Elise Bannier, Isabelle Bonan, Isabelle Corouge, Jean-Christophe Ferré, Jean-Yves Gauvrit, Pierre Maurel, Lorraine Perronnet, Christian Barillot.

The HEMISFER project ("Hybrid Eeg-Mri and Simultaneous neuro-Feedback for brain Rehabilitation") will be conducted at Inria Rennes with the support of the Cluster of Excellence "CominLabs"¹. The goal of HEMISFER is to make full use of the neurofeedback paradigm in the context of rehabilitation and psychiatric disorders. The major breakthrough will come from the use of a coupling model associating functional and metabolic information from Magnetic Resonance Imaging (fMRI) to Electro-encephalography (EEG) to "enhance" the neurofeedback protocol. We propose to combine advanced instrumental devices (Hybrid EEG and MRI platforms), with new man-machine interface paradigms (Brain computer interface and serious gaming) and new computational models (source separation, sparse representations and machine learning) to provide novel therapeutic and neuro-rehabilitation paradigms in some of the major neurological and psychiatric disorders of the developmental and the aging brain (stroke, attention-deficit disorder, language disorders, treatment-resistant mood disorders, ...). This project will be conducted with the HYBRID and PANAMA Teams from Inria Rennes, the EA 4712 team from University of Rennes I and the ATHENA team from Inria Sophia-Antipolis. This work will benefit from the research 3T MRI and MRI-compatible EEG systems provided by the NeurInfo in-vivo neuroimaging platform on which these new research protocols will be set up. A budget of 500keuros will be provided by the CominLabs cluster in the next 3 years to support this project (through experimental designs, PhDs, Post-docs and Expert Engineers).

8.2.2.2. France Life Imaging (FLI)

Participants: Christian Barillot, Olivier Commowick, Michael Kain.

¹ <https://iww.inria.fr/cominlabs-newsletter/april-2013-four-projects-selected/#hemisfer>

France Life Imaging (FLI) is a proposed large-scale research infrastructure project aimed at establishing a coordinated and harmonized network of biomedical imaging in France. This project was recently selected by the call “Investissements d’Avenir - Infrastructure en Biologie et Santé”. One node of this project is the node Information Analysis and Management (IAM), a transversal node build by a consortium of teams that will contribute to the construction of a network for data storage and information processing. Instead of building yet other dedicated facilities, the IAM node will use already existing data storage and information processing facilities (LaTIM Brest; CREATIS Lyon; CIC-IT Nancy; Visages U746 Inria Rennes; CATI CEA Saclay; LSII/ICube Strasbourg) that will increase their capacities for the FLI infrastructure. Inter-connections and access to services will be achieved through a dedicated software platform that will be developed based on the expertise gained through successful existing developments. The IAM node has several goals. It aims first at building a versatile facility for data management that will inter-connect the data production sites and data processing for which state-of-the-art solutions, hardware and software, will be available to infrastructure users. Modular solutions are preferred to accommodate the large variety of modalities acquisitions, scientific problems, data size, and adapted for future challenges. Second, it aims at offering the latest development that will be made available to image processing research teams. The team VISAGES fulfills multiple roles in this nation-wide project. Christian Barillot is the chair of the node IAM, Olivier Commowick is participating in the working group workflow and image processing and Michael Kain the technical manager. Apart from the team members, software solutions like medInria and Shanoir will be part of the final software platform.

8.2.2.3. OFSEP

Participants: Justine Guillaumont, Elise Bannier, Christian Barillot, Olivier Commowick, Gilles Edan, Isabelle Corouge, Jean-Christophe Ferré, Michael Kain.

The French Observatory of Multiple Sclerosis (OFSEP) is one of 10 projects selected in January 2011 in response to the call for proposal in the “Investissements d’Avenir - Cohorts 2010” program launched by the French Government. It allows support from the National Agency for Research (ANR) of approximately € 10 million for 10 years . It is coordinated by the Department of Neurology at the Neurological Hospital Pierre Wertheimer in Lyon (Professor Christian Confavreux), and it is supported by the EDMUS Foundation against multiple sclerosis, the University Claude Bernard Lyon 1 and the Hospices Civils de Lyon. OFSEP is based on a network of neurologists and radiologists distributed throughout the French territory and linked to 61 centers. OFSEP national cohort includes more than 35,000 people with Multiple Sclerosis, approximately half of the patients residing in France. The generalization of longitudinal monitoring and systematic association of clinical data and neuroimaging data is one of the objectives of OFSEP in order to improve the quality , efficiency and safety of care and promote clinical, basic and translational research in MS. For the concern of data management, the Shanoir platform of Inria has been retained to manage the imaging data of the National OFSEP cohort in multiple sclerosis.

8.3. European Initiatives

8.3.1. FP7 Projects

8.3.1.1. EuroBioimaging

Type: CAPACITIES

Defi: Provide access and training in imaging technologies, and share the best practice and image data in order to make Euro-BioImaging an engine that will drive European innovation in imaging research and technologies

Instrument: Combination of COLLABORATIVE PROJECTS and COORDINATION and SUPPORT ACTIONS

Objectif: Euro-BioImaging is a large-scale pan-European research infrastructure project on the European Strategy Forum on Research Infrastructures (ESFRI) Roadmap.

Duration: December 2010 - November 2013

Coordinators: Jan Ellenberg (EMBL) and Oliver Speck (University of Magdeburg)

Partner: EMBL (Germany); Erasmus Medical Center (Netherlands) for WG11

Inria contact: Ch. Barillot X. Pennec

Abstract: Euro-BioImaging is a pan-European infrastructure project whose mission is to build a distributed imaging infrastructure across Europe that will provide open access to innovative biological and medical imaging technologies for European researchers. The project is funded by the EU and currently the consortium is finalizing the basic principles for the operation of future Euro-BioImaging organisation.

Euro-BioImaging will be governed by representatives of the European countries that will join Euro-BioImaging (Euro-BioImaging member states).

The infrastructure established by Euro-BioImaging will consist of a set of geographically distributed but strongly interlinked imaging facilities (Euro-BioImaging Nodes), which will be selected among the leading European imaging facilities based on an independent evaluation process.

Inria and the Visages team is involved through the FLI national infrastructure and contributes to the WG11 Working Group on Data Storage and Analysis. This WG performs a series of tasks to define a European Biomedical Imaging Data Storage and Analysis infrastructure plan for the construction phase.

8.3.2. Collaborations in European Programs, except FP7

Program: COST

Project acronym: AID (oc-2010-2-8615)

Project title: Arterial spin labelling Initiative in Dementia

Acceptation date: 18/05/2011

Coordinator: X. Golay, UCL, London, UK

Other partners: Ghent University (BE), Liege University (BE), Hospital Cantonal de Geneve (CH), Fraunhofer MEVIS (D), Freiburg University (D), Max Planck Institute for Human Cognitive & Brain Sciences (D), Glostrup Hospital (DK), Hospital Santa Creu I Sant Pau (ES), Universidad Rey Juan Carlos (ES), University of Navarra (ES), INSERM U836 Grenoble (FR), University of Rennes I (FR), Centro San Giovanni di Dio - Fatebenefratelli (IT), Fondazione Istituto Neurologico Besta (IT), Leiden University Medical Center (NL), UMC Utrecht (NL), VU University Medical Centre (NL), Instituto Superior Técnico (PT), University of Porto (PT), Lund University Hospital (SE), Uppsala University Hospital (SE), Skane University Hospital (SE), Bogazici University (TR), King's College London (UK), University College London (UK), University of Nottingham (UK), University of Oxford (UK)

Abstract: Dementia is a major clinical challenge with care costs approaching 1% of global GDP. Recent estimates suggest that delaying disease onset by 5 years would halve its prevalence. As new disease-modifying treatments will be specific to causative diseases, expensive and bear significant side effects, early diagnosis of dementia will be essential. Current diagnostic criteria include the use of image-based biomarkers using radiotracers. The AID Action aims at coordinating the development of an alternative and cost-effective tool based on an MRI technique, Arterial Spin Labelling (ASL), to obtain reproducible brain perfusion measurements in dementia patients by bringing together scientists and clinicians from across Europe through the flexibility of the COST mechanism. The scientific program is centered around four work packages and three workgroups aiming at developing standards, improving the reliability of the technique and as establishing it as a possible clinical trial outcome measure. Development of MRI methods, post-processing tools, protocols of cross-validation, statistical analyses and launch of clinical and comparative studies will be undertaken. The main benefit of this Action will be to provide a cost-effective alternative to radiotracer-based biomarkers, and help care providers throughout Europe balancing the need for early diagnosis of dementia with the necessary healthcare cost containment.

8.4. International Initiatives

8.4.1. Inria Associate Teams

8.4.1.1. BARBANT

Title: Boston and Rennes, Brain image Analysis Team

Inria principal investigator: Christian Barillot

International Partner:

Children's Hospital Boston - Harvard Medical School (United States) - Computational Radiology Laboratory - Christian Barillot

Duration: 2012 - 2014

See also: <https://team.inria.fr/barbant/>

This associated team is shared between Inria Visages team and the Computational Radiology Laboratory of the Children's hospital Boston at Harvard Medical School. We will address the topic of better understanding the behavior and evolution of neurological pathologies (such as neurodevelopmental delay or multiple sclerosis) at the organ and local level, and the modeling of normal and pathological groups of individuals (cohorts) from image descriptors. At term, this project will allow to introduce objective figures to correlate qualitative and quantitative phenotypic markers coming from the clinic and image analysis, mostly at the early stage of the pathologies. This will allow for the selection or adaptation of the treatment for patients at an early stage of the disease.

8.5. International Research Visitors

8.5.1. Visits of International Scientists

- Within the BARBANT associate team, P. Simon K. Warfield, Dr. Benoit Scherrer and Dr. Maxime Taquet (Computational Radiology Laboratory, Harvard Medical School) visited us for a workshop on multiple sclerosis and diffusion image processing.

8.5.2. Visits to International Teams

- Several members of the Visages team (Christian Barillot, Olivier Commowick, Renaud Hédouin, Yogesh Karpate) visited the Computational Radiology Laboratory (Harvard Medical School) for an associate team (BARBANT) meeting to discuss new research topics.
- Christian Barillot visited the Information and Communications department at the Graduate School of Information Science of the Nagoya University, Japan in May 2013

ACES Project-Team

7. Partnerships and Cooperations

7.1. National Initiatives

7.1.1. *Bin That Thinks*

- Partners: ACES (Inria Rennes) and POPS (Inria Lilles), Veolia Propreté, and Etineo (a start up company focused on M2M communications and ambient networking)
- Starting: November 2010; ending: December 2013

BinThatThinks is an ANR project funded by the ANR Ecotech program, that is ended in December 2013. It aimed at sorting domestic waste at early stage in order to reduce costs and risks in waste sorting center, as well as helping citizens to adopt environment respectful. To this end, Bin That Think introduced a new system for (1) identifying the waste which involve a reject during waste collection, (2) detecting incompatible products and (3) implementing a reporting infrastructure enabling an efficient management/planning of the waste collecting process.

An infrastructure of smart bins was designed. This infrastructure leverage on waste identification mechanism based on self describing objects, helping user to sort their waste correctly, using either QR codes or RFID technologies. Wastes are grouped in smart bags, that can be read to determine their content. A given bin can accept or reject wastes depending on the sorting policy, or to prevent hazardous conditions to happen. Waste identification and wastes/bins interactions were the main focus of ACES in the project. The second important aspect of the project is the communication infrastructure, which was studied by Inria Fun. Smart bins are connected together using ambient networks taking advantage of the city streets topology: this allow the balanced use of short range and low power communication interface between the nodes and cellular communication interface, prolonging the life of the network. A thesis on this topic was defended in November 2013. A prototype was implemented and integrated as a demonstrator Etineo, a company specialized in M2M communications.

7.1.2. *Pervasive_RFID*

- Partner: IETR
- Starting: July 2013; ending: July 2016

Pervasive_RFID is a joint effort (within the CominLabs initiative, see <http://www.cominlabs.ueb.eu/>) started in July 2013 with IETR (institut d'électronique et de télécommunications de Rennes) to study and design innovative RFID reading protocols in the context of pervasive computing applications. Some limitations of existing RFID technology become challenging: unlike standard RFID application scenarios, pervasive computing often involves uncontrolled environment for RFID, where tags and reader have to operate in much more difficult situations that those usually encountered or expected for classical RFID systems.

RFID technology is to avoid missing tags when reading multiple objects, as reading reliability is affected by various effects such shadowing or wave power absorption by some materials. The usual applications of RFID operate in a controlled environment in order to reduce the risk of missing tags while scanning objects.

In pervasive computing applications, a controlled reading environment is extremely difficult to achieve, as one of the principle is to enhance existing processes "in situ", unlike the controlled conditions that can be found in industrial processes. Consider for example a logistic application, where RFID tags could be used on items inside a package in order to check for its integrity along the shipping process. Tags would likely be placed randomly on items inside the package, and reading conditions would be variable depending on where the package is checked.



Figure 4. BinThatThink general architecture

RFID operation in uncontrolled environments is challenging because RFID performance is affected by multiple parameters, in particular:

- Objects materials (on which tags are attached to),
- Materials in the surrounding environment,
- RFID frequency spectrum,
- Antenna nature and placement with respect to the tags.

In controlled environment, the difficulty to read tags can be limited by using the appropriate parameters to maximize the RFID performance for the application. But in many cases, it is needed to read large number of objects of various nature, arranged randomly in a given area or container. Most pervasive computing applications fall in this context.

At the software level, RFID inventory reliability issue is usually addressed by anti-collisions mechanisms and redundancy mechanisms. Anti-collisions protocols limit the risk of data corruption when multiples tags have to reply to an inventory request. Redundancy is often implemented in RFID readers by aggregating the results of multiple inventory requests over a time frame, to give the tags multiple opportunities to reply. While useful, these strategies cannot ensure that a given inventory is valid or not (in other words, one or more tags may be missing without being noticed). We propose to address this issue with an original approach based on integrity checking, developed by ACES.

In situations where we have to read large collection of objects of various types, the performance is difficult to predict but may still be adequate for a given application. For example, some application can tolerate missing some tags, provided that miss read probability could be characterized. In some cases, read reliability could be improved using mechanical approaches, such as introducing movements in objects or antenna to introduce radio diversity during read. Finally, distributed data structure can be used over a set of tags to be used to mitigate the impact of mis-read (by using data redundancy) and to help the reading protocol by integrating hints about the tag set collection being read.

Our objective is to study extensively by experimentation the behavior of existing RFID solutions in the context of uncontrolled environment (meaning, random placement of tags on objects mixing various materials) in order to characterize their real-world performance regarding the parameters of such as tags numbers, density, frequencies, reader antenna design, dynamicity of objects (movements), etc. From these experimentations, we would like to identify the conditions that are favorable to acceptable performance, and the way where there are hopes of improvement with specific design for these difficult environments. These results should also allow improving the performance : high level integrity checks can guide low level operations by determining whether inventories are complete or not. This cross layer strategy should enable faster and more efficient inventory protocols, as we have shown in [3] where some first results of this approach are presented.

The first step in the project is the implementation of an experiment test bed in order to support the experiment campaign. This task involves a significant engineering effort, which is ongoing. The following figures shows the elements of the testbed being built, featuring multi-axis mobile RFID antenna that we will driven by the high level protocols to use radio diversity, and a target container which will support custom designed arrangement of tags that are challenging to read by standard RFID configurations.



Figure 5. Overview of the Pervasive RFID testbed

ADAM Project-Team

8. Partnerships and Cooperations

8.1. Regional Initiatives

8.1.1. ADT eSurgeon

Participants: Maxime Colmant, Loïc Huertas, Romain Rouvoy [correspondant].

ADT eSurgeon (2013–15) is a technology development initiative supported by the Inria Lille - Nord Europe Center that aims at supporting the development of the POWERAPI software library (see Section 5.3) for measuring and monitoring the energy consumption of middleware and software systems.

8.1.2. ADT Adapt

Participants: Gwenaël Cattez, Philippe Merle [correspondant].

ADT Adapt (2011–13) is a technology development initiative supported by the Inria Lille - Nord Europe Center that aims at building a demonstrator of our ADAM software technologies in the application domain of smart digital homes. Firstly, this demonstrator will show adaptive and reflective capabilities of FraSCAti (see Section 5.2), *i.e.*, supporting various implementation languages (*e.g.*, Java, WS-BPEL, scripting languages, template technologies) to develop business components, supporting various remote communication protocols (*e.g.*, SOAP, REST, JMS, JGroups) to access and expose services, supporting various non functional properties, deploying business components on demand, and reconfiguring business applications/components/services at runtime. Secondly, these capabilities will be illustrated on several ambient intelligence scenarios, *e.g.*, Fire Emergency and Home Automation. Thirdly, this demonstrator will integrate our recent and future scientific results in the domains of dynamic software product lines, autonomic computing, control loops, complex event processing, energy control, etc. Gwenaël Cattez (recent graduated engineer) has been recruited in the context of this ADT.

8.1.3. North European Lab SOCS

Participants: María Gómez Lacruz, Nicolas Haderer, Christophe Ribeiro, Romain Rouvoy [correspondant], Lionel Seinturier.

North European Lab SOCS (2013–15) is an international initiative supported by the Inria Lille - Nord Europe Center that takes place in the context of a well-established collaboration between Inria and *Universitetet i Oslo* (UiO) initiated in 2008. SOCS focuses on the self-optimization issues in cyber-physical systems. Cyber-Physical Systems (CPS) are complex systems-of-systems that blend hardware and software to fulfill specific missions. However, traditional CPS are statically configured to achieve predefined goals, which not only limit their sharing and their reuse, but also hinder their sustainability. We believe that this waste of resources stems from the lack of agility of CPS to adapt to change in their environment or objectives. The SOCS Inria Lab (Self-Optimization of Cyber-physical Systems) therefore intends to extend the technologies developed as part of the SEAS associate team and more recently the APISENSE platform (see Section 5.1) to leverage the development of agile CPS.

8.1.4. LEDA

Participants: Gwenaël Cattez, Philippe Merle [correspondant].

LEDA (2013–16) Laboratoire d'Expérimentation et de Démonstrations Ambiantes is a demonstration space allocated by the Inria Lille - Nord Europe Center whose goal is to show the scientific results of the ADAM project-team in the domains of distributed systems, adaptable middleware, software product lines, green computing, and ambient computing. These results are illustrated around the scenario of a mock digital home.

- **North European Lab SOCS** (2013–2015) is an international initiative supported by the Inria Lille - Nord Europe Center that takes place in the context of a well-established collaboration between Inria and *Universitetet i Oslo* (UiO) initiated in 2008. SOCS focuses on the self-optimization issues in cyber-physical systems. Cyber-Physical Systems (CPS) are complex systems-of-systems that blend hardware and software to fulfill specific missions. However, traditional CPS are statically configured to achieve predefined goals, which not only limit their sharing and their reuse, but also hinder their sustainability. We believe that this waste of resources stems from the lack of agility of CPS to adapt to change in their environment or objectives. The SOCS Inria Lab (Self-Optimization of Cyber-physical Systems) therefore intends to extend the technologies developed as part of the SEAS associate team and more recently the APISENSE[®] platform (see Section 5.3) to leverage the development of agile CPS.

Participants: Maria Gomez Lacruz, Nicolas Haderer, Christophe Ribeiro, Romain Rouvoy, Lionel Seinturier.

8.2. National Initiatives

8.2.1. ANR SocEDA

Participants: Nabil Djarallah, Fawaz Paraíso, Romain Rouvoy, Lionel Seinturier [correspondant].

SocEDA is a 36-month ANR ARPEGE project started in November 2010 and involving EBM WebSourcing, ActiveEon, EMAC, I3S, LIG, LIRIS, Inria ADAM, France Telecom and Thales Communications. The goal of SocEDA is to develop and validate an elastic and reliable federated SOA architecture for dynamic and complex event-driven interaction in large highly distributed and heterogeneous service systems. Such architecture will enable exchange of contextual information between heterogeneous services, providing the possibilities to optimize/personalize their execution, according to social network information. The main outcome will be a platform for event-driven interaction between services, that scales at the Internet level based on the proposed architecture and that addresses Quality of Service (QoS) requirements.

8.2.2. ANR MOANO

Participants: Nabil Djarallah, Laurence Duchien [correspondant], Nicolas Petitprez.

MOANO (Models & Tools for Pervasive Applications focusing on Territory Discovery) is a 46-month project of the ANR CONTINT program which started in December 2010. The partners are LIUPPA/University of Pau and Pays de L'Adour, University of Toulouse/IRIT, University of Grenoble/LIG, University of Lille/LIFL/Inria. While going through a territory, mobile users often encounter problems with their handheld computers/mobiles. Some locally stored data become useless or unnecessary whereas other data is not included in the handheld computer. Some software components, part of the whole applications can become unnecessary to process some information or documents that the user did not plan to manage during his mission. In order to answer such difficulties, our project has three operational studies which are i) to enlarge the communication scale, ii) to provide people without computer-science skills with a toolset that will enable them to produce/configure mapping applications to be hosted on their mobile phone and iii) to process all the documents of interest in order to make their spatial and thematic semantics available to mobile users.

8.2.3. ANR YourCast

Participants: Laurence Duchien [correspondant], Clément Quinton, Daniel Romero.

YourCast (Software Product Lines for Broadcasting Systems) is a 36-month ANR Emergence project that started in January 2012 and that involves University of Nice Sophia Antipolis, Valorpaca and Inria ADAM. The project aims at defining an information broadcasting system by a dedicated software product line which will be used in schools or events, such as gatherings of scouts.

8.2.4. *FUI Macchiato*

Participants: Nabil Djarallah, Laurence Duchien [correspondant], Nicolas Petitprez, Romain Rouvoy.

Macchiato is a 36-month project of the competitiveness cluster PICOM (**Pôle des Industries du COMmerce**), which has started in January 2011. The partners of this project are Auchan (leader), University of Bordeaux/LABRI, Inria, and the Web Pulser SME. The Macchiato project aims at rethinking the design of e-commerce sites to better integrate the Internet of Things and facilitate online sales. In addition to setting up an infrastructure and a common application base, this challenge needs to refocus the design of e-commerce sites on the concept of "single electronic cart". We believe that including the next generation of e-commerce sites will enable to offer a personalized offer to consumers by adapting the content and form of the web sites to their preferences and needs and will allow them to manage their purchases uniformly with a single electronic cart [79].

8.2.5. *FUI EconHome*

Participants: Aurélien Bourdon, Rémi Druilhe, Laurence Duchien, Adel Noureddine, Romain Rouvoy, Lionel Seinturier [correspondant].

EconHome is a 40-month project funded by FUI and labeled by the Minalogic and Systematic competitiveness clusters. The project started in July 2010. The partners of this project include Sagemcom, Orange, STMicroelectronics, ST-Ericsson, SPiDCOM, Utrema, COMSIS, DOCEA, CEA, ETIS. The project aims at reducing the energy consumption of home and middleware networks. The target is to reduce of at least 70% the energy consumption of devices such as residential gateways, set top boxes, CPL plugs. Two axes are investigated: the optimization of the energy consumption of individual devices with innovative low power and sleep modes, and the optimization of the overall network with innovative techniques, such as service migration and energy aware service feedbacks to the user.

8.2.6. *FUI Hermes*

Participants: Laurence Duchien, Romain Rouvoy, Lionel Seinturier [correspondant].

Hermes is a 41-month project funded by FUI and labeled by the PICOM (**Pôle des Industries du COMmerce**) competitiveness cluster which has started in August 2012. The goal of the project is to define a modular and context-aware marketing platform for the retail industry. The focus is put on the interactions with customers in order to extract and mine relevant informations related to shopping habits, and on a multi-device, cross-canal, approach to better match customer usages.

8.2.7. *FSN PIA Datalyse*

Participants: Filip Křikava, Romain Rouvoy, Lionel Seinturier [correspondant], Bo Zhang.

Datalyse is a 36-month project of the FSN Programme Investissement d'Avenir Cloud Computing 3rd call for projects. The project started in May 2013. The partners are Business & Decision Eolas, Groupement des Mousquetaires, Université Grenoble 1, Université Lille 1, Inria, Université Montpellier 2. The project aims at defining an elastic cloud computing infrastructure for processing big volumes of data. The originality of the project is to consider jointly data generated by users and by the infrastructure, and to correlated data at these two levels.

8.2.8. *Inria ARC SERUS*

Participants: Laurence Duchien [correspondant], Alexandre Feugas, Lionel Seinturier.

ARC SERUS (2011–13) (Software Engineering for Resilient Ubiquitous Systems) is funded by the Inria collaboration program. The partners are Inria ADAM, Inria PHOENIX and TSF-LAAS (CNRS). Resilience is defined as the ability of a system to stay dependable when facing changes. For example, a building management system (*e.g.*, anti-intrusion, fire detection) needs to evolve at runtime (*e.g.*, deployment of new functions) because its critical nature excludes interrupting its operation. Resilience concerns occur in various application domains such as civil systems (civil protection, control of water or energy, etc.) or private systems (home automation, digital assistance, etc.). The objectives of this project is to propose a design-driven development methodology for resilient systems that takes into account dependability concerns in the early stages and ensures the traceability of these requirements throughout the system life-cycle, even during runtime evolution. To provide a high level of support, this methodology will rely on a design paradigm dedicated to sense/compute/control applications. This design will be enriched with dependability requirements and used to provide support throughout the system life-cycle.

8.2.9. Inria ADT AntDroid

Participants: María Gómez Lacruz, Nicolas Haderer, Christophe Ribeiro, Romain Rouvoy [correspondant].

ADT AntDroid (2012–14) is a technology development initiative supported by Inria that aims at pushing the results of Nicolas Haderer's PhD thesis into production. AntDroid therefore focuses on deploying and disseminating the APISENSE[®] software platform to the public and to support the users of the platform. APISENSE[®] is a distributed platform dedicated to crowd-sensing activities. APISENSE[®] exploits the sensors of mobile devices that are shared by participants to observe physical or behavioral phenomena. The challenges related to the development of such a platform encompasses user privacy and security, battery preservation, and user accessibility.

8.3. European Initiatives

8.3.1. FP7 Projects

Program: FP7 ICT

Project acronym: **PaaSage**

Project title: Model Based Cloud Platform Upperware

Duration: October 2012–September 2016

Coordinator: ERCIM

Other partners: ERCIM (Fr), SINTEF (No), STFC (UK), U. of Stuttgart (De), Inria (Fr), CETIC (Be), FORTH (El), Be.Wan (Be), EVRY Solutions (No), SysFera (Fr), Flexiant (UK), Lufthansa Systems AG (De), Gesellschaft für wissenschaftliche Datenverarbeitung mbH Göttingen (De), Automotive Simulation Center Stuttgart (De).

Abstract: Cloud computing is a popular and over-hyped concept in ICT. The concept of infinitely scalable elastic resources changing without complex systems administration and paying only for resources used is attractive. These benefits are not immediately realizable. Within organisation benefits are realizable at considerable cost. IaaS (*Infrastructure-as-a-Service*) public CLOUDs have different interfaces and conditions of use thus for an organisation to "scale out" requires considerable investment using skilled technical staff. The business need is to allow organisations to "scale out" from their private CLOUD to public CLOUDs without a technical chasm between. This cannot easily be achieved. Aligned with the EU strategic direction of an open market for services, SOA (*Service-Oriented architecture*) offers a way to virtualize across heterogeneous public CLOUDs and organizational private CLOUDs. It opens a market for European SMEs to provide services to be utilized (and paid for) by business applications and for all organisations to benefit from a catalogue of services that can be used across the environment. PaaSage will deliver an open and integrated platform, to support both deployment and design of Cloud applications, together with an accompanying methodology that allows model-based development, configuration, optimisation, and deployment of

existing and new applications independently of the existing underlying Cloud infrastructures. Specifically it will deliver an IDE (*Integrated Development Environment*) incorporating modules for design time and execution time optimisation of applications specified in the CLOUD Modeling Language (CLOUD ML), execution-level mappers and interfaces and a metadata database.

Participants: Laurence Duchien, Clément Quinton, Daniel Romero [correspondant], Romain Rouvoy, Lionel Seinturier.

Program: FP7 FET

Project acronym: **DIVERSIFY**

Project title: More software diversity. More adaptivity in CAS.

Duration: 36 months (2013-16)

Coordinator: Inria

Other partners: SINTEF (Norway), Trinity College Dublin (Ireland), University of Rennes 1 (France)

Abstract: DIVERSIFY explores diversity as the foundation for a novel software design principle and increased adaptive capacities in CASs (*Collective Adaptive Systems*). Higher levels of diversity in the system provide a pool of software solutions that can eventually be used to adapt to unforeseen situations at design time. The scientific development of DIVERSIFY is based on a strong analogy with ecological systems, biodiversity, and evolutionary ecology. DIVERSIFY brings together researchers from the domains of software-intensive distributed systems and ecology in order to translate ecological concepts and processes into software design principles.

Participant: Martin Monperrus [correspondant], Matias Martinez.

8.4. International Initiatives

8.4.1. Inria Associate Teams

8.4.1.1. SEAS

Title: Middleware for Sensor as a Service

Inria principal investigator: Romain Rouvoy

International Partner:

University of Oslo (Norway) - Department of informatics

Duration: 2010–2012

See also: <http://seas.ifi.uio.no>

Middleware for Sensor as a Service (SeaS) is a collaboration initiative that intends to contribute to the vision of the Future Internet as an open-source middleware platform, based on robust Web standards, breaking existing IT silos and leveraging the development of innovative hybrid service-oriented architectures spanning from Wireless Sensor Networks to Ubiquitous and Cloud Computing. Given that one of the objectives of Europe is to develop the convergence of IT networks (being it mobile or fixed) and the fact that many of the upcoming mobile devices are integrating services (from phones down to sensors and radio frequency identification), we believe that one of the challenges for the next generation society will consist in enabling a distributed middleware platform for the dynamic provision of hybrid services and the scalable dissemination of data. In particular, we believe that the sensor capabilities can be reflected as a service accessible from the Internet or any IT system using standard Web protocols. The resulting services will be hybrid in the sense that they will reflect the wide diversity of sensor devices available nowadays, but we aim at providing a uniform solution to leverage the development of applications on top of physical or virtual sensors. This platform includes not only the sensor level (description, discovery, communication, reconfiguration...), but also the platform level services (dissemination, storage, query, adaptation...) that are required for enabling such a vision. The resulting platform will bring additional opportunities for the development of innovative service-based systems by exploiting the emergence of Wireless Sensor Networks (WSN), Ubiquitous Computing, and Cloud Computing environments.

Participants: Nicolas Haderer, Russel Nzekwa, Daniel Romero, Romain Rouvoy [correspondant], Lionel Seinturier.

8.4.2. Inria International Partners

8.4.2.1. Declared Inria International Partners

8.4.2.1.1. University of Los Andes, Bogota, Colombia

The ADAM project-team has a long term collaboration since 2005 with this university. Over the years, four PhD thesis (Carlos Noguera, Carlos Parra, Daniel Romero, Gabriel Tamura) have been defended in our team with students who obtained their MSc in this university. The first three were full French PhD, whereas the last one was a co-tutelle with this university. Professor Rubby Casallas from University of Los Andes is frequently visiting our team. The most recently defended PhD thesis, that of Gabriel Tamura, deals with QoS (quality-of-service) contract preservation in distributed service-oriented architectures. A formal theory to perform, in a safe way, the process of self-adaptation in response to quality-of-service (QoS) contracts violation has been proposed. The results have been published in [86][43] and in the PhD thesis document itself [85].

Participants: Laurence Duchien [correspondant], Clément Quinton, Daniel Romero, Romain Rouvoy, Lionel Seinturier.

8.4.2.1.2. University of Oslo, Norway

The scientific collaboration with this international partner deals with complex distributed systems that have to seamlessly adapt to a wide variety of deployment targets. This is due to the fact that developers cannot anticipate all the runtime conditions under which these systems are immersed. A major challenge for these software systems is to develop their capability to continuously reason about themselves and to take appropriate decisions and actions on the optimizations they can apply to improve themselves. This challenge encompasses research contributions in different areas, from environmental monitoring to real-time symptoms diagnosis, to automated decision making. The SEAS associated team (see Section 8.4.1.1) contributes to this collaboration.

Participants: Nicolas Haderer, Russel Nzekwa, Daniel Romero, Romain Rouvoy [correspondant], Lionel Seinturier.

8.4.2.2. Informal International Partners

8.4.2.2.1. Université du Québec à Montréal

The ADAM project-team has established a new collaboration with UQÀM (*Université du Québec à Montréal*) to improve the software quality of distributed systems. This collaboration has been initiated with a joint PhD thesis (Geoffrey Hecht) that intends to empirically identify design patterns and anti-patterns in Cloud-based applications. The objective of this work is to leverage the development of *Software-as-a-Service* (SaaS) to build modular yet efficient solutions to be deployed in the Cloud.

Participants: Laurence Duchien, Geoffrey Hecht, Romain Rouvoy.

8.4.3. Participation in Other International Programs

8.4.3.1. OW2

Participants: Gwenaël Cattez, Philippe Merle [correspondant], Fawaz Paraíso, Romain Rouvoy, Lionel Seinturier.

OW2, previously ObjectWeb, is an international consortium to promote high quality open source middleware. The vision of OW2 is that of a set of components which can be assembled to offer high-quality middleware systems. We are members of this consortium since 2002. Philippe Merle is the leader of both FRACTAL and FRASCATI projects, which are hosted by this consortium. Philippe Merle and Lionel Seinturier are members of the Technology Council of OW2.

8.4.3.2. ERCIM Working Group on Software Evolution

Participant: Laurence Duchien [correspondant].

The **Working Group (WG) on Software Evolution** is one of the working groups supported by ERCIM. The main goal of the WG is to identify a set of formally-founded techniques and associated tools to support software developers with the common problems they encounter when evolving large and complex software systems. With this initiative, the WG plans to become a Virtual European Research and Training Centre on Software Evolution.

8.5. International Research Visitors

8.5.1. Visits of International Scientists

8.5.1.1. Internships

Favio Demarco

Subject: Automated Software Repair

Date: from Apr 2013 until Sep 2013

Institution: University of Buenos Aires (Argentina)

Gabriel Moyano

Subject: Crowd-driven Automatic Inference of Traffic Maps

Date: from Mar 2013 until Aug 2013

Institution: University Los Andes (Colombia)

Herman Mekontso

Subject: An SOA Approach for the Design of Information Systems: The Case of the PPR FTH Platform in Central Africa

Date: Oct 2013

Institution: University of Yaoundé (Cameroon)

ALGORILLE Project-Team

7. Partnerships and Cooperations

7.1. Regional Initiatives

CPER MISN, EDGE project (2010-2013, 518k€). M. Quinson and L. Nussbaum are leading a project of the regional CPER contract, called *Expérimentations et calculs distribués à grande échelle* (EDGE). It focuses on maintaining and improving the local Grid'5000 infrastructure, and animating both the research on experimental grids and the research community using these facilities. More information is available at <http://misn.loria.fr/spip.php?rubrique8>.

Other partners: EPI CAMEL, VERIDIS

Lorraine Region (2011-2013, 30k€). The project "*Systèmes dynamiques : étude théorique et application à l'algorithmique parallèle pour la résolution d'équation aux dérivées partielles*" lead by S. Contassot-Vivier is the sequel of his research on dynamical systems and consists in designing more efficient algorithmic schemes for parallel iterative solvers. This project is closely linked to the collaboration with the Lemta as the real case application provided by F. Asllanaj will be the target of our future developments in this field.

7.2. National Initiatives

7.2.1. ANR

Plate-form(E)³ (2012-2015, 87k€) has been accepted in 2012 in the ANR SEED program. It deals with the design and implementation of a multi-scale computing and optimization platform for energetic efficiency in industrial environment. It gathers 7 partners either academic (LEMMA, Fédération Charles Hermite (including ALGORILLE), Mines Paris, INDEED) or industrial (IFP, EDF, CETIAT). We will contribute to the design and development of the platform.

ANR SONGS (2012-2015, 1800k€) Martin Quinson is also the principal investigator of this project, funded by the ANR INFRA program. **SONGS** (Simulation Of Next Generation Systems) aims at increasing the target community of SimGrid to two new research domains, namely Clouds (restricted to the *Infrastructure as a Service* context) and High Performance Computing. We develop new models and interfaces to enable the use of SimGrid for generic and specialized researches in these domains.

As project leading team, we are involved in most parts of this projects, which allows the improvement of our tool even further and sets it as the reference in its domain (see Section 6.3.1).

7.2.2. Inria financed projects and clusters

AEN Hemera (2010-2013, 2k€) aims at demonstrating ambitious up-scaling techniques for large scale distributed computing by carrying out several dimensioning experiments on the Grid'5000 infrastructure, and at animating and enlarging the scientific community around the testbed. M. Quinson, L. Nussbaum and S. Genaud lead three working groups, respectively on *simulating large-scale facilities*, on *conducting large and complex experimentations on real platforms*, and on *designing scientific applications for scalability*.

Other partners: 20 research teams in France, see <https://www.grid5000.fr/mediawiki/index.php/Hemera> for details.

ADT Aladdin-G5K (2007-2015, 200k€ locally) aims at the construction of a scientific instrument for experiments on large-scale parallel and distributed systems, building on the Grid'5000 testbed (<http://www.grid5000.fr>). It structures INRIA's leadership role (8 of the 9 Grid'5000 sites) concerning this platform. The technical team is now composed of 10 engineers, of which 2 are currently hosted in the AlGorille team. As a member of the executive committee, L. Nussbaum is in charge of following the work of the technical team, together with the Grid'5000 technical director.

Other partners: EPI DOLPHIN, GRAAL, MESCAL, MYRIADS, OASIS, REGAL, RESO, RUN-TIME, IRIT (Toulouse), Université de Reims - Champagne Ardennes

ADT Kadeploy (2011-2013, AlGorille is the only partner, 90k€) focuses on the Kadeploy software, a tool for efficient, scalable and reliable cluster deployment. It is used on several clusters at INRIA and playing a key role on the Grid'5000 testbed. This ADT allows the continuation of the development to improve its performance, reliability and security, and aims at a larger distribution to industry and other INRIA platforms with similar needs.

ADT Solfège (2011-2013, AlGorille is the only partner, 100k€), for *Services et Outils Logiciels Facilitant l'Experimentation à Grande Échelle* aims at developing or improving a tool suite for experimentation at large scale on testbeds such as Grid'5000. Specifically, we will work on control of a large number of nodes, on data management, and on changing experimental conditions with emulation. E. Jeanvoine (SED) is delegated in the AlGorille team for the duration of this project.

ADT Cosette (2013-2015, AlGorille is the only partner, 120k€), for *COherent SET of Tools for Experimentation* aims at developing or improving a tool suite for experimentation at large scale on testbeds such as Grid'5000. Specifically, we will work on (1) the development of Ruby-CUTE, a library gathering features useful when performing such experiments; (2) the porting of Kadeploy, Distem and XPFlow on top of Ruby-CUTE; (3) the release of XPFlow, developed in the context of Tomasz Buchert's PhD; (4) the improvement of the Distem emulator to address new scientific challenges in Cloud and HPC. E. Jeanvoine (SED) is delegated in the AlGorille team for the duration of this project.

INRIA Project Lab MC (2012-) Supporting multicore processors in an efficient way is still a scientific challenge. This project introduces a novel approach based on virtualization and dynamicity, in order to mask hardware heterogeneity, and to let performance scale with the number and nature of cores. Our main partner within this project is the Camus team on the Strasbourg site. The move of J. Gustedt there, will strengthen the collaboration within this project.

7.3. European Initiatives

7.3.1. FP7 Projects

7.3.1.1. FED4FIRE

Participant: Lucas Nussbaum.

Title: Federation for Future Internet Research and Experimentation

Type: ICT

Instrument: Integrated Project

Duration: October 2012 - September 2016

Coordinator: iMinds

Other partners: IT Innovation, UPMC, Fraunhofer, TUB, UEDIN, Inria, NICTA, ATOS, UTH, NTUA, UNIVBRIS, i2CAT, EUR, DANTE Limited, UC, NIA.

See also: <http://www.fed4fire.eu>

Abstract: The key outcome of Fed4FIRE will be an open federation solution supporting all stakeholders of FIRE. Fed4FIRE is bringing together key players in Europe in the field of experimentation facilities and tool development who play a major role in the European testbeds of the FIRE initiative projects.

Lucas Nussbaum started participating in the project in September 2013, mainly with an expert role.

7.4. International Research Visitors

7.4.1. Visits of International Scientists

7.4.1.1. Internships

Maximiliano Geier

Subject: Leveraging multiple experimentation methodologies to study P2P broadcast

Date: from Sep 2012 until Mar 2013

Institution: University of Buenos Aires (Argentina)

Ahmed Bessifi

Subject: Reliability and Scalability improvements in Kadeploy

Date: from Mar 2013 until Aug 2013

Institution: Université de Tunis El Manar - Faculté des Sciences (Tunisia)

Luis Esteban Campostrini

Subject: Formal Verification of Distributed Algorithms

Date: from May 2013 to Oct 2013

Institution: Universidad Nacional de Rosario (Argentina)

Rodrigo Campos

Subject: Ordered Read-Write Locks on Multicore Architectures

Date: from Mar 2013 until Aug 2013

Institution: University of Buenos Aires (Argentina)

ALPINES Team

8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. ANR

8.1.1.1. PETALh

ANR Cosinus project - *PETascale ALgorithms for preconditioning for scientific applications* January 2011 - September 2013 (<http://petal.saclay.inria.fr/>). The global cost of the project is 1,350,910, the funding from ANR is 304,232. The total personne.mois is 140. Collaboration with Laboratoire Lions - UPMC, IFPEN, Inria Bordeaux and CEA, UC Berkeley. This project can be seen as a continuation of ANR funded PETAL project, the goal is to design parallel algorithms for the preconditioning techniques proposed during PETAL suitable for heterogeneous architectures based on multicore processors and accelerators.

8.1.1.2. Medimax

ANR-MN (Modèles Numériques) October 2013 - September 2017

The main goal is the methodological and numerical development of a new robust inversion tool, associated with the numerical solution of the electromagnetic forward problem, including the benchmarking of different other existing approaches (Time Reverse Absorbing Condition, Method of Small-Volume Expansions, Level Set Method). This project involves the development of a general parallel open source simulation code, based on the high-level integrated development environment of FreeFEM++, for modeling an electromagnetic direct problem, the scattering of arbitrary electromagnetic waves in highly heterogeneous media, over a wide frequency range in the microwave domain. The first applications considered here will be medical applications: microwave tomographic images of brain stroke, brain injuries, from both synthetic and experimental data in collaboration with EMTensor GmbH, Vienna (Austria), an Electromagnetic Medical Imaging company.

8.2. European Initiatives

8.2.1. FP7 Projects

8.2.1.1. EXA2CT

Type: COOPERATION

Instrument: Specific Targeted Research Project

Objectif: NC

Duration: September 2013 - August 2016

Coordinator: Imec, Belgium

Partner: UA Belgium, USI Switzerland, Intel France, NAG England, UVSQ France, T-Systems SfR Germany, IT4Inovations Czech Republic.

Inria contact: Luc Giraud

Abstract: The goal of this project is to develop novel algorithms and programming models to tackle what will otherwise be a series of major obstacles to using a crucial component of many scientific codes at exascale, namely solvers and their constituents. The results of this work will be combined in running programs that demonstrate the application-targeted use of these algorithms and programming models in the form of proto-applications. The application targeting will be done by an analysis of a representative selection of scientific applications using solvers and/or the constituent parts that we target. The results of the project will be disseminated to the reference application owners through a scientific and industrial board (SIB), and board-partner specific code targeting

activities, to help generate momentum behind our approach in the HPC community. The proto-applications will serve as a proof-of-concept, a benchmark for doing machine/software co-design, and as a basis for constructing future exascale full applications. In addition, the use of the SIB is a means to extract the commonalities of a range of HPC problems from different scientific domains and different industrial sectors to be able to concentrate on maximising the impact of the project by improving precisely those parts that are common across different simulation needs.

Alpines role: in charge of the Task "Preconditioners" in the working group focusing on numerical algorithms.

8.3. International Initiatives

8.3.1. Inria Associate Teams

8.3.1.1. COALA Inria associated team, Alpines and UC Berkeley

COALA associated team <https://who.rocq.inria.fr/Laura.Grigori/COALA2010/coala.html> focuses on communication optimal algorithms for linear algebra. We have a long term collaboration with Prof. J. Demmel, which focuses currently on communication avoiding algorithms. Since 2010, this collaboration takes place in the context of COALA Inria Associated team, and every year students visit our groups in both directions.

8.3.2. Inria International Partners

8.3.2.1. Informal International Partners

A collaboration focused on the theoretical and numerical analysis for the simulation of wave scattering by means of boundary integral formulation has been in place for several years between Xavier Claeys and the group of Ralf Hiptmair from the Seminar of Applied Mathematics at ETH Zürich.

8.3.3. Inria International Labs

Joint Laboratory for Petascale Computing, JLPC Etats-Unis. We take part in this joint effort, in the numerical libraries aspects of the joint laboratory. We collaborate and interact in particular with B. Gropp, UIUC, and J. Brown and M. Knepley, Argonne.

8.4. International Research Visitors

8.4.1. Visits of International Scientists

- Euan Spence from the University of Bath visited Xavier Claeys for one week to discuss about his work on high frequency wave scattering, and to see whether this work could apply to the formulations developed by Xavier Claeys.
- Grey Ballard from U.C. Berkeley, USA, visit of 2 weeks in January 2013. In the context of COALA Inria associated team, Grey has visited us to finalize our joint work on the publication [6].

8.4.1.1. Internships

- Sebastien Cayrols, Master 2 student Paris 11 University, March - August 2013, supervisor L. Grigori. Sebastien worked on communication avoiding ILU0 preconditioner.
- Antoine Liandrat, Ecole Centrale Lyon 2nd year, June-July 2013, supervisor L. Grigori. Antoine has worked in the context of Petal project.
- Clement Guerin, ENS Lyon, L3 student, Mai-Juin 2013, supervisor L. Grigori. Clement's objective was to understand some of the numerical problems in communication avoiding algorithms.

8.4.2. Visits to International Teams

- L. Grigori, visit to U.C. Berkeley for 1 month (August 2013) in the context of COALA Inria associated team.

ARLES Project-Team

7. Partnerships and Cooperations

7.1. National Initiatives

7.1.1. ANR

7.1.1.1. ANR MURPHY

Participant: Animesh Pathak [correspondent].

- **Name:** MURPHY – *Dependability-focused Evaluation of Sensor Networks*
- **URL:** <http://cedric.cnam.fr/~sailhanf/murphy/>
- **Related activities:** § 6.5
- **Period:** [January 2011 – September 2014]
- **Partners:** CNAM (**Coordinator**), Inria ARLES, LAAS - CNRS, SmartGrains, Univ. Valenciennes.

Murphy aims at easing the development of dependable and pervasive applications built on top of robust wireless sensor networks, thus providing a mean for early detection of possible failures, by estimating dependability metrics. This endeavor is undertaken by providing:

- Fault detection based on in-network event processing;
- Fault injection that attempts to accelerate the occurrence of faults so as to judge the quality of the error handling and hence, facilitate the evaluation of dependability;
- Advanced code dissemination across sensor networks, which is intended to enable the dynamic and distributed insertion of faults and hide from the end user the complexity related to this task; and
- Suitable abstractions to reason on faults, wireless sensor networks, data-centric and event-driven applications.

The aforementioned components enable to detect faults, diagnose possible causes and select appropriate corrective actions, and therefore to consolidate the dependability of sensor applications.

7.1.2. Inria Support

7.1.2.1. Inria ADT iConnect

Participant: Valérie Issarny [correspondent].

- **Name:** iConnect – *Emergent Middleware Enablers*
- **Related activities:** § 6.2 and 6.3
- **Period:** [October 2013 – September 2015]
- **Partners:** Inria ARLES.

The pervasive computing vision is hampered by the extreme level of heterogeneity in the underlying infrastructure, which impacts on the ability to seamlessly interoperate. Further, the fast pace at which technology evolves at all abstraction layers increasingly challenges the lifetime of networked systems in the digital environment.

Overcoming the interoperability challenge in pervasive computing systems has been at the heart of the FP7 FET IP CONNECT project (<http://www.connect-forever.eu/>), which ran from 2009 to 2012, and was coordinated by Inria ARLES. Specifically, CONNECT has been investigating the paradigm of *Emergent middleware*, where protocol mediators are dynamically synthesized so as to allow networked systems that provide complementary functionalities to successfully coordinate. The CONNECT project has in particular delivered prototype implementation of key enablers for emergent middleware, spanning discovery, protocol learning, and mediator synthesis and deployment. Further, while CONNECT focused on learning and reconciling interaction protocols at the application layer, the FP7 project CHOReOS (<http://www.choreos.eu>) to which ARLES contributed as well, investigated a complementary enabler that supports interoperability across systems implementing heterogeneous interaction paradigms (i.e., client-service, event-based and shared memory). The proposed enabler introduces the concept of XSB - eXtensible Service Bus, which revisits the notion of Enterprise Service Bus and features an end-to-end interaction protocol that preserves the interaction paradigms of the individual components, while still allowing interoperability.

The objective of the Inria iConnect ADT is to leverage and integrate the above complementary results, packaging and further enhancing enabler prototypes, for take-up of the results by the relevant open source community. The work will involve development effort focused on the following core enablers:

- Universal discovery of resources composing legacy discovery protocols,
- Dynamic synthesis and deployment of mediators specified as enhanced labelled transition systems,
- XSB as underlying run-time support for mediators so as to support interoperability across systems based on heterogeneous interaction paradigms,
- Experiment in the area of federated social networking.

We intend to release the software prototypes through the newly created OW2 open source initiative FISSI (Future Internet Software and Services initiative – http://www.ow2.org/view/Future_Internet/) as our solutions are of direct relevance to sustaining interoperability in the future Internet.

7.1.2.2. Inria ADT Yarta

Participant: Animesh Pathak [correspondent].

- **Name:** Yarta – *Middleware for mobile social ecosystems*
- **Period:** [October 2012 – September 2014]
- **Partners:** Inria ARLES.

Yarta is a middleware for managing mobile social ecosystems, which builds upon existing research in context-awareness in the pervasive computing domain. The work involves development effort in the multi-layer middleware architecture of Yarta, providing the needed functionalities, including: (i) Storage of social data in an interoperable format, using semantic technologies such as RDF; (ii) Extraction of social ties from context (both physical and virtual); (iii) Enforcement of access control to protect social data from arbitrary access; and (iv) A rich set of mobile social ecosystem (MSE) management functionalities, using which mobile social applications can be developed. Specifically, the ADT supports the public open source release and evolution of the Yarta middleware, which is currently a research prototype.

7.2. European Initiatives

7.2.1. FP7 Projects

7.2.1.1. FP7 ICT IP CHOReOS

Participants: Nikolaos Georgantas [correspondent], Valérie Issarny [correspondent].

Name: CHOReOS – *Large Scale Choreographies for the Future Internet*

URL: <http://www.choreos.eu/>

Type: COOPERATION (ICT)

Defi: Internet of Services, Software & Virtualisation

Instrument: Integrated Project (IP)

Related activities: § 6.3

Period: [October 2010 - September 2013]

Partners: NoMagic Europe (Lithuania), CEFRIEL (Italy), CNR (Italy), Linagora (France), Inria ARLES [**scientific leader**], MLS Multimedia A.E. (Greece), OW2 Consortium, Thales Communications S.A. (France) [**coordinator**], The City University, London (UK), Università degli Studi dell'Aquila (Italy), Universidade de São Paulo (Brazil), University of Ioannina (Greece), SSII VIA (Latvia), Virtual Trip Ltd. (Greece), Wind Telecomunicazioni S.p.A (Italy).

CHOReOS aims at assisting the engineering of software service composition in the revolutionary networking environment created by the Future Internet. Indeed, sustaining service composition and moving it closer to the end users in the Future Internet is a prime requirement to ensure that the wealth of networked services will get appropriately leveraged and reused. This stresses the required move from static to dynamic development, effectively calling for adequate support for service reuse; much like software reuse has been a central concern in software engineering over the last two decades. This is why CHOReOS adopts the Service Oriented Computing (SOC) paradigm, where networked resources are abstracted as services so as to ease their discovery, access and composition, and thus reuse. However, although latest advances in the SOC domain enable facing (at least partly) the requirements of today's Internet and related networking capabilities, engineering service compositions in the light of the Future Internet challenges — in particular the ultra large scale (ULS) on all imaginable dimensions as well as the evolution of the development process from a mostly static process to a dynamic user-centric one — is far from adequately addressed. Therefore, the CHOReOS goal is to address these challenges by devising a dynamic development process, and associated methods, tools and middleware, to sustain the composition of services in the Future Internet.

7.2.1.2. FP7 ICT NoE NESSoS

Participants: Valérie Issarny [correspondent], Animesh Pathak [correspondent].

Name: NESSoS – *Network of Excellence on Engineering Secure Future Internet Software Services and Systems*

URL: <http://www.nessos-project.eu>

Type: COOPERATION (ICT)

Defi: Trustworthy ICT

Instrument: Network of Excellence (NoE)

Related activities: § 6

Period: [October 2010 - March 2014]

Partners: Atos Origin (Spain), CNR (Italy) [**coordinator**], ETH Zürich (Switzerland), IMDEA Software (Spain), Inria (EPIs ARLES, CASSIS, and TRISKELL), KU Leuven (Belgium), LMU München (Germany), Siemens AG (Germany), SINTEF (Norway), University Duisburg-Essen (Germany), Universidad de Malaga (Spain), Università degli studi di Trento (Italy).

The Network of Excellence NESSoS on "Engineering Secure Future Internet Software Services and Systems" aims at constituting and integrating a long lasting research community on engineering secure software-based services and systems. The NESSoS engineering of secure software services is based on the principle of addressing security concerns from the very beginning in system analysis and design, thus contributing to reduce the amount of system and service vulnerabilities and enabling the systematic treatment of security needs through the engineering process. In light of the unique security requirements exposed by the Future Internet, new results are achieved by means of an integrated research, as to improve the necessary assurance level and to address risk and cost during the software development cycle in order to prioritize and manage investments.

7.2.1.3. FP7 ICT CA EternalS

Participant: Valérie Issarny [correspondent].

Name: EternalS – *Trustworthy Eternal Systems via Evolving Software, Data and Knowledge*

URL: <http://www.eternals.eu>

Type: CAPACITIES (ICT)

Defi: FET - Proactive

Instrument: Coordination and Support Action (CSA)

Related activities: § 6.2

Period: [March 2010 - February 2013]

Partners: Inria (CRI Paris-Rocquencourt), KU Leuven (Belgium), Queen Mary University (UK), University of Chalmers (Sweden), University of Trento (Italy) [**coordinator**], Waterford Institute of Technology (Ireland).

Latest research work within ICT has allowed to pinpoint the most important and urgently required features that future systems should possess to meet users' needs. Accordingly, methods making systems capable of adapting to changes in user requirements and application domains have been pointed out as key research areas. Adaptation and evolution depend on several dimensions, e.g., time, location, and security conditions, expressing the diversity of the context in which systems operate. A design based on an effective management of these dimensions constitutes a remarkable step toward the realization of Trustworthy Eternal Systems. The EternalS Coordination Action (CA) specifically aims at coordinating research in that area based on a researcher Task Force together with community building activities, where the organization of large workshops and conferences is just one of the tools that are used to conduct a successful CA.

7.2.1.4. FP7 PEOPLE Requirements@run.time

Participant: Nelly Bencomo [correspondent].

Name: Requirements@run.time – *Requirements-aware systems*

URL: <https://www-roc.inria.fr/arles/index.php/members/220-marie-curie-project-requirements-aware-systems-requirementsruntime>

Type: PEOPLE

Instrument: Marie Curie Intra-European Fellowships for Career Development (IEF)

Related activities: § 6.7

Period: [May 2011 - May 2013]

Partners: Inria ARLES.

This project uses the novel notion of requirements reflection, that is, the ability of a system to dynamically observe and reason about its requirements. It aims to address the need of having systems requirements-aware by reifying requirements as run-time objects (i.e., requirements@run.time). These systems provide a runtime model of their requirements that allow them to reason, evaluate and report on their conformance to their requirements during execution. This project contributes towards development of conceptual foundations, engineering techniques, and computing infrastructure for the systematic development of dynamically-adaptive systems based on the principle of requirements reflection.

7.2.2. Collaborations in European Programs, except FP7

7.2.2.1. EIT ICT Labs TravelDashboard

Participant: Animesh Pathak [correspondent].

Name: TravelDashboard – *Personalized Mobility to Urban Travelers*

URL: <https://www.rocq.inria.fr/arles/traveldashboard/>

Period: [January 2013 - December 2013]

Partners: Alcatel/Lucent (Ir and Be), Ambientic (F), Inria (CRI Paris-Rocquencourt), Systmatic (F), Thales [**coordinator**], Transport for London (UK), UC London (UK).

With over 70% of the world's entire population expected to be living in cities by 2050, supporting citizens' mobility within the urban environment is a priority for municipalities worldwide. Although public multi-modal transit systems, coupled with integrated fare management and road user charging, are necessary to better manage mobility, they are not sufficient. Citizens must be offered personalized travel information, where and when such information is needed to take decisions that will make their journeys more efficient and enjoyable. Notably, such information is not purely qualitative (e.g., bus timetable, live bus tracking), but crucially subjective (e.g., crowdedness of trains, heat of tube platforms, sociability of the coaches). The perception and value attached to this information varies substantially, not only across people (e.g., different tolerance to delays, different perception of crowdedness, different taste in the social environment), but also for the same person in different contexts (e.g., work commute, leisure trip with the family). Thanks to the increased abundance of smart phones (equipped with various types of physical sensors, as well as enabling the users to easily report phenomena), the field of mobile participatory sensing has emerged recently, and can be leveraged towards providing a more fine-grain and up-to-date view of the city's transportation system. In that direction, the TravelDashboard project works towards an open source middleware platform, enriched with personalized mobility services for urban travelers, evaluated via real-life demonstrators assessment, and accompanied by novel business models.

7.3. International Initiatives

7.3.1. Inria International Labs

Valérie Issarny acts as scientific manager of the Inria@Silicon Valley program (<https://project.inria.fr/inria-siliconvalley/>) for the academic year 2013-14, and is on leave at UC Berkeley since August 2013.

7.3.2. Participation in other International Programs

7.3.2.1. International scientific cooperation program Inria/Brazil – Project M@TURE

Participant: Nikolaos Georgantas [correspondent].

Name: M@TURE – *Models @ runtime for self-adaptive pervasive systems*

Instrument: Inria-Brazil cooperation programme

Period: [October 2012 - September 2014]

Partners: Institute of Informatics of Federal University of Goias (Brazil), Inria ARLES.

The overall goal of the M@TURE project is to design, implement and evaluate a novel approach and architecture - comprising conceptual foundations, engineering techniques, and supporting middleware infrastructure - for self-adaptive pervasive systems by building on the notion of Models@run.time. Models@run.time extends the applicability of models and abstractions to the runtime environment. In contrast to design-time models, runtime models are used to reason about the running system taking into account its operating environment, and thus these models enable automating runtime decisions and actions regarding the creation, configuration, and evolution of the system. We in particular focus on the following dimensions and related models: (i) Requirements models making a system requirements-aware at runtime; (ii) Application- and middleware-level interoperability models exposing to an external observer the technological and business features of a system; and (iii) End-user and system engineer models modeling the internal elements of a system at two different abstraction levels. These models are considered both independently and, more importantly, in synergy in order to introduce a comprehensive conceptual and architectural solution for self-adaptive pervasive systems.

7.4. International Research Visitors

7.4.1. Visits of International Scientists

Prof. Peter Sawyer from Lancaster University (UK), visited the ARLES team during Q1 2013, where he investigated how to leverage requirements engineering in the context of distributed software systems, with a special emphasis on the exploitation of requirements@runtime.

7.4.1.1. Internships

Aness Bajia (from Feb. 2013 until Jul. 2013)

Subject: *Fault Tolerance in Sensor Network Macroprogramming*

Institution: Faculté des sciences de Tunis (Tunisia)

Amel Belaggoun (from Jan. 2013 until Aug. 2013)

Subject: *Runtime and Representation of Requirements in Self-Adaptive Systems*

Institution: Université de Versailles Saint-Quentin-en-Yvelines (France)

Ankur Gautam (from Jan. 2013 until Feb. 2013)

Subject: *Semantic Composition of Services in the Internet of Things*

Institution: Indian Institute of Technology, Banaras Hindu University, Varanasi (India)

Yijun Liu (from Jun. 2013 until Sep. 2013)

Subject: *Smartphone-supported Indoor Location System*

Institution: Stanford University (USA)

Akash Nawani (from Jan. 2013 until Mar. 2013)

Subject: *Middleware Support for Federated Social Networking*

Institution: Indian Institute of Technology, Banaras Hindu University, Varanasi (India)

Dimitrios Soukaras (from Feb. 2013 until Apr. 2013)

Subject: *Enabling High-level Application Development in the Internet of Things*

Institution: University of Peloponnese (Greece)

ASAP Project-Team

8. Partnerships and Cooperations

8.1. National initiatives

8.1.1. LABEX CominLabs

Participants: Anne-Marie Kermarrec, Davide Frey, Michel Raynal, François Taïani.

ASAP participates in the CominLabs initiative sponsored by the "Laboratoires d'Excellence" program. The initiative federates the best teams from Bretagne and Nantes regions in the broad area of telecommunications, from electronic devices to wide area distributed applications "over the top." These include, among the others, the Inria teams: ACES, ALF, ASAP, CELTIQUE, CIDRE, DISTRIBCOM, MYRIADS, TEMICS, TEXMEX, and Visages. The scope of CominLabs covers research, education, and innovation. While being hosted by academic institutions, CominLabs builds on a strong industrial ecosystem made of large companies and competitive SMEs. In this context, ASAP received funding for DeSeNt (a collaborative project with the Université de Nantes / LINA).

8.1.2. ANR ARPÈGE project Streams

Participants: Marin Bertier, Michel Raynal.

The Streams project started in November 2010. Beside the ASAP group, it includes teams from Inria Nancy and PARIS. Its aim is to design a real-time collaborative platform based on a peer-to-peer network. For this it is necessary to design a support architecture that offers guarantees on the propagation, security and consistency of the operations and the updates proposed by the different collaborating sites.

8.1.3. ANR project SocioPlug

Participants: Anne-Marie Kermarrec, Davide Frey, Michel Raynal, François Taïani.

SocioPlug is a collaborative ANR project involving Inria (ASAP team), the université de Nantes, and LIRIS (INSA Lyon and Université Claude Bernard Lyon). The project emerges from the observation that the features offered by the Web 2.0 or by social media do not come for free. Rather they bring the implicit cost of privacy. Users are more or less consciously selling personal data for services. SocioPlug aims to provide an alternative for this model by proposing a novel architecture for large-scale, user centric applications. Instead of concentrating information of cloud platforms owned by a few economic players, we envision services made possible by cheap low-end plug computers available in every home or workplace. This will make it possible to provide a high amount of transparency to users, who will be able to decide their own optimal balance between data sharing and privacy.

8.1.4. DeScenT CominLabs

Participants: Resmi Ariyattu Chandrasekharannair, Davide Frey, Michel Raynal, François Taïani.

The DeScenT project aims to ease the writing of distributed programs on a federation of plug computers. Plug computers are a new generation of low-cost computers, such as Raspberry pi (25\$), VIA- APC (49\$), and ZERO Devices Z802 (75\$), which offer a cheap and readily available infrastructure to deploy domestic on-line software. Plug computers open the opportunity for everyone to create cheap nano-clusters of domestic servers, host data and services and federate these resources with their friends, colleagues, and families based on social links. More particularly we will seek in this project to develop novel decentralized protocols than can encapsulate the notion of privacy-preserving federation in plug-based infrastructures. The vision is to use these protocols to provide a programming toolkit that can support the convergent data types being developed by our partner GDD (Grande Données Distribuées) at Université de Nantes.

8.1.5. ANR Blanc project Displexity

Participants: George Giakkoupis, Anne-Marie Kermarrec, Michel Raynal.

The Displexity project started in October 2011. The aim of this ANR project that also involves researchers from Paris and Bordeaux is to establish the scientific foundations for building up a consistent theory of computability and complexity for distributed computing. One difficulty to be faced by DISPLEXITY is to reconcile two non necessarily disjoint sub-communities, one focusing on the impact of temporal issues, while the other focusing on the impact of spatial issues on distributed algorithms.

8.2. European initiatives

8.2.1. FP7 projects

8.2.1.1. ALLYOURS ERC Proof of Concept

Title: AllYours: A distributed privacy-aware instant item recommender

Type: IDEAS

Instrument: ERC Proof of Concept Grant (Starting)

Duration: January 2013 - December 2013.

Coordinator: Inria (France)

See also: <http://www.gossple.fr>

Abstract: The goal of this PoC proposal is to boost the creation of a start-up (AllYours/MEDIEGO) targeting both Internet users as well as small to medium companies (SME) offering full-fledged personalization in notification systems. AllYours is a direct outcome from the GOSSPLE ERC Starting Grant, and more specifically from one of the activities conducted within the project, that today involves most of the team and forces. In the GOSSPLE ERC SG project, we have invented the concept of implicit social network, built and maintained in a fully decentralized manner so that each user is in charge of her own personalized data, addressing both the privacy concern that users may have with respect to Big Brother-like companies, and scalability as the resources present at the edges of the Internet can then be fully leveraged. The GOSSPLE social network has been the basis of several Web 2.0 applications in order to personalize Web functionalities within the project, such as search, recommendation, query expansion, top-k queries, etc. More specifically, we have been applying the GOSSPLE social network to personalized notification, defining on top of it a novel dissemination protocol. This is P2P-AllYours currently under development. Our MEDIEGO software is now applied to centralized systems for recommendations.

8.2.1.2. TOWARD THE ALLYOURS START-UP

Title: TOWARD THE ALLYOURS START-UP: Focus on the mobile version

Type: EIT-ICT Labs

Instrument: ACLD Computing in the Cloud

Duration: January 2013 - December 2013.

Coordinator: Inria (France)

Partners: Trento Rise, BDP EIT-ICT

See also: <http://www.gossple.fr>

Abstract: The goal of the Activity proposal is to turn the inventions from the ERC Starting Grant Project GOSSPLE to innovation by setting up a start-up (AllYours) targeting both Internet users as well as small to medium companies (SME) offering full-fledged personalization in notification systems. This proposal focuses on the mobile versions of AllYours software. While the wired setting is a goal of the foreseen startup, this proposal will focus on the mobile versions of E-AllYours and P2P AllYours that will be experimented on the live platform provided by the TrentoRise partners.

8.2.1.3. ERC SG Gossple

Title: GOSSPLE

Type: IDEAS

Instrument: ERC Starting Grant

Duration: September 2008 - August 2013

Coordinator: Inria (France)

See also: <http://www.gossple.fr>

Abstract: Anne-Marie Kermarrec is the principal investigator of the GOSSPLE ERC starting Grant (Sept. 2008 - Sept. 2013). GOSSPLE aims at providing a radically new approach to navigating the digital information universe. This project has been granted a 1.250.000 euros budget for 5 years.

GOSSPLE aims at radically changing the navigation on the Internet by placing users affinities and preferences at the heart of the search process. Complementing traditional search engines, GOSSPLE will turn search requests into live data to seek the information where it ultimately is: at the user. GOSSPLE precisely aims at providing a fully decentralized system, self-organizing, able to discover, capture and leverage the affinities between users and data.

8.2.2. Collaborations in European programs, except FP7

8.2.2.1. Transform Marie Curie Initial Training Network (ITN)

Participants: Tyler Crain, Eleni Kanellou, Anne-Marie Kermarrec, Michel Raynal.

Program: Marie Curie Initial Training Network

Project acronym: Transform

Project title: Theoretical Foundations of Transactional Memory

Duration: May 2010 - October 2013

Grant agreement no.: 238639

Date of approval of Annex I by Commission: May 26, 2009

Coordinators: Michel Raynal - Panagiota Fatourou

Other partners: Foundation for Research and Technology Hellas ICS FORTH Greece, University of Rennes I UR1 France, Ecole Polytechnique Federale de Lausanne EPFL Switzerland, Technische Universitaet Berlin TUB Germany, and Israel Institute of Technology Technion.

Abstract: Transform is a Marie Curie Initial Training Networks European project devoted to the Theoretical Foundations of Transactional Memory (TM). Major chip manufacturers have shifted their focus from trying to speed up individual processors into putting several processors on the same chip. They are now talking about potentially doubling efficiency on a 2x core, quadrupling on a 4x core and so forth. Yet multi-core is useless without concurrent programming. The constructors are now calling for a new software revolution: the concurrency revolution. This might look at first glance surprising for concurrency is almost as old as computing and tons of concurrent programming models and languages were invented. In fact, what the revolution is about is way more than concurrency alone: it is about concurrency for the masses. The current parallel programming approach of employing locks is widely considered to be too difficult for any but a few experts. Therefore, a new paradigm of concurrent programming is needed to take advantage of the new regime of multicore computers. Transactional Memory (TM) is a new programming paradigm which is considered by most researchers as the future of parallel programming. Not surprisingly, a lot of work is being devoted to the implementation of TM systems, in hardware or solely in software. What might be surprising is the little effort devoted so far to devising a sound theoretical framework to reason about the TM abstraction. To understand properly TM systems, as well as be able to assess them and improve them, a rigorous theoretical study of the approach, its challenges and its benefits is badly needed. This is the challenging research goal undertaken by this MC-ITN. Our goal

through this project is to gather leading researchers in the field of concurrent computing over Europe, and combine our efforts in order to define what might become the modern theory of concurrent computing. We aim at training a set of Early Stage Researchers (ESRs) in this direction and hope that, in turn, these ESRs will help Europe become a leader in concurrent computing. Its keywords are Transactional Memory, Parallelization Mechanisms, Parallel Programming Abstractions, Theory, Algorithms, Technological Sciences

8.2.3. Collaborations with major European organizations

Ecole Polytechnique Federale de Lausanne EPFL Switzerland; collaboration on the ERC SG GOSSPLE and Transform, and the Google Focused Award Web-Alter-Egos.

Foundation for Research and Technology Hellas ICS FORTH Greece; collaboration on Transform

8.3. International initiatives

8.3.1. Inria associate teams

8.3.1.1. RADCON

Title: Randomized Algorithms for Distributed Computing and Networks

Inria principal investigator: George Giakkoupis

International Partner:

University of Calgary (Canada) - Department of Computer Science - Philipp Woelfel

Duration: 2013 - 2015

See also: <http://www.irisa.fr/asap/radcon>

Over recent years, computing systems have seen a massive increase in parallelism and interconnectivity. Peer-to-peer systems, ad-hoc networks, sensor networks, or the "cloud" are based on highly connected and volatile networks. Individual nodes such as cell phones, desktop computers or high performance computing systems rely on parallel processing power achieved through multiple processing units. To exploit the power of massive networks or multiple processors, algorithms must cope with the scale and asynchrony of these systems, and their inherent instability, e.g., due to node, link, or processor failures. In this research project we explore randomized algorithms for large-scale networks of distributed systems, and for shared memory multi-processor systems. For large-scale networks, decentralized gossip protocols have emerged as a standard approach to achieving fault-tolerant communication between nodes with simple and scalable algorithms. We will devise new gossip protocols for various complex distributed tasks, and we will explore the power and limits of gossip protocols in various settings. For shared memory systems, randomized algorithms have proved extremely useful to deal with asynchrony and failures. Sometimes probabilistic algorithms provide the only solution to a problem; sometimes they are more efficient; sometimes they are simply easier to implement. We will devise efficient algorithms for some of the fundamental problems of shared memory computing, such as mutual exclusion, renaming, and consensus.

8.3.2. Inria international partners

University of Calgary

Universidad Nacional Autonoma de Mexico

University of Glasgow

8.3.3. Participation in international programs

8.3.3.1. Demdyn: Inria/CNPq Collaboration

Participants: Marin Bertier, Michel Raynal.

The aim of this project is to exploit dependable aspects of dynamic distributed systems such as VANETs, WiMax, Airborn Networks, DoD Global Information Grid, P2P, etc. Applications that run on these kind of networks have a common point: they are extremely dynamic both in terms of the nodes that take part of them and available resources at a given time. Such dynamics results in instability and uncertainty of the environment which provide great challenges for the implementation of dependable mechanisms that ensure the correct work of the system. This requires applications to be adaptive, for instance, to less network bandwidth or degraded Quality-of-Service (QoS). Ideally, in these highly dynamic scenarios, adaptiveness characteristics of applications should be self-managing or autonomic. Therefore, being able to detect the occurrence of partitions and automatically adapting the applications for such scenarios is an important dependable requirement for such new dynamic environments.

8.4. International research visitors

8.4.1. Visits of international scientists

Zarah Aghazadeh, University of Calgary, from 6 to 27 July 2013

Laurent Fournier, Cup Foundation Toulouse, 13 November 2013

Roy Friedman, Technion University Tel Aviv, 20 December 2013

Christian Grothoff, TU Munich, 26 November 2013

Jean-Loup Guillaume, Lip6 Paris, 12 March 2013

Gilles Tredan, Laass Toulouse, from 2 to 10 September 2013

Philipp Woelfel, University of Calgary, from 6 to 14 July 2013

8.4.2. Internships

Hoël Kervadec; 1 July 2013 to 6 September 2013. "Construction décentralisée de topologies informatiques réparties à mémoire de forme." Supervised by François Taïani.

Nabil Kmihi; 16 May 2013 to 8 November 2013. "Offline social networks." Supervised by Anne-Marie Kermarrec.

Olivier Ruas; 1 February 2013 to 30 June 2013. "Degree-based routing in small world networks." Supervised by George Giakkoupis and Anne-Marie Kermarrec.

Sylvain Fabre; 1 July 2013 to 31 August 2013. "Elaboration d'un overlay qui prend en compte la localisation des noeuds." Supervised by Marin Bertier.

Vincent L'Honore; 10 July 2013 to 2 August 2013. "The development of the mobile-based Android application of MEDIEGO Dashboard." Supervised by Antoine Boutet.

Yahya Benkaouz; 1 December 2013 to 28 February 2014. "La conception et la mise en œuvre d'un réseau social décentralisé respectant la vie privée des utilisateurs et son intégration dans le système Gossple." Supervised by Anne-Marie Kermarrec.

8.4.3. Visits to international teams

George Giakkoupis visited University of Calgary, Canada, twice, from 15 April to 6 May and from 23 November to 14 December. He also visited MPI, Saarbrücken, Germany, from 3 to 9 August.

Anne-Marie Kermarrec was a part-time visiting professor at EPFL, Lausanne.

Anne-Marie Kermarrec visited University of Sydney and NICTA, Australia, Jan 2014.

ASCOLA Project-Team

8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. CominLabs laboratory of excellence

8.1.1.1. EPOC

Participants: Jean-Marc Menaud [coordinator], Thomas Ledoux.

The project EPOC (Energy Proportional and Opportunistic Computing system) is an (academic) Labex CominLabs project running for 4 years. Four other partners collaborate within the project that is coordinated by ASCOLA: Myriads team, ENIB, ENSTB and University of Nantes. In this project, partners aim at focusing on energy-aware task execution from the hardware to application's components in the context of a *mono-site* data center (all resources are in the same physical location) which is connected to the *regular electric Grid and to renewable energy sources* (such as windmills or solar cells). Three major challenges are addressed in this context: Optimize the energy consumption of distributed infrastructures and service compositions in the presence of ever more dynamic service applications and ever more stringent availability requirements for services; Design a clever cloud's resource management which takes advantage of renewable energy availability to perform opportunistic tasks, then exploring the trade-off between energy saving and performance aspects in large-scale distributed system; Investigate energy-aware optical ultra high-speed interconnection networks to exchange large volumes of data (VM memory and storage) over very short periods of time.

One of the strengths of the proposal is to provide a systematic approach, and use a single model for the system (from hard to soft) by mixing constraint programming and behavioral models to manage energy consumption in data centers.

8.1.1.2. SecCloud

Participants: Jacques Noyé [coordinator], Florent Marchand de Kerchove de Denterghem, Mario Südholt.

The high-level objective of the 3-year SecCloud (Secure Scripting for the Cloud) project is to enhance the security of devices on which web applications can be downloaded, i.e. to enhance client-side security in the context of the Cloud. In order to do so, the project relies on a language-based approach, focusing on three related issues:

- The definition of security policies for web architectures, especially on the client-side.
- Formally-proven analyses of web programming languages.
- Multi-level enforcement mechanisms for the security policies (based on static and dynamic analysis encompassing application-level and system-level software).

ASCOLA members are mainly interested in JavaScript as a programming language as well as the use of aspects as a seamless path from the definition of security policies and their composition to their implementation.

This year we have proposed new means for the modularization of JavaScript-based security mechanisms and policies (see 6.1).

8.1.2. ANR

8.1.2.1. CESSA (ANR/ARPEGE)

Participants: Mario Südholt [coordinator], Diana Allam, Rémi Douence, Hervé Grall, Jean-Claude Royer.

The project CESSA (Compositional Evolution of Secure Services with Aspects) is an (industrial) ANR project running for 3 years months, with funding amounting to 290 KEUR for ASCOLA from Jan. 10 on. Three other partners collaborate within the project that is coordinated by ASCOLA: a security research team from Eurecom, Sophia-Antipolis, the Security and Trust team from SAP Labs, also located at Sophia-Antipolis, and IS2T, an innovative start-up company developing middleware technologies located at Nantes. The project deals with security in service-oriented architectures.

This year our group has contributed several scientific publications as part of the project. All partners have been involved in the publication of a unifying model for WD*/SOAP-based and RESTful web services. Furthermore, we have formally defined a type system that is safe in the presence of malicious attackers and insecure communication channels (see 6.1).

All information is available from the CESSA web site: <http://cessa.gforge.inria.fr>.

8.1.2.2. MyCloud (ANR/ARPEGE)

Participants: Thomas Ledoux [coordinator], Jean-Marc Menaud, Yousri Kouki, Frederico Alvares.

The MyCloud project is an ANR/ARPEGE project running for 42 months, starting in Nov. 2010. It was accepted in Jul. 2010 for funding amounting to 190 KEUR (ASCOLA only). MyCloud involves a consortium with three academic partners (Inria, LIP6, EMN) and one industrial partner (We Are Cloud).

Cloud Computing provides a convenient means of remote on-demand and pay-per-use access to computing resources. However, its ad-hoc management of quality-of-service (QoS) and SLA poses significant challenges to the performance, dependability and costs of online cloud services.

The objective of MyCloud (<http://mycloud.inrialpes.fr>) is to define and implement a novel cloud model: SLAaaS (SLA as a Service). The SLAaaS model enriches the general paradigm of Cloud Computing and enables systematic and transparent integration of SLA to the cloud [45], [50]. From the cloud provider's point of view, MyCloud proposes autonomic SLA management to handle performance, availability, energy and cost issues in the cloud. From the cloud customer's point of view, MyCloud provides SLA governance allowing cloud customers to be part of the loop and to be automatically notified about the state of the cloud, such as SLA violation and cloud energy consumption.

This year, the ASCOLA project-team has proposed: (i) SCALing, an auto-scaling approach driven by SLA and based on a MAPE-K control loop framework [39]; (ii) RightCapacity, a cross-layer (application-resource) Cloud elasticity approach based on queueing network model, taking into account the SLA concept and the Cloud economic model [17].

8.1.2.3. SONGS (ANR/INFRA)

Participants: Adrien Lèbre [coordinator], Flavien Quesnel, Jonathan Pastor, Takahiro Hirofuchi.

The SONGS project (Simulation of Next Generation Systems) is an ANR/INFRA project running for 48 months (starting in January 2012 with an allocated budget of 1.8MEuro, 95KEuro for ASCOLA).

The consortium is composed of 11 academic partners from Nancy (AlGorille, coordinator), Grenoble (MESCAL), Villeurbanne (IN2P3 Computing Center, GRAAL/Avalon - LIP), Bordeaux (CEPAGE, HiePACS, RUNTIME), Strasbourg (ICPS - LSIIT), Nantes (ASCOLA), Nice (MASCOTTE, MODALIS).

The goal of the SONGS project (<http://infra-songs.gforge.inria.fr>) is to extend the applicability of the SimGrid simulation framework from Grids and Peer-to-Peer systems to Clouds and High Performance Computation systems. Between January and December 2013, we have hosted Takahiro Hirofuchi, Researcher at AIST (Japan). During his stay, we have extended the Simgrid toolkit with VM abstractions [35]. In addition to elementary functionalities such as VM start/stop, we have delivered the first accurate model of live migration operations within IaaS systems [36].

8.1.3. FSN

8.1.3.1. OpenCloudware (FSN)

Participants: Jean-Marc Menaud [coordinator], Thomas Ledoux, Yousri Kouki.

The OpenCloudware project is coordinated by France Telecom, funded by the French Fonds National pour la Société Numérique (FSN, call Cloud n°1) and endorsed by competitiveness clusters Minalogic, Systematic and SCS. OpenCloudware is developed by a consortium of 18 partners bringing together industry and academic leaders, innovative technology start-ups and open source community expertise. Duration: 36 months - 2012–2014.

The OpenCloudware project aims at building an open software engineering platform, for the collaborative development of distributed applications to be deployed on multiple Cloud infrastructures. It will be available through a self-service portal. We target virtualized multi-tier applications such as JavaEE - OSGi. The results of OpenCloudware will contain a set of software components to manage the lifecycle of such applications, from modelling(Think), developing and building images (Build), to a multi-IaaS compliant PaaS platform (Run).

The ASCOLA project-team is mainly involved in the sub-projects "Think" (SLA model accross Cloud layers) and "Run" (virtual machine manager for datacenters and placement constraints). In 2013, the team has developed btrCloudStack, a private cloud based on the OpenSource CloudStack and integrating the work on placement rules and energy optimization.

8.2. European Initiatives

8.2.1. FP7 Projects

8.2.1.1. A4Cloud (IP)

Participants: Mario Südholt [coordinator], Ronan-Alexandre Cherrueau, Rémi Douence, Hervé Grall, Jean-Claude Royer, Mohamed Sellami.

The A4Cloud project (Accountability for the Cloud) is an integrated EU project, coordinated by HP, UK, on the topic of accountability, that is, the responsible stewardship of private data, in the Cloud. This 42-months project started in Oct. 2012 and Ascola's funding amounts to 600 KEuro.

The project involves 13 partners: in addition to HP, two enterprises (SAP AG, Germany; ATC, Greece), a non-governmental organisation (the Cloud Security Alliance, CSA) and 9 universities and research organisations (EMNantes and Eurecom, France; HFU. Furtwangen, Germany; Karlstadt U., Sweden; U. Malaga, Spain; Queen Mary U., U.K.; U. Stavanger and Sintef, Norway; Tilburg U., The Netherlands).

A4Cloud focuses on accountability properties for the cloud and other future internet services as the most critical prerequisite for effective governance and control of corporate and private data processed by cloud-based IT services. The research being conducted in the project will increase trust in cloud computing by devising methods and tools, through which cloud stakeholders can be made accountable for the privacy and confidentiality of information held in the cloud. These methods and tools will combine risk analysis, policy enforcement, monitoring and compliance auditing. They will contribute to the governance of cloud activities, providing transparency and assisting legal, regulatory and socio-economic policy enforcement. For further information, see <http://www.a4cloud.eu>.

ASCOLA is mainly involved in the sub-projects on the enforcement of accountability and security policies, as well as tool validation efforts.

8.2.2. Collaborations in European Programs, except FP7

8.2.2.1. SCALUS (MC ITN)

Participants: Adrien Lèbre [coordinator], Mario Südholt, Gustavo Bervian Brand.

The vision of the Scalus (SCALing by means of Ubiquitous Storage) (MC international training network) was to deliver the foundation for ubiquitous storage systems, which can be scaled with respect to multiple characteristics (capacity, performance, distance, security, ...). Providing ubiquitous storage will become a major demand for future IT systems and leadership in this area can have significant impact on European competitiveness in IT technology. To get this leadership, it is necessary to invest into storage education and research and to bridge the current gap between local storage, cluster storage, grid storage, and cloud storage. During the four last years, the consortium proceeded into this direction by building the first interdisciplinary teaching and research network on storage issues. It consisted of top European institutes and companies in storage and cluster technology, building a demanding but rewarding interdisciplinary environment for young researchers.

The network involved the following partners: University of Paderborn (Germany, coordinator), Barcelona Super Computing (Spain), University of Durham (England), University of Frankfurt (Germany), ICS-FORTH (Greece), Universidad Polytechnica de Madrid (Spain), EMN/ARMINES (France), Inria Rennes Bretagne Atlantique (France), XLAB (Slovenia), University of Hamburg (Germany), Fujitsu Technology Systems (Germany).

The overall funding of the project by the European Union was closed to 3,3 MEUR. ASCOLA's share amounts to 200 KEUR. The project ended in October.

8.3. International Initiatives

8.3.1. Inria Associate Teams

8.3.1.1. REAL

Title: Reasoning about Effects in Aspect Languages

Inria principal investigator: Jacques Noyé

International Partner (Institution - Laboratory - Researcher):

University of Chile (Chile) - PLEIAD - Éric Tanter

Duration: 2013 - 2015

See also: <http://real.gforge.inria.fr>

The scientific goals of this collaboration are twofold. On the one hand, we plan to develop a theory to reason about aspect interference in general, i.e. covering both base/aspect and aspect/aspect composition and, more precisely, to reason about effects that can be used by aspects. This provides foundations for secure aspects. On the other hand, we plan to study how secure aspects can help construct security aspects, i.e. aspects ensuring security policies. Our case study is web applications built with web scripting languages such as JavaScript.

8.3.2. Inria International Partners

8.3.2.1. Informal International Partners

ASCOLA is closely cooperating with several other international partners:

- **AIST, Japan; Dr. Takahiro Hirofuchi.** This year we have started a cooperation on the simulation of Cloud infrastructures and new scheduling algorithms for virtual environments 6.3 . Dr. Takahiro Hirofuchi has visited the team in 2013 in the context of this collaboration.
- **Soft team, VU Brussel, Belgium; Prof. Wolfgang De Meuter.** In the context of a joint PhD thesis that started in Dec. 2013, we are working on new means for the declarative definition and efficient implementation of event-based systems.
- **Software Technology Group, TU Darmstadt, Germany; Prof. Mira Mezini.** In the context of a joint PhD thesis we are working on a common model for object-oriented programming, event-based programming and aspect-oriented programming, see 6.2 .

8.4. International Research Visitors

8.4.1. Visits of International Scientists

- Éric Tanter (University of Chile), 2-12 July 2013, in the context of the Associate Team REAL.
- Takahiro Hirofuchi (AIST, Japan), 1 Jan-31 Dec 2013, in the context and with the financial support of the ANR SONGS project.

8.4.1.1. Internships

Ismael FIGUEROA (from Apr 2013 until Jun 2013)

Compositional Reasoning About Aspect Interference (this leads to a publication in *Modularity'14* [33]).

Institution: University of Chile (Chile)

ATLANMOD Project-Team

8. Partnerships and Cooperations

8.1. Regional Initiatives

Program: Pole Images et Reseaux - Appel Projets PME 2011

Project title: StreamMaster

Duration: 2012 - 2014

Coordinator: Data Syscom

Other partners: Research and University (University of Nantes, Ecole de Design Nantes Atlantique, ESC Rennes) and Vendors and service providers (IMINFO)

Abstract: The purpose of the StreamMaster project is creating a universal software solution for the smart management of document streams, providing an added value over all the chain. StreamMaster will provide: an hybrid (local and remote) technological platform to allow user access, the possibility of connection to every information system and every input and output stream, the management of all the parameters of the document stream (cost, speed, delay, quality, environmental impact), security and reinforced document authentication mechanisms, non-falsifiable documents by means of invisible document tatooining, an innovative and multimodal HMI.

Program: Pays de la Loire regional funding. Call: Creation of new teams

Project title: AtlanMod New Team Creation

Duration: 2011 - 2014

Coordinator: AtlanMod

Other partners: None

Abstract: AtlanMod has been funded by the Pays de la Loire Regional Council new research teams program. This funding will mainly cover a PhD Student and two years of a postdoc to work on the quality of models research line.

8.2. National Initiatives

8.2.1. FUI

Program: FUI - AAP 15

Project acronym: MoNoGe

Project title: Atelier de Modélisation de Nouvelle Génération

Duration: 2013 - 2016

Coordinator: Softeam

Other partners: Industry (DCNS), Research and University (ARMINES AtlanMod, LIP6) and Vendors and service providers (Softeam, Soft-Maint, Mia-Software)

Abstract: There is currently in companies a wide diversity of models and modeling tools according to the application domains, services or contexts which are concerned. This implies different problems forbidding their plain exploitation: traceability, global coherence, continuity between works, knowledge management, etc. All are largely penalized by this situation that harms the mastering of the complexity of the related systems and software. The MoNoGe project has for objective to bring innovative solutions allowing to ensure the agility of the models and modeling tools. The term agility is here referring to the properties of interoperability, extensibility and evolution of models. The dynamic extension mechanism to be developed in MoNoGe, potentially inspiring from the OMG MEF standard currently under definition, is intended to preserve the original metamodel which can be conserved, partially hidden or extended. Thus, the legacy data and models can stay operational with the extended metamodel. The user does not have to deal with heavy migration or conversion operations, and can this way focus on its modeling activities while continuously exploiting past models.

Program: ANR - ARPEGE program

Project acronym: Galaxy

Project title: Galaxy

Duration: 2010 - 2013

Coordinator: Airbus

Other partners: Industry (Airbus), Research and University (Armines -AtlanMod-, IRIT, LIP6) and Vendors and service providers (AKKA, Softeam)

Abstract: GALAXY (<http://galaxy.lip6.fr>) proposes to deal with the model driven collaborative development of complex systems. Galaxy aims at defining an open and flexible architecture particularly designed to be scalable. One of the key points is related to the fragmentation and distributiveness of huge models, their synchronization and relationship with communication means classically used by development teams. The work is being driven by use cases provided by a company (Airbus), which describe scalability issues they face during systems developments. Our work in this project is composed of two main parts: 1) the conception of efficient mechanisms for multiple views of complex (large) models; 2) the definition of a solution for the automation of modeling tasks on large model repositories, like the execution of large amounts of transformations, the orchestration of their execution, and the effective browsing of repositories for finding specific models. In this context we have developed MoScript, a scripting language (and corresponding execution engine) to write batch processing modeling tasks.

Program: FUI - AAP 13

Project acronym: TEAP

Project title: TOGAF Enterprise Architecture Platform

Duration: 2012 - 2014

Coordinator: Obeo

Other partners: Industry (DCNS), Research and University (Inria AtlanMod) and Vendors and service providers (Obeo, Capgemini)

Abstract: The fast evolution of technologies (SOA, Cloud, mobile environments), the systems complexity and the growing need for agility require to be able to represent information systems as a whole. The high-level approach promoted by Enterprise Architecture (EA) is a key element in this context and intends to address all the systems dimensions: software components, associated physical resources, relationships with the companies requirements and business processes, implied actors/roles/structures, etc. The objective of the TEAP project is to specify and implement an EA platform based on the Open Group international standard named TOGAF and on the SmartEA technical solution. In addition to its base modeling capabilities, this platform will allow data federation from different existing sources (e.g. for reverse engineering purposes such as retro-cartography) as well as the definition of possible transformation chains (for governance and modernization). As part of this project, we are notably using in practice (and improving) some of our works such as Virtual EMF, ATL or some MoDisco components.

Program: FUI - AAP 13

Project acronym: ITM Factory

Project title: Information Technology Modernisation Factory

Duration: 04/2012 - 10/2014

Coordinator: Soft-Maint (Groupe SODIFRANCE)

Other partners: Mia-Software (Groupe SODIFRANCE), ACAPNOS, MMA and Inria AtlanMod.

Abstract: Application maintenance represents about 80 per cent of the computer market (at the French and global level). The challenge of software maintenance is to keep running applications with technologies that are no longer required to be maintained and with changing development teams and whose skills are not always validated on ancient languages. The main goal of the ITM Factory is to propose a software modernization framework, based on the ModDisco project and including: (i) an integrated workbench for software modernization engineers and (ii) a set of ready to use modernization cartridges, i.e., a solution brick that meets a business challenge level, as opposed to a technical bricks that provides technical solutions that are integrated into a business solution.

8.3. European Initiatives

8.3.1. FP7 Projects

8.3.1.1. ARTIST

Type: COOPERATION

Defi: Cloud Computing, Internet of Services and Advanced Software engineering

Instrument: Integrated Project

Duration: October 2012 - September 2015

Coordinator: Clara Pezuela (ATOS Spain)

Partner: ATOS and TECNALIA (Spain), Inria AtlanMod (France), Fraunhofer (Germany), TU Wien and Sparks (Austria), ENGINEERING (Italy), Spikes (Belgium), ATC and ICCS (Greece)

Inria contact: Hugo Bruneliere

Abstract: Nowadays Cloud Computing is considered as the ideal environment for engineering, hosting and provisioning applications. A continuously increasing set of cloud-based solutions is available to application owners and developers to tailor their applications exploiting the advanced features of this paradigm for elasticity, high availability and performance. Even though these offerings provide many benefits to new applications, they often incorporate constraints to the modernization and migration of legacy applications by obliging the use of specific development technologies and explicit architectural design approaches. The modernization and adaptation of legacy applications to cloud environments is a great challenge for all involved stakeholders, not only from the technical perspective, but also in business level with the need to adapt the business processes and models of the modernized application that will be offered from now on, as a service. The purpose of the ARTIST project is to propose and develop a novel model-driven approach for the migration of legacy applications in modern cloud environments which covers all aspects and phases of the migration process, as well as an integrated framework that supports all migration process.

8.3.1.2. MONDO

Title: Scalable Modelling and Model Management on the Cloud

Type: COOPERATION (ICT)

Defi: Cloud Computing, Internet of Services and Advanced Software engineering

Instrument: Small or medium-scale focused research project (STREP)

Duration: November 2013 - May 2016

Coordinator: The Open Group - X/Open Company

Partners: The Open Group - X/Open Company (United Kingdom), University of York (United Kingdom), Universidad Autonoma de Madrid (Spain), Budapest University of Technology and Economics (Hungary), IKERLAN (Spain), MIA Software (France), Cassidian (Germany)

Inria contact: Massimo Tisi

Abstract: As Model Driven Engineering (MDE) is increasingly applied to larger and more complex systems, the current generation of modelling and model management technologies are being pushed to their limits in terms of capacity and efficiency, and as such, additional research is imperative in order to enable MDE to remain relevant with industrial practice and continue delivering its widely recognised productivity, quality, and maintainability benefits. The aim of MONDO is to tackle the increasingly important challenge of scalability in MDE in a comprehensive manner. Achieving scalability in modelling and MDE involves being able to construct large models and domain specific languages in a systematic manner, enabling teams of modellers to construct and refine large models in a collaborative manner, advancing the state-of-the-art in model querying and transformations tools so that they can cope with large models (of the scale of millions of model elements), and providing an infrastructure for efficient storage, indexing and retrieval of large models. To address these challenges, MONDO brings together partners with a long track record in performing internationally-leading research on software modelling and MDE, and delivering research results in the form of robust, widely-used and sustainable open-source software, with industrial partners active in the fields of reverse engineering and systems integration, and a global consortium including more than 400 organisations from all sectors of IT.

8.3.1.3. Automobile

Title: Automated Mobile App Development

Type: Research For SMEs

Duration: November 2013 - October 2015

Coordinator: WebRatio s.r.l.

Partners: WebRatio, Politecnico di Milano (Italy), AtlanMod-Armines, Moon Submarine (UK), ForwardSoftware (Rumania).

Inria contact: Jordi Cabot

Abstract: The AutoMobile project aims at designing and bringing to the market innovative methodologies, software tools, and vertical applications for the cost-effective implementation of cross-platform, multi-device mobile applications, i.e. business applications that can be accessed by users on a variety of devices and operating systems, including PC, cellular / smart phones and tablets.

Cross-platform and multi-device design, implementation and deployment is a barrier for today's IT solution providers, especially SME providers, due to the high cost and technical complexity of targeting development to a wide spectrum of devices, which differ in format, interaction paradigm, and software architecture.

AutoMobile will exploit the modern paradigm of Model-Driven Engineering and code generation to dramatically simplify multi-device development, reducing substantially cost and development times, so as to increase the profit of SME solution providers and at the same time reduce the price and total cost of ownership for end-customers.

AutoMobile will rely on modeling languages such as IFML (Interaction Flow Modeling Languages) and on tools like WebRatio.

8.3.2. Collaborations in European Programs, except FP7

Program: CORE Multi-annual thematic research programme. Fonds National de la Recherche Luxembourg.

Project acronym: TOOM

Project title: Testing Orders of Magnitude

Duration: September 2013 - August 2015

Coordinator: SnT/University of Luxembourg

Other partners: the iTrust company, EBRC, Inria Rennes/University of Nantes and the UFPR (Brazil).

Abstract: Over the last decade, large-scale systems drew much attention due to scalability and resiliency features. Many popular large-scale data-oriented systems (i.e., BigData), including, Peer-to-peer (P2P) and MapReduce, reached millions of users and processed petabytes of data, such as: Hadoop, Skype, Bittorrent, and Gnutella. The main reason is due to a decentralized manner to remove potential performance bottlenecks and centralized points of failure. Recently, cloud computing is gathering all these BigData systems underneath its layers (e.g. Paas, Saas, Iaas) to free developers from large-scale issues, such as: deployment, distribution, resiliency, security, and performance. Several companies around the globe rely on cloud computing to build robust and reliable services for their business operations (e.g. eBay, Amazon, Skype) mainly to handle heavy load conditions (e.g. seasonal sales, Internet-scale malicious attacks). Testing robustness and reliability of cloud computing services is a hard activity, the state of the art shows that the existing testing techniques suffer to handle aspects, such as: the scale of the cloud, the dynamism of the nodes, and the amount of data and load. In general, these testing techniques rely on a combination of unit tests with some mocking approach that may hide the cloud aspects and may not be suited for large-scale testing. The TOOM project is planned to present a solution for testing robustness of cloud computing services built on top of P2P technology to address scalability and dynamism aspects. The main contributions lie on two main steps. The first one is to validate the overall resilience and reliability of cloud services. The second one is to reproduce large-scale stress loads, such as Distributed Denial of Service (DDoS) and peak loads, either gathered from the real load traces or synthetically generated. We plan to leverage data warehouse technology to house real load traces and use them during testing. To generate synthetic loads, we plan to use known load patterns or adapt them to new load trends. To assess the effectiveness of the TOOM outcomes, we will reproduce stress loads submitted by P2P technology across the cloud infrastructure on top of step-stress testing methodologies. In this manner, we can progressively increase the load in orders of magnitude up to a peak load. Then, we will measure the effectiveness either by code coverage whether the SUT is open-source, by the quality of service (QoS) of the SUT, or by the coverage of network and computing components used by the cloud computing services.

8.4. International Initiatives

8.4.1. Inria International Partners

8.4.1.1. Informal International Partners

The three main research partners of the team are:

- Politecnico di Milano (Italy) - DB Group, specially with Marco Brambilla
- TU Wien (Austria) - BiG Group, specially Manuel Wimmer
- Politecnica de Catalunya (Spain) - GESSI Group, specially Xavier Franch

8.5. International Research Visitors

8.5.1. Visits of International Scientists

This year, the following visitors did a research stay with AtlanMod:

- Galina Besova (University of Paderborn, Germany), May-July
- Javier Criado (University of Almeria, Spain), October

8.5.1.1. Internships

Camilo Alvarez

Subject: Transformations from Legacy Models to the Cloud

Date: from Apr 2013 until Aug 2013

Institution: University of Los Andes (Colombia)

Matthieu Allon

Subject: Interoperability and traceability between modeling languages and standards

Date: from February 2013 until Aug 2013

Institution: University of Science and Technology of Nantes (France)

8.5.2. Visits to International Teams

No long term visits.

AVALON Team

7. Partnerships and Cooperations

7.1. National Initiatives

7.1.1. French National Fund for the Digital Society Project (FSN)

7.1.1.1. FSN XLcloud, 2012-2014

Participants: Jean-Patrick Gelas, Laurent Lefèvre, François Rossigneux.

Focused on high-performance computing, the XLcloud collaborative project sets out to define and demonstrate a cloud platform based on *HPC-as-a-Service*. This is designed for computational intensive workloads, with interactive remote visualisation capabilities, thus allowing different users to work on a common platform. XLcloud project's members design, develop and integrate the software elements of a High Performance Cloud Computing (HPCC) System.

Expected results of the projects include : Functional and technical specification of the XLcloud platform architecture, open source API of the XLcloud platform, implementation of algorithms for 3D and video streaming display, prototype of the XLcloud platform including the support of on-demand virtual clusters and remote visualisation service, use cases for validation, illustrating the performance and suggesting future improvements.

XLcloud aims at overcoming some of the most important challenges of implementing operationally high performance applications in the Cloud. The goal is to allow partners of the project to take leadership position in the market, as cloud service providers, or as technology providers. XLcloud relies on a consortium of various partners (BULL (project leader), TSP, Silkan, EISTI, Ateme, Inria, CEA List, OW2, AMG.Lab).

In this project, the Avalon team investigates the issue of energy awareness and energy efficiency in OpenStack Cloud based platforms.

7.1.2. French National Research Agency Projects (ANR)

7.1.2.1. ANR INFRA MOEBUS, Multi-objective scheduling for large computing platforms, 4 years, ANR-13-INFRA-000, 2013-2016

Participants: Christian Perez, Laurent Lefèvre, Frédéric Suter.

The ever growing evolution of computing platforms leads to a highly diversified and dynamic landscape. The most significant classes of parallel and distributed systems are supercomputers, grids, clouds and large hierarchical multi-core machines. They are all characterized by an increasing complexity for managing the jobs and the resources. Such complexity stems from the various hardware characteristics and from the applications characteristics. The MOEBUS project focuses on the efficient execution of parallel applications submitted by various users and sharing resources in large-scale high-performance computing environments.

We propose to investigate new functionalities to add at low cost in actual large scale schedulers and programming standards, for a better use of the resources according to various objectives and criteria. We propose to revisit the principles of existing schedulers after studying the main factors impacted by job submissions. Then, we will propose novel efficient algorithms for optimizing the schedule for unconventional objectives like energy consumption and to design provable approximation multi-objective optimization algorithms for some relevant combinations of objectives. An important characteristic of the project is its right balance between theoretical analysis and practical implementation. The most promising ideas will lead to integration in reference systems such as SLURM and OAR as well as new features in programming standards implementations such as MPI or OpenMP.

7.1.2.2. *ANR ARPEGE MapReduce, Scalable data management for Map-Reduce-based data-intensive applications on cloud and hybrid infrastructures, 4 years, ANR-09-JCJC-0056-01, 2010-2013*

Participants: Frédéric Desprez, Gilles Fedak, Sylvain Gault, Christian Perez, Anthony Simonet.

MapReduce is a parallel programming paradigm successfully used by large Internet service providers to perform computations on massive amounts of data. After being strongly promoted by Google, it has also been implemented by the open source community through the Hadoop project, maintained by the Apache Foundation and supported by Yahoo! and even by Google itself. This model is currently getting more and more popular as a solution for rapid implementation of distributed data-intensive applications. The key strength of the MapReduce model is its inherently high degree of potential parallelism.

In this project, the AVALON team participates to several work packages which address key issues such as efficient scheduling of several MapReduce applications, integration using components on large infrastructures, security and dependability, and MapReduce for Desktop Grid.

7.1.2.3. *ANR COSINUS COOP, Multi Level Cooperative Resource Management, 3.5 years, ANR-09-COSI-001-01, 2009-2013*

Participants: Frédéric Desprez, Christian Perez, Noua Toukourou.

The main goals of this project are to set up a cooperation as general as possible between programming models and resource management systems and to develop algorithms for efficient resource selection. In particular, the project targets the SALOME platform and the GRID-TLSE expert-site (<http://gridtlse.org/>) as an example of programming models, and PadicoTM, DIET and XtremOS as examples of communication manager, grid middleware and distributed operating systems.

The project is led by Christian Perez.

7.1.2.4. *ANR INFRA SONGS, Simulation Of Next Generation Systems, 4 years, ANR-12-INFRA-11, 2012-2015*

Participants: Frédéric Desprez, Georgios Markomanolis, Jonathan Rouzauud-Cornabas, Frédéric Suter.

The last decade has brought tremendous changes to the characteristics of large scale distributed computing platforms. Large grids processing terabytes of information a day and the peer-to-peer technology have become common even though understanding how to efficiently such platforms still raises many challenges. As demonstrated by the USS SIMGRID project, simulation has proved to be a very effective approach for studying such platforms. Although even more challenging, we think the issues raised by petaflop/exaflop computers and emerging cloud infrastructures can be addressed using similar simulation methodology.

The goal of the SONGS project is to extend the applicability of the SIMGRID simulation framework from Grids and Peer-to-Peer systems to Clouds and High Performance Computation systems. Each type of large-scale computing system will be addressed through a set of use cases and lead by researchers recognized as experts in this area.

Any sound study of such systems through simulations relies on the following pillars of simulation methodology: Efficient simulation kernel; Sound and validated models; Simulation analysis tools; Campaign simulation management.

7.1.3. Inria Large Scale Initiative

7.1.3.1. *HEMERA, 4 years, 2010-2014*

Participants: Christian Perez, Laurent Pouilloux, Laurent Lefèvre.

Hemera deals with the scientific animation of the GRID'5000 community. It aims at making progress in the understanding and management of large scale infrastructure by leveraging competences distributed in various French teams. Hemera contains several scientific challenges and working groups. The project involves around 24 teams located in all around France.

C. Pérez is leading the project; L. Lefevre and L. Pouilloux are managing scientific challenges on GRID'5000.

7.1.3.2. *C2S@Exa, Computer and Computational Sciences at Exascale, 4 years, 2013-2017*

Participants: Frédéric Desprez, Christian Perez, Laurent Lefèvre.

Since January 2013, the team is participating to the C2S@Exa Inria Project Lab (IPL). This national initiative aims at the development of numerical modeling methodologies that fully exploit the processing capabilities of modern massively parallel architectures in the context of a number of selected applications related to important scientific and technological challenges for the quality and the security of life in our society. At the current state of the art in technologies and methodologies, a multidisciplinary approach is required to overcome the challenges raised by the development of highly scalable numerical simulation software that can exploit computing platforms offering several hundreds of thousands of cores. Hence, the main objective of C2S@Exa is the establishment of a continuum of expertise in the computer science and numerical mathematics domains, by gathering researchers from Inria project-teams whose research and development activities are tightly linked to high performance computing issues in these domains. More precisely, this collaborative effort involves computer scientists that are experts of programming models, environments and tools for harnessing massively parallel systems, algorithmists that propose algorithms and contribute to generic libraries and core solvers in order to take benefit from all the parallelism levels with the main goal of optimal scaling on very large numbers of computing entities and, numerical mathematicians that are studying numerical schemes and scalable solvers for systems of partial differential equations in view of the simulation of very large-scale problems.

7.1.4. Inria ADT

7.1.4.1. Inria ADT Aladdin, 4 years, 2008-2014

Participants: Simon Delamare, Frédéric Desprez, Matthieu Imbert, Laurent Lefèvre, Christian Perez.

ADT ALADDIN is an Inria support action of technological development which supports the GRID'5000 instrument. Frédéric Desprez is leading this action (with David Margery from Rennes as the Technical Director). More information at Section 5.8 .

7.2. European Initiatives

7.2.1. FP7 Projects

7.2.1.1. PRACE 2IP

Participants: Zhengxiong Hou, Vincent Lanore, Christian Perez.

Title: PRACE – Second Implementation Phase Project

Type: Integrated Infrastructure Initiative Project (I3)

Instrument: Combination of Collaborative projects and Coordination and support action

Duration: September 2011 - August 2014

Coordinator: Thomas Lippert (Germany)

Others partners: Jülich GmbH, GCS, GENCI, EPSRC, BSC, CSC, ETHZ, NCF, JKU, Vetenskapssradet, CINECA, PSNC, SIGMA, GRNET, UC-LCA, NUI Galway, UYBHM, CaSToRC, NCSA, Technical Univ. of Ostrava, IPB, NIIF

See also: <http://prace-ri.eu>

Abstract: The purpose of the PRACE RI is to provide a sustainable high-quality infrastructure for Europe that can meet the most demanding needs of European HPC user communities through the provision of user access to the most powerful HPC systems available worldwide at any given time. In tandem with access to Tier-0 systems, the PRACE-2IP project will foster the coordination between national HPC resources (Tier-1 systems) to best meet the needs of the European HPC user community. To ensure that European scientific and engineering communities have access to leading edge supercomputers in the future, the PRACE-2IP project evaluates novel architectures, technologies, systems, and software. Optimizing and scaling of application for Tier-0 and Tier-1 systems is a core service of PRACE.

Inria participates to Work Package 12 which is about novel programming techniques.

7.2.1.2. PaaSage

Participants: Amine Bsila, Christian Perez, Jonathan Rouzard-Cornabas.

Title: PaaSage: Model-based Cloud Platform Upperware

Type: Seventh Framework Programme

Instrument: Collaborative project

Duration: October 2012 - September 2016 (48 months)

Coordinator: Pierre Guisset (GEIE ERCIM)

Others partners: SINTEF, STFC, HLRS, University of Stuttgart, Inria, CETIC, FORTH, be.wan, EVRY, SysFera, Flexiant, Lufthansa Systems, AG GWDG, Automotive Simulation Center Stuttgart e.V.

See also: <http://paasage.eu>

Abstract: PaaSage will deliver an open and integrated platform, to support both deployment and design of Cloud applications, together with an accompanying methodology that allows model-based development, configuration, optimization, and deployment of existing and new applications independently of the existing underlying Cloud infrastructures. Specifically it will deliver an IDE (Integrated Development Environment) incorporating modules for design time and execution time optimizations of applications specified in the CLOUD Modeling Language (CLOUD ML), execution-level maps and interfaces and a metadata database.

7.2.2. Collaborations in European Programs, except FP7

7.2.2.1. SEED4C

Program: Celtic-Plus

Project acronym: SEED4C

Project title: Security Embedded Element and Data privacy for the Cloud.

Duration: 2012-2015

Coordinator: Bertrand Marquet (Alcatel-Lucent lab)

Other partners: Gemalto, ENSI Bourges, Inria, Wallix, VTT Technical Research centre of Finland, Mikkelin Puhelin Oyj, Cygate, Nokia Siemens Networks, Finceptum OY (Novell), Solacia, Innovalia Association, Nextel, Software Quality Systems, Ikusi, Vicomtech, Biscaytik

Abstract: SEED4C is a Celtic-Plus project: an industry-driven European research initiative to define, perform and finance through public and private funding common research projects in the area of telecommunications, new media, future Internet, and applications and services focusing on a new "Smart Connected World" paradigm. Celtic-Plus is a EUREKA ICT cluster and is part of the inter-governmental EUREKA network.

The cloud security challenge not only reflects on the secure running of software on one single machine, but rather on managing and guaranteeing security of a computer group or cluster seen as a single entity. Seed4C focus is to evolve from cloud security with an isolated point or centralized points of enforcement for security to cloud security with cooperative points of enforcement for security.

7.2.2.2. COST IC804

Participants: Ghislain Landry Tsafack Chetsa, Mohammed El Mehdi Diouri, Laurent Lefèvre.

Program: COST

Project acronym: IC804

Project title: : Energy efficiency in Large Scale Distributed Systems

Duration: 2009-2013

Coordinator: J.M. Pierson (IRIT Toulouse)

Other partners: 26 research institute and countries

Abstract: The COST Action IC0804 proposes realistic energy-efficient alternate solutions to share IT distributed resources. As large scale distributed systems gather and share more and more computing nodes and Storage resources, their energy consumption is exponentially increasing. While much effort is nowadays put into hardware specific solutions to lower energy consumptions, the need for a complementary approach is necessary at the distributed system level, i.e. middleware, network and applications. This Action characterizes the energy consumption and energy efficiencies of distributed applications. Then based on the current hardware adaptation possibilities and innovative algorithms it proposes adaptive and alternative approaches taking into account the energy saving dimension of the problem. This Action also characterizes the trade-off between energy savings and functional and non-functional parameters, including the economic dimension. Deliverables includes workshop proceedings, books, good practice leaflets fostering consciousness rise at ICT researchers, scientists, managers and users levels. Finally, benefits addresses scientific and societal needs.

7.2.2.3. COST IC0805

Participants: Ghislain Landry Tsafack Chetsa, Mohammed El Mehdi Diouri, Laurent Lefèvre.

Program: COST

Project acronym: IC0805

Project title: Open Network for High-Performance Computing on Complex Environments (ComplexHPC)

Duration: 2009-2013

Coordinator: Emmanuel Jeannot (Inria Bordeaux - Sud Ouest)

Other partners: 26 research institute and countries

Abstract: The main objective of the Action is to develop an integrated approach for tackling the challenges associated with heterogeneous and hierarchical systems for High Performance Computing.

7.2.2.4. CHIST-ERA STAR

Participants: Laurent Lefèvre, Olivier Glück.

Title: SwiTching And tRansmission project

Type: CHIST-ERA (European Coordinated Research on Long-term Challenges in Information and Communication Sciences & Technologies ERA-Net)

Duration: 2013-2015

Coordinator: Jaafar Elmighani (University of Leeds - UK)

Others partners: Inria ,University of Cambridge (UK), University of Leeds (UK), AGH University of Science and Technology Department of Telecommunications (Poland)

See also: <http://www.chistera.eu/projects/star>

Abstract: The Internet power consumption has continued to increase over the last decade as a result of a bandwidth growth of at least 50 to 100 times. Further bandwidth growth between 40% and 300% is predicted in the next 3 years as a result of the growing popularity of bandwidth intensive applications. Energy efficiency is therefore increasingly becoming a key priority for ICT organizations given the obvious ecological and economic drivers. In this project we adopt the GreenTouch energy saving target of a factor of a 100 for Core Switching and Routing and believe this ambitious target is achievable should the research in this proposal prove successful. A key observation in core networks is that most of the power is consumed in the IP layer while optical transmission and optical switching are power efficient in comparison, hence the inspiration for this project. Initial studies by the applicants show that physical topology choices in networks have the potential to significantly reduce the power consumption, however network optimization and the consideration of traffic and the opportunities afforded by large, low power photonic switch architectures will lead to further power savings. Networks are typically over provisioned at present to maintain quality of service. We

will study optimum resource allocation to reduce the overprovisioning factor while maintaining the quality of service. Protection is currently provided in networks through the allocation of redundant paths and resources, and for full protection there is a protection route for every working route. Avalon is contributing to STAR in terms of software network protocols and services optimizations which will be combined with more efficient photonic switches in order to obtain a factor of 100 power saving in core networks can be realised through this project with significant potential for resulting impact on how core photonic networks are designed and implemented.

7.3. International Initiatives

7.3.1. Inria International Partners

7.3.1.1. GreenTouch

Participants: Laurent Lefèvre, Jean-Patrick Gelas.

GreenTouch is a consortium of leading Information and Communications Technology (ICT) industry, academic and non-governmental research experts dedicated to fundamentally transforming communications and data networks, including the Internet, and significantly reducing the carbon footprint of ICT devices, platforms and networks.

In this project, we explore the design of virtual home gateway at large scale [62], [72] and participate in the SEASON project.

7.3.2. Inria International Labs

7.3.2.1. Inria-UIUC-NCSA Joint Laboratory for Petascale Computing

Participants: Eddy Caron, Frédéric Desprez, Mohammed El Mehdi Diouri, Olivier Glück, Vincent Lanore, Laurent Lefèvre, Christian Perez, Jonathan Rouzaud-Cornabas.

The Joint Laboratory for Petascale Computing focuses on software challenges found in complex high-performance computers. The Joint Laboratory is based at the University of Illinois at Urbana-Champaign and includes researchers from the French national computer science institute called Inria, Illinois' Center for Extreme-Scale Computation, and the National Center for Supercomputing Applications. Much of the Joint Laboratory's work will focus on algorithms and software that will run on Blue Waters and other petascale computers.

CEPAGE Project-Team

7. Partnerships and Cooperations

7.1. National Initiatives

- **ANR ALADDIN** (Algorithm Design and Analysis for Implicitly and Incompletely Defined Interaction Networks; GANG and CEPAGE project-teams): the members of Cepage have been participating to the ANR project "blanc" (i.e. fundamental research) about the fundamental aspects of large interaction networks enabling massive distributed storage, efficient decentralized information retrieval, quick inter-user exchanges, and/or rapid information dissemination. The project is mostly oriented towards the design and analysis of algorithms for these (logical) networks, by taking into account proper ties inherent to the underlying infrastructures upon which they are built. The infrastructures and/or overlays considered in this project are selected from different contexts, including communication networks (from Internet to sensor networks), and societal networks (from the Web to P2P networks).
- **ANR SONGS** (Simulation of Next Generation Systems; participants: AlGorille (LORIA, Nancy), MESCAL (Grenoble), GRAAL (ENS Lyon), IN2P3 (Lyon), CEPAGE, HiePACS, RUNTIME (Bordeaux), LSIIT (Strasbourg), ASCOLA (Nantes), MASCOTTE, MODALIS (Sophia Antipolis)). This project started in 2012 as a follow-up of the USS-SIMGRID project. The aim is to further extend the domain of SimGrid, by designing a unified simulation framework for the four application domains: Grids, Peer-to-Peer systems, High Performance Computing, and Cloud systems. Achieving this goal mandates careful representation and modeling of the underlying concepts presented by each domain (memory, disks, energy, network and volatility) and of the interfaces specific to each domain. It also requires a transversal work on the simulation framework itself. CEPAGE is actively involved in this project, both for the peer-to-peer use cases and for the coordination of the modeling effort of the project.
- **ANR Displexity** (Calcul DIStribué: calculabilité et comPLEXITé; participants: CEPAGE, GANG and ASAP projects). The main goal of DISPLEXITY is to establish the scientific foundations of a theory of calculability and complexity for distributed computing. Displexity started in 2012.
- **ANR IDEA** ANR program "defis": project IDEA (2009-2012). The goal of this ANR is the study of identifying codes in evolving graphs. Ralf Klasing is the overall leader of the project.
- **ANR "Jeunes chercheurs" EGOS - Embedded Graphs and their Oriented Structures** (2012-2014) (see <http://www.lirmm.fr/egos/>)
Participants: CEPAGE/LaBRI(Bordeaux) LIRMM(Montpellier), LIX(Palaiseau) The goal of this project is the study oriented structures on graphs of arbitrary genus.
- **AMADEUS** (CNRS funding on "BIG DATA": 2012-): Analysis of MASSive Data in Earth and Universe Sciences. This a multidisciplinary research project between computer science teams (LIRMM: University of Montpellier, LIF: University of Marseille) and CEPAGE), earth and climate science (CEREGE: Montpellier and IRD: Aix) and astronomy (LAM: University of Marseille). The aim of the project is to propose effective techniques for mining large data by essentially using distributed computing, visualization, summarization and approximation.

7.2. European Initiatives

7.2.1. FP7 Projects

7.2.1.1. EULER

EULER

- Title: EULER (Experimental UpdateLess Evolutive Routing)
 - Type: COOPERATION (ICT)
 - Defi: Future Internet Experimental Facility and Experimentally-driven Research
 - Instrument: Specific Targeted Research Project (STREP)
 - Duration: October 2010 - September 2013
 - Coordinator: ALCATEL-LUCENT (Belgium)
 - Others partners:
 - Alcatel-Lucent Bell, Antwerpen, Belgium
 - 3 projects from Inria: CEPAGE, GANG and MASCOTTE, France
 - Interdisciplinary Institute for Broadband Technology (IBBT), Belgium
 - Laboratoire d'Informatique de Paris 6 (LIP6), Université Pierre Marie Curie (UPMC), France
 - Department of Mathematical Engineering (INMA) Université Catholique de Louvain, Belgium
 - RACTI, Research Academic Computer Technology Institute University of Patras, Greece
 - CAT, Catalan Consortium: Universitat Politècnica de Catalunya, Barcelona and University of Girona, Spain
 - See also: <http://www-sop.inria.fr/mascotte/EULER/wiki/>
 - Abstract: The title of this study is "Dynamic Compact Routing Scheme". The aim of this projet is to develop new routing schemes achieving better performances than current BGP protocols. The problems faced by the inter-domain routing protocol of the Internet are numerous:
 - The underlying network is dynamic: many observations of bad configurations show the instability of BGP;
 - BGP does not scale well: the convergence time toward a legal configuration is too long, the size of routing tables is proportional to the number of nodes of network (the network size is multiplied by 1.25 each year);
 - The impact of the policies is so important that the many packets can oscillated between two Autonomous Systems.
- In this collaboration, we mainly focus on the scalability properties that a new routing protocol should guarantee. The main measures are the size of the local routing tables, and the time (or message complexity) to update or to generate such tables. The design of schemes achieving sub-linear space per routers, say in n where n is the number of AS routers, is the main challenge. The target networks are AS-network like with more than 100,000 nodes. This projet, in collaboration with the MASCOTE Inria-project in Nice Sophia-Antipolis, makes the use of simulation, developed at both sites.

7.2.2. Collaborations in European Programs, except FP7

- Program: European COST
- Project acronym: Complex HPC IC0805.
- Project title: Open Network for High-Performance Computing on Complex Environments
- Duration: 2010-2013
- Coordinator: Inria
- Other partners: 26 countries, see list at http://www.cost.eu/domains_actions/ict/Actions/IC0805?parties
- Abstract: The main objective of this COST action is to coordinate European groups working on the use of heterogeneous and hierarchical systems for HPC as well as the development of collaborative activities among the involved research groups (<http://complexhpc.org/index.php>).

7.3. International Initiatives

7.3.1. Inria International Partners

- **Royal Society Grant with the University of Liverpool.** International Joint Project, 2011-2013, entitled “SEarch, RENdezvous and Explore (SERENE)”, on foundations of mobile agent computing, in collaboration with the Department of Computer Science, University of Liverpool. Funded by the Royal Society, U.K. Principal investigator on the UK side: Leszek Gasieniec. Ralf Klasing is the principal investigator on the French side.

Participants: Nicolas Hanusse, David Ilcinkas, Ralf Klasing, Adrian Kosowski.

- **Spanish program CLOUDS:** Cloud Computing for Scalable, Reliable and Ubiquitous Services (<http://sd.ls.fi.upm.es/clouds>). This is a large scale program which aims at advancing research in the area of Cloud Computing. CEPAGE is more particularly in contact with the LaDyr team of Univ. Rey Juan Carlos in Madrid, on the topic of resource allocation problems for Cloud providers.

Participants: Olivier Beaumont, Lionel Eyraud-Dubois.

- **Collaboration with Canada.**

Members of CEPAGE have a long-standing collaboration with researchers from the Chair of Distributed Computing at the University of Quebec in Outaouais and the Department of Computer Science at Carleton University. Sources of financing include: personal NSERC grants of Canadian professors (Prof. Andrzej Pelc, Prof. Jurek Czyzowicz, Prof. Evangelos Kranakis), funding from other Canadian grant agencies (a travel grant from Mitacs Inc.), and University of Bordeaux funding (a 3-month invited professorship for Prof. Jurek Czyzowicz).

Participants: David Ilcinkas, Ralf Klasing, Adrian Kosowski.

- **Collaboration with Chile.**

Adrian Kosowski is a foreign partner of the Chilean ministry grant (ANILLO CONICYT programme) entitled “Mathematical modeling for industrial and management science applications: a multidisciplinary approach”. The Project Director is Eric Goles from Universidad Adolfo Ibañez, and collaborating researchers on the Chilean side include Karol Suchan and Ivan Rappaport. The collaboration has led to 2 joint papers.

Participants: Adrian Kosowski.

7.4. International Research Visitors

7.4.1. Visits of International Scientists

Tomasz Radzik, King’s College London, UK, 02/12-06/12/2013

Mirosław Korzeniowski, TU Wrocław, Poland, 09/13-10/2013

Petra Berenbrink, Simon Fraser University, Burnaby, Canada, 22/10-26/10/2013

Joseph G. Peters, Simon Fraser University, Burnaby, Canada (Invited professor Bdx1) 24/01-24/02/2013

Carlos Ordonez, the University of Houston, USA (06-07/2013) supported by CNRS.

Dariusz Dereniowski, Gdansk University of Technology, Poland, 26/04-31/05/2013

Lukasz Kuszner, Gdansk University of Technology, Poland, 24/04-02/06/2013

Marcin Markiewicz, University of Gdansk, Poland, 02/09-15/09/2013

Leszek Gasieniec, University of Liverpool, UK, 24/09-27/09/2013

Jakub Lacki, University of Warsaw, Poland, 25/11-30/11/2013

Przemysław Uznanski, Universite de Marseille, France, 25/11-30/11/2013

7.4.1.1. Internships

Siddharth Mandal

Subject: Reliability Issues in Cloud Computing

Date: from May 2013 until Jul 2013

Institution: IIT Delhi (India)

Rohit Kumar

Subject: Robust Dynamic Allocation in Cloud Computing

Date: from May 2013 until Aug 2013

Institution: IIT Delhi (India)

CIDRE Project-Team

8. Partnerships and Cooperations

8.1. Regional Initiatives

- **Région Bretagne ARED grant:** the PhD of Regina Marin on privacy protection in distributed social networks is supported by a grant from the Région Bretagne.

- **Labex COMINLAB contract (2012-2015): “POSEIDON”**

POSEIDON deals with the protection of data in outsourced or shared systems such as cloud computing and peer-to-peer networks. While these approaches are very promising solutions to outsource storage space, contents, data and services, they also raise serious security and privacy issues since users lose their sovereignty on their own data, services and systems. Instead of trying to prevent the bad effects of the cloud and of peer-to-peer systems, the main objective of the POSEIDON project is to turn benefit from their main characteristics (distribution, decentralization, multiple authorities, etc.) to improve the security and the privacy of the users’ data, contents and services.

This project is conducted in cooperation with Télécom Bretagne and Université de Rennes I. The PhD of Julien Lolive (co-supervised by Sébastien Gambs and Caroline Fontaine), which deals with the entwining of identification and privacy mechanisms, is funded by the POSEIDON project.

- **Labex COMINLAB contract (2012-2015): “SecCloud”**

Nowadays attacks targeting the end-user and especially its web browser constitute a major threat. Indeed web browsers complexity has been continuously increasing leading to a very large attack surface. Among all possible threats, we tackle in the context of the SecCloud project those induced by client-side code execution (for example javascript, flash or html5).

Existing security mechanisms such as os-level access control often only rely on users identity to enforce the security policy. Such mechanisms are not sufficient to prevent client-side browser attacks as the web browser is granted the same privileges as the user. Consequently, a malicious code can perform every actions that are allowed to the user. For instance, it can read and leak user private data (credit card numbers, registered passwords, email contacts, etc.) or download and install malware.

One possible approach to deal with such threats is to monitor information flows within the web browser in order to enforce a security information flow policy. Such a policy should allow to define fine-grained information flow rules between user data and distant web sites. This implies to propose an approach and to design and implement a mechanism that can handle both OS-level and browser-level information flows.

Dynamically monitoring information flow at the web browser level may dramatically impact runtime performances of executed codes. Consequently, an important aspect of this work will be to benefit as far as possible from static analysis of application code. This static-dynamic hybrid approach should reduce the number of verifications performed at run time.

This study is conducted in cooperation with other Inria Teams (Ascola and Celtique). Deepak Subramanian is doing his PhD in the context of this project.

- **Labex COMINLAB contract (2013-2016): “DeScenT”**

In DeScenT, we propose to investigate how decentralized home-based networks of plug computers can support personal clouds according to sound architectural principles, mechanisms, and programming abstractions. To fulfill this vision we see three core scientific challenges, which we think must be overcome. The first challenge, decentralized churn-poor design, arises from the nature of plug federations, which show much lower levels of churn than traditional peer-to-peer environments. The

second challenge, quasi-causal consistency, is caused by the simultaneous needs to produce a highly scalable environment (potentially numbering millions of users), that also offers collaborative editing capabilities of mutable data-structures (to offer rich social interactions). The third and final challenge, intuitive data structures for plug programming, arises from the need by programmers for intuitive and readily reusable data-structures to rapidly construct rich and robust decentralized personal cloud applications.

This study is conducted in cooperation with other teams (GDD Team (University of Nantes), EPI ASAP)

8.2. National Initiatives

8.2.1. ANR

- **ANR INS Project: AMORES (2011-2015) - <http://amores-project.org/>**

Situated in the ubiquitous context characterized by a high mobility of individuals, most of them wearing devices capable of geolocation (smartphones or GPS-equipped cars), the AMORES project is built around three use-cases related to mobility, namely (1) dynamic carpooling, (2) real-time computation of multi-modal transportation itineraries and (3) mobile social networking. For these three use cases, the main objective of the AMORES project is to define and develop geo-communication primitives at the middleware level that can offer the required geo-located services, while at the same time preserving the privacy of users, in particular with respect to their location (notion of geo-privacy). Within this context, we study in particular the problem of anonymous routing and the design of a key generation protocol tied to a particular geographical location. Each of these services can only work through cooperation of the different entities composing the mobile network. Therefore, we also work on the development of mechanisms encouraging entities to cooperate together in a privacy-preserving manner. The envisioned approach consists in the definition of generic primitives such as the management of trust and the incentive to cooperation. This project is joint between the Université de Rennes I, Supélec, LAAS-CNRS, Mobigis and Tisséo. The research project AMORES received the Innovation Award at the Toulouse Space Show last June. Simon Boche and Paul Lajoie-Mazenc are doing their PhD in the context of this project.

- **ANR INS Project: LYRICS (2011-2014) - <http://projet.lyrics.orange-labs.fr/>**

With the fast emergence of the contactless technology such as NFC, mobile phones will soon be able to play the role of e-tickets, credit cards, transit pass, loyalty cards, access control badges, e-voting tokens, e-cash wallets, etc. In such a context, protecting the privacy of an individual becomes a particularly challenging task, especially when this individual is engaged during her daily life in contactless services that may be associated with his identity. If an unauthorized entity is technically able to follow all the digital traces left behind during these interactions then that third party could efficiently build a complete profile of this individual, thus causing a privacy breach. Most importantly, this entity can freely use this information for some undesired or fraudulent purposes ranging from targeted spam to identity theft. The objective of LYRICS (ANR INS 2011) is to enable end users to securely access and operate contactless services in a privacy-preserving manner that is, without having to disclose their identity or any other unnecessary information related to personal data. Within this project, we work mainly on the privacy analysis of the risks incurred by users of mobile contactless services as well as on the development of the architecture enabling the development of privacy-preserving mobile contactless services. The project is joint between France Télécom, Atos Worldline, CryptoExperts, ENSI Bourges, ENSI Caen, MoDyCo, Oberthur Technologies, NEC Corporation, Microsoft and Université de Rennes I.

8.2.2. Inria Project Labs

- **CAPPRIS (2012-2016)**

CAPPRIS stands for “Collaborative Action on the Protection of Privacy Rights in the Information Society”. The main objective of CAPPRIS is to tackle the privacy challenges raised by the most recent developments and usages of information technologies such as profiling, data mining, social networking, location-based services or pervasive computing by developing solutions to enhance the protection of privacy in the Information Society. To solve this generic objective, the project focuses in particular on the following four fundamental issues:

- The design of appropriate metrics to assess and quantify privacy, primarily by extending and integrating the various possible definitions existing for the generic privacy properties such as anonymity, pseudonymity, unlinkability and unobservability, as well as notions coming from information theory or databases such as the recent but promising concept of differential privacy;
- The definition and the understanding of the fundamental principles underlying “privacy by design”, with the hope of deriving practical guidelines to implement notions such as data minimization, proportionality, purpose specification, usage limitation, data sovereignty and accountability directly in the formal specifications of our information systems;
- The integration between the legal and social dimensions, intensely necessary since the developed privacy concepts, although they may rely on computational techniques, must be in adequacy with the applicable law (even in its heterogeneous and dynamic nature). In particular, privacy-preserving technologies cannot be considered efficient as long as they are not properly understood, accepted and trusted by the general public, an outcome which cannot be achieved by the means of a mathematical proof.

Three major application domains have been identified as interesting experimentation fields for this work: online social networks, location-based services and electronic health record systems. Each of these three domains brings specific privacy-related issues. The aim of the collaboration is to apply the techniques developed to the application domains in a way that promotes the notion of privacy by design, instead of simply considering them as a form of privacy add-ons on the top of already existing technologies. CAPPRIS is a joint project between Inria, LAAS-CNRS, Université de Rennes I, Supélec, Université de Namur, Eurecom, and Université de Versailles.

8.2.3. Research mission “*Droit et Justice*”

- **Droit à l’oubli (2012-2014)**

The “right to be forgotten” can be viewed as a consequence and an extension of the right to privacy and to personal data protection, emphasized by the inherent difficulty to erase any given information from the omnipresent digital world. The French ministry of Justice has launched two twin projects (one of which is the DAO project), in order to explore the possible legal definitions of a “right to be forgotten”. Even though there are no legal foundations for such a right in France at the moment, the concept is already known from the general public and is also present in courts. Furthermore, individuals expect to be protected by such a right, thus it is important to understand why, how, in which circumstances and to which extent this new right may apply before envisioning a legal notion defining it. The DAO project involves a major legal component, a sociological survey and a technical study. In a nutshell, the legal part explores the possible boundaries and requirements of a right to be forgotten with respect to labor law, civil statuses, personal data protection, legal prescription and IT law. The sociological survey aims at understanding the root causes making people build a desire for forgetfulness in others. Finally, the objective of the computer science part is to elaborate a state of the art of the techniques that could be used to enforce a right to be forgotten in practice in the digital world. The expected output of the project as a whole is a detailed recommendation about whether an independent legislation proposal for the right to be forgotten would be justified, and how it should be done. The project is joint between Université de Rennes I, Inria and Supélec.

8.2.4. Competitiveness Clusters

The AMORES project (ANR INS 2011, <http://www.images-et-reseaux.com/en/content/amores>) is recognized by the Images & Réseaux cluster.

8.3. European Initiatives

8.3.1. FP7 Projects

The **PANOPTESE**C project started on the 1st of November 2013. It deals with the automated and assisted security management of SCADA system. The main objective of PANOPTESE is to provide an integrated solution that will allow to efficiently monitor SCADA systems, detect intrusions and react to them. To that end, it encompasses many of the research topics that are addressed by the CIDre team: alerts aggregation and correlation, policy-aware intrusion detection, architecture-aware intrusion detection, automated trust management, trust-based automated reaction and visualization. The CIDre team is involved in the project on all of these aspects. The partners are REHA, Alcatel-Lucent Bell Labs France, Epistemica, The university of Rome, the university of Hamburg, the institut Mines-Telecom, ACEA and Supelec.

8.3.2. Collaborations in European Programs, except FP7

Program: EIT ICT labs

Project acronym: “Privacy, security and trust in information society” action line

Project title: “Security and privacy for location-based services” activity

Duration: January 2012 - December 2013

Coordinator: Sébastien Gambs

Other partners: KTH (Sweden), Privatics Inria team (France), Alcatel-Lucent (France), University of Trento (Italy), DFKI (Germany).

Abstract: The main objective of this activity is to address the issues of privacy and security for location-based services. More precisely, the main outcomes of this activity are (1) secure and privacy-preserving implementations of location-based services (for instance traffic monitoring), (2) tools to raise the public awareness about the privacy issues in such context but also to help a user to prevent/limit privacy leaks (thus contributing to the protection of privacy), (3) demonstrators to secure the position of an individual and (4) the application of the results and findings of the activity to other thematic Action Lines of EIT ICT labs.

COATI Project-Team

8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. ANR

8.1.1.1. ANR Blanc AGAPE, 10/2009-09/2013

Participants: David Coudert, Frédéric Havet, Ana Karolinnna Maia de Oliveira, Nicolas Nisse, Stéphane Pérennes, Michel Syska.

The project AGAPE (Parameterized and exact graph algorithms) is led by COATI and implies also LIRMM (Montpellier) and LIFO (Orléans). The aim of AGAPE is to develop new techniques to solve exactly NP-hard problems on graphs. To do so, we consider two approaches which are closely related ways to reduce the combinatorial explosion of NP-hard problems: moderately exponential exact algorithms and fixed-parameter tractability.

(<http://www-sop.inria.fr/mascotte/Contrats/Agape.php>)

8.1.2. GDR Actions

8.1.2.1. Action ResCom, ongoing (since 2006)

Réseaux de communications, working group of GDR ASR, CNRS.

(<http://rescom.asr.cnrs.fr/>)

8.1.2.2. Action Graphes, ongoing (since 2006)

Action Graphes, working group of GDR IM, CNRS.

(<http://www.labri.fr/perso/raspaud/pmwiki/pmwiki.php>)

8.2. European Initiatives

8.2.1. FP7 Projects

8.2.1.1. EULER

Participants: David Coudert, Luc Hogie, Aurélien Lancin, Bi Li, Nicolas Nisse, Stéphane Pérennes, Issam Tahiri.

Title: EULER (Experimental UpdateLess Evolutive Routing)

Type: COOPERATION (ICT)

Defi: Future Internet Experimental Facility and Experimentally-driven Research

Instrument: Specific Targeted Research Project (STREP)

Duration: October 2010 - June 2014

Partners: Alcatel-Lucent Bell (leader) (Antwerp, Belgique), iMind (Ghent, Belgium), UCL (Louvain, Belgium), RACTI (Patras, Grece), UPC (Barcelona, Spain), UPMC (ComplexNetworks, Paris 6), Inria (COATI, GANG, CEPAGE).Coordinator: ALCATEL-LUCENT (Belgium)

STREP EULER (Experimental UpdateLess Evolutive Routing) is part of FIRE (Future Internet Research and Experimentation) objective of FP7. It aims at finding new paradigms to design, develop, and validate experimentally a distributed and dynamic routing scheme suitable for the future Internet and its evolution. COATI is the leader of WP3 on Topology Modelling and Routing scheme experimental analysis.

See also: <http://www-sop.inria.fr/mascotte/EULER/wiki/>

8.2.2. Collaborations in European Programs, except FP7

8.2.2.1. PHC PROCOPE (with Discrete Optimization group of RWTH Aachen University), 01/2011-06/2013

Participants: Christelle Molle-Caillouet, David Coudert, Alvinice Kodjo, Issam Tahiri, Truong Khoa Phan.

Bilateral collaboration funded by the french ministry of foreign affairs (MAE), the french ministry of research and education (MESR), and the Deutscher Akademischer Austauschdienst (DAAD). The funding covers scientific visits.

"Défis algorithmiques dans les réseaux de communication". The purpose of the project is to exchange expertise between the discrete optimization group of RWTH Aachen University and the COATI team at Inria Sophia-Antipolis and to address algorithmic problems in communication networks.

8.3. International Initiatives

8.3.1. Inria Associate Teams

8.3.1.1. AlDyNet

Title: Algorithm for large and Dynamic Networks

Inria principal investigator: Nicolas Nisse

International Partner (Institution - Laboratory - Researcher):

Universidad Adolfo Ibañez, Santiago, Chile

Facultad de Ingeniería y Ciencias

Karol Suchan

Duration: 2013 - 2015

See also: <http://team.inria.fr/coati/projects/aldynet/>

The main goal of this Associate Team is to study the structure of networks (modeled by graphs) to design both efficient distributed algorithms and reliable network topologies suitable to applications. We are interested both in large-scale (Facebook, Internet, etc.) and in smaller networks (e.g., WDM) that handle heavy traffic. More precisely, we aim at designing new techniques of distributed and localized computing to test structural properties of networks and to compute structures (e.g., decompositions) to be used in applications. Concerning the applications, we will first focus on routing and subgraph packing problems.

There are two main objectives:

- Find efficient localized algorithms to test certain graph properties or to prove that no such algorithms exist. We will formalize several distributed computing models and analyze which properties can and which cannot be tested in them.
- Define graph properties – computable or approximable in distributed systems – such as structures/decompositions/representations. The driving idea is to combine several well studied graph properties in order to obtain more specific structures which we hope to be more easily computable.

To verify the practical efficiency of our results, the designed algorithms will be implemented and compared to existing ones. For this purpose, a particular effort will be put to design and implement algorithms to generate graphs that satisfy properties of interest, in order to use them to test the algorithms.

The originality of the proposal is to combine powerful tools of graphs theory (e.g., FPT complexity) and of combinatorial optimization (Mixed Integer Programming) with distributed computing. One challenge here is to balance between the degree of locality of desired algorithms and the relevance of properties that may be computed.

8.3.2. Inria International Partners

8.3.2.1. ANR International Taiwan GRATEL, 01/2010 – 12/2013

Participants: Jean-Claude Bermond, Frédéric Havet.

GRATEL (Graphs and Telecommunications) has been started in collaboration with LABRI Bordeaux, UJF Grenoble and three partners in Taiwan: Sun Yat-sen University, the National Taiwan University and Academia Sinica.

(<https://gratel.labri.fr/pmwiki.php?n=Main.HomePage>)

8.3.3. Participation In other International Programs

Inria FUNCAP (Inria-FAP): ALERTE (ALgorithmes Efficaces pour les Réseaux de Télécommunications), with Pargo Team, Universidade Federal do Ceará, Brazil, 07/2011-07/2013.

Action ECOS-SUD: ALgorithmes Distribués pour le calcul de la structure des réseaux, with Chile, 2013-2015.

8.4. International Research Visitors

8.4.1. Visits of International Scientists

Jørgen Bang-Jensen: Univ. Southern Denmark, Odensee, Denmark, from October 11 to November 2, 2013 (3 weeks);

Gianlorenzo D'Angelo: Univ. degli studi di Perugia, Italy, September 9-17, 2013 (2 weeks);

Xavier Défago: Japan Advanced Institute of Science and Technology, Nomi, Ishikawa, Japan, from September 16, 2013 to January 31, 2014 (4.5 months);

Mattia D'Emidio: Univ. L'aquila, Italy, from March 1 to April 30, 2013 (2 months);

Michele Flammini: Univ. of L'Aquila, Italy, from June 22 to July 13, 2013 (3 weeks);

Brigitte Jaumard: Concordia Univ., Montréal, Canada, February 11-22, 2013 (2 weeks);

Mejdi Kaddour: Univ. Oran, Algeria, December 6-13, 2013 (1 week);

Takako Kodate: Tokyo Woman's Christian Univ., Suginami-ku, Tokyo, Japan, from March 21 to April 4, 2013 (2 weeks);

Arie M.C.A. Koster: RWTH Aachen Univ., Germany, February 11-15, 2013 (1 week);

Claudia Linhares-Sales: UFC Fortaleza, Brazil, November 5-11, 2013 (1 week);

Euripides Markou: Univ. Thessaly, Volos, Greece, March 24th-31th (1 week);

Gianpiero Monaco: Univ. L'Aquila, Italy, September 1-8, 2013 (1 week);

Joseph Peters: Simon Frasier Univ., Vancouver, Canada, from January 20 to June 14, 2013 (5 months);

Guido Proietti: Univ. L'Aquila, Italy, September 1-9, 2013 (1 week);

Esteban H. Roman Catafau: Univ. Adolfo Ibañez, Chile, from September 7 to October 6, 2013 (1 month);

Karol Suchan: Univ. Adolfo Ibañez, Chile, September 7-21, 2013 (2 weeks);

Amel Tandjaoui: Univ. Oran, Algeria, June 12 till July 13, 2013 (1 month);

Joseph Yu: Abbotsford and SFU, Vancouver, Canada, from March 1 to April 19, 2013 (1 month 1/2);

8.4.1.1. Internships

Guillaume Ducoffe: ENS Cachan, from March 18, 2013 until August 31, 2013, and since October 15, 2013;

Rennan Ferreira Dantas: Univ. Federal do Ceará, Brazil, since November 2013;

Klaus Christoph Jaschan Little: Univ. Adolfo Ibañez, Chile, since December 2013;

Ioannis Lamprou: National and Kapodistrian Univ. Athens, Greece, from March 2013 until September 2013;

Christos Papageorgakis: Univ. Central Greece, from January 2013 until July 2013;

Phablo Fernando Soares Moura: Univ. São Paulo (USP), Brazil, from March 2013 until July 2013;

Claudio Soares De Carvalho Neto: Univ. Federal do Ceará, Brazil, since November 2013;

8.4.2. Visits to International Teams

J. Araújo and A.K. Maia: Visit to Simon Fraser Univ., Vancouver, Canada (January 11-February 10, 2013).

J-C. Bermond: LRI, Orsay (March 29, 2013); LIRMM, Montpellier (April 16, 2013);

D. Coudert: Visit to Univ. Adolfo Ibañez (part of EA AIDyNet), Santiago Chile (November 15-30, 2013);

F. Havet: Visit to LIRMM, Univ. Montpellier 2, (December 9-11, 2013);

A. Kodjo: Visit to Concordia Univ., Montreal, Canada, (August 1st-September 1st, 2013);

F.Z. Moataz and B. Li: Visit to Univ. Adolfo Ibañez, Santiago, Chile, (November 14-December 12, 2013);

N. Nisse: Visit to Univ. Adolfo Ibañez (part of EA AIDyNet), Santiago Chile (November 15-December 1st, 2013); Visit to Univ. Perugia, Italy (October 20-25, 2013)

DANTE Team

8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. ANR

- Equipex FIT (Futur Internet of Things) Fit is one of 52 winning projects in the Equipex research grant program. It will set up a competitive and innovative experimental facility that brings France to the forefront of Future Internet research. FIT benefits from 5.8€ million grant from the French government Running from 22.02.11 – 31.12.2019. The main ambition is to create a first-class facility to promote experimentally driven research and to facilitate the emergence of the Internet of the future.
- As proposed by initiatives in Europe and worldwide, enabling an open, general-purpose, and sustainable large-scale shared experimental facility will foster the emergence of the Future Internet. There is an increasing demand among researchers and production system architects to federate testbed resources from multiple autonomous organisations into a seamless/ubiquitous resource pool, thereby giving users standard interfaces for accessing the widely distributed and diverse collection of resources they need to conduct their experiments. The F-Lab project builds on a leading prototype for such a facility: the OneLab federation of testbeds. OneLab pioneered the concept of testbed federation, providing a federation model that has been proven through a durable interconnection between its flagship testbed PlanetLab Europe (PLE) and the global PlanetLab infrastructure, mutualising over five hundred sites around the world. One key objective of F-Lab is to further develop an understanding of what it means for autonomous organisations operating heterogeneous testbeds to federate their computation, storage and network resources, including defining terminology, establishing universal design principles, and identifying candidate federation strategies. On the operational side, F-Lab will enhance OneLab with the contribution of the unique sensor network testbeds from SensLAB, and LTE based cellular systems. In doing so, F-Lab continues the expansion of OneLab's capabilities through federation with an established set of heterogeneous testbeds with high international visibility and value for users, developing the federation concept in the process, and playing a major role in the federation of national and international testbeds. F-Lab will also develop tools to conduct end-to-end experiments using the OneLab facility enriched with SensLAB and LTE.

F-Lab is a unique opportunity for the French community to play a stronger role in the design of federation systems, a topic of growing interest; for the SensLAB testbed to reach an international visibility and use; and for pioneering testbeds on LTE technology.

- ANR RESCUE started in December 2010: Access and metropolitan networks are much more limited in capacity than core networks. While the latter operate in over-provisioning mode, access and metropolitan networks may experience high overload due to evolution of the traffic or failures. In wired networks, some failures (but not all) are handled by rerouting the traffic through a backup network already in place. In developed countries, backup networks are adopted wherever possible (note that this is generally not the case for the links between end users and their local DSLAM). Such a redundant strategy may not be possible in emerging countries because of cost issues. When dedicated backup networks are not available, some operators use their 3G infrastructure to recover some specific failures; although such an alternative helps avoid full network outage, it is a costly solution. Furthermore, availability of 3G coverage is still mainly concentrated in metropolitan zones. When no backup networks are available, it would be interesting to deploy, for a limited time corresponding to the period of the problem (*i.e.*, failure or traffic overload), a substitution network to help the base network keep providing services to users.

In the RESCUE project (2010-2013), we investigate both the underlying mechanisms and the deployment of a substitution network composed of a fleet of dirigible wireless mobile routers. Unlike many projects and other scientific works that consider mobility as a drawback, in RESCUE we use the controlled mobility of the substitution network to help the base network reduce contention or to create an alternative network in case of failure. The advantages of an on-the-fly substitution network are manifold: Reusability and cost reduction; Deployability; Adaptability.

The RESCUE project addresses both the theoretical and the practical aspects of the deployment of a substitution network. From a theoretical point of view, we will propose a two-tiered architecture including the base network and the substitution network. This architecture will describe the deployment procedures of the mobile routing devices, the communication stack, the protocols, and the services. The design of this architecture will take into account some constraints such as quality of service and energy consumption (since mobile devices are autonomous), as we want the substitution network to provide more than a best effort service. From a practical point of view, we will provide a proof of concept, the architecture linked to this concept, and the necessary tools (*e.g.*, traffic monitoring, protocols) to validate the concept and mechanisms of on-the-fly substitution networks. At last but not least, we will validate the proposed system both in laboratory testbeds and in a real-usage scenario.

<http://rescue.lille.inria.fr/>

- ANR PETAFLOW (Appel Blanc International) started in march 2010 and ended in october 2013. It is a collaborative project between the GIPSA Lab (Grenoble), MOAIS (Inria Grenoble), DANTE (Inria Grenoble), the University of Osaka (the Cybermedia Center and the Department of Information Networking) and the University of Kyoto (Visualisation Laboratory).

The aim of this collaboration was to propose network solutions to guarantee the Quality of Service (in terms of reliability level and of transfer delay properties) of a high speed, long-distance connection used in an interactive, high performance computing application. Another specificity of this application was the peta-scale volume of the treated data corresponding to the upper airway flow modelling.

<http://petaflow.gforge.inria.fr/>

- ANR CONTINT CODDDE accepted in December 2013: It is a collaborative project between the ComplexNetwork team at LIP6/UPMC; Linkfluence and Inria Dante. The CODDDE project aims at studying critical research issues in the field of real-world complex networks study:
 - How do these networks evolve over time?
 - How does information spread on these networks?
 - How can we detect and predict anomalies in these networks?

In order to answer these questions, an essential feature of complex networks will be exploited: the existence of a community structure among nodes of these networks. Complex networks are indeed composed of densely connected groups of that are loosely connected between themselves.

The CODDDE project will therefore propose new community detection algorithms to reflect complex networks evolution, in particular with regards to diffusion phenomena and anomaly detection.

These algorithms and methodology will be applied and validated on a real-world online social network consisting of more than 10 000 blogs and French media collected since 2009 on a daily basis (the dataset comprises all published articles and the links between these articles).

- ANR FETUSES: The goals of this ANR project consist in the development of statistical signal processing tools dedicated to per partum fetal heart rate characterisation and acidosis detection, and are organised as follows: – construction of a large dataset of per partum fetal heart rate recordings, which is well documented and of significant clinical value; – Developments of adaptive (*e.g.* data driven) algorithms to separate data into trend (deceleration induced by contractions) and fluctuation (cardiac variability) components; – Developments of algorithms to characterise the non stationary and multifractal properties of per partum fetal heart rate ; – Acidosis detection and assessment using

the large datasets; – Algorithm implementation for performing tests in real clinical situations. ANR is a joint project between DANTE, the Physics Lab of ENS Lyon (SiSyPhe team) and the *Hôpital Femme-Mère-Enfant* of Bron (Lyon). Fetuses started in January 2012.

- ANR INFRA DISCO (DIstributed SDN COntrollers for rich and elastic network services) project: the DANTE team will explore the way SDN (Software Designed Network) can change network monitoring, control, urbanisation and abstract description of network resources for the optimisation of services. More specifically, the team will address the issues regarding the positioning of SDN controllers within the network, and the implementation of an admission control that can manage IP traffic prioritisation.

8.2. International Initiatives

8.2.1. Inria International Partners

8.2.1.1. Declared Inria International Partners

- LNCC - Laboratório Nacional de Computação Científica (several collaboration, e.g., STIC AMSUD and Inria/FAPERJ)
- Academy of Science and Technology, Vietnam (collaboration via CNSR PEPS)
- Department of Mathematics/Naxys, University of Namur, Belgium (Student exchanges)
- Department of Biomedical Engineering and Computational Science, Aalto University, Finland

8.2.2. Participation In other International Programs

DANTE is part of a FAPERJ/Inria collaborative project: Complex Dynamic Networks Acronym (CoDyN). The collaboration is done with the Mechanisms and ARchitectures for TeleINformatics (MARTIN) team (<http://martin.lncc.br>), a R&D group at the National Laboratory for Scientific Computing (LNCC), a research unit of the Brazilian Ministry of Science and Technology. MARTIN houses staff working in Information and Communication Technologies (ICT), with a particular focus on computer networks. Currently, the main activities of the group are on Network Measurements, Mobile Computing, and Network Software Architecture and Modelling. In particular, the group promotes research and development in inter- and multidisciplinary applications based on the above-mentioned areas and their intersections (e.g. mobile health applications).

8.3. International Research Visitors

8.3.1. Visits of International Scientists

- Artur Ziviani and Klaus Wehmuth from LNCC spent several weeks at IXXI.
- Dr. Gerardo Iñiguez from Aalto University (Finland) spent time in the DANTE team and was hosted by IXXI.

8.3.1.1. Internships

- **Arashpreet Singh Mor** master student from Indian Institute of Technology Dehli (India) did his M1 internship with DANTE from May to August 2013.
- **Thibaud Trolliet** L3 student at the department of physics of ENS Lyon did a 2 months internship with the team DANTE (June-July 2013).
- **ANH Ha Pham The** Master student at IFI (Institut de la Francophonie pour l'Informatique - Hanoi Vietnam) did his M2 internship with DANTE from May to November 2013.

8.3.2. Visits to International Teams

- Christophe Crespelle, 2 months in January-February 2013, Vietnam Institute for Advanced Study in Mathematics (VIASM), Hanoi.
- Christophe Crespelle, 1 month in June-July 2013, Institute of Mathematics, Vietnam Academy of Science and Technology, Hanoi.
- Eric Fleury visited the team of Jose Ignacio Alvarez-Hamelin at Buenos Aires, Argentina in collaboration with Artur Ziviani.

DIANA Team

8. Partnerships and Cooperations

8.1. Regional Initiatives

- **PFT** (2011-2014) is a DGCIS funded project, in the context of the competitiveness cluster SCS, whose aim is to provide to PACA region industrials wishing to develop or validate new products related to future mobile networks and services and M2M application, a networking infrastructure and tools helpful for development, test and validation of those products. Other partners : 3Roam, Audilog Groupe Ericsson, Ericsson, Eurecom, Inria, iQsim, MobiSmart, Newsteo, OneAccess, Orange Labs, Pôle SCS, ST Ericsson, Telecom Valley. Our contribution is centred around providing a test methodology and tools for wireless networks experimentation.

8.2. National Initiatives

8.2.1. ANR

- **ANR FIT** (2011-2018): FIT (Future Internet of Things) aims to develop an experimental facility, a federated and competitive infrastructure with international visibility and a broad panel of customers. It will provide this facility with a set of complementary components that enable experimentation on innovative services for academic and industrial users. The project will give French Internet stakeholders a means to experiment on mobile wireless communications at the network and application layers thereby accelerating the design of advanced networking technologies for the Future Internet. FIT is one of 52 winning projects from the first wave of the French Ministry of Higher Education and Research's "Équipements d'Excellence" (Equipex) research grant programme. The project will benefit from a 5.8 million euro grant from the French government. Other partners are UPMC, IT, Strasbourg University and CNRS. See also <http://fit-equipex.fr/>.
- **ANR F-Lab** (2011-2013): ANR funded project on the federation of computation, storage and network resources, belonging to autonomous organizations operating heterogeneous testbeds (e.g. PlanetLab testbeds and Sensors testbeds). This includes defining terminology, establishing universal design principles, and identifying candidate federation strategies. Other partners : UPMC, A-LBLF and Thales.
- **ANR DISCO** (2013-2016): DISCO (DIstributed SDN COntrollers for rich and elastic network services) aims to explore the way how Software Defined Networking changes network monitoring, control, urbanisation and abstract description of network resources for the optimisation of services. The project works throughout experimentations and application use cases on the next generation of Software-Defined Networking solutions for large and critical distributed systems. The project will study the distribution of the current SDN control plane and the optimization of network operations that the integrated system view of cloud computing-based architectures allows.

8.3. European Initiatives

8.3.1. FP7 Projects

8.3.1.1. NOVI

Title: Networking innovations Over Virtualized Infrastructures

Type: COOPERATION (ICT)

Defi: CAPACITIES programme.

Instrument: Specific Targeted Research Project (STREP)

Duration: September 2010 - February 2013

Coordinator: NTUA (Greece)

Others partners: 13 european partners including GARR, ELTE, Cisco, etc.

See also: <http://www.fp7-novi.eu/>

Abstract: NOVI (Networking innovations Over Virtualized Infrastructures) research concentrates on efficient approaches to compose virtualized e-Infrastructures towards a holistic Future Internet (FI) cloud service. Resources belonging to various levels, i.e. networking, storage and processing are in principle managed by separate yet interworking providers. NOVI will concentrate on methods, information systems and algorithms that will enable users with composite isolated slices, baskets of resources and services provided by federated infrastructures.

8.3.1.2. Fed4Fire

Title: Federation for Future Internet Research and Experimentation

Type: COOPERATION (ICT)

Defi: FIRE programme.

Instrument: Integrating Project (IP)

Duration: October 2012 - October 2016

Coordinator: iMinds (Belgium)

Others partners: 17 european partners including iMinds, IT Innovation, UPMC, Fraunhofer, TUB, UEDIN, NICTA, etc.

See also: <http://www.fed4fire.eu/>

Abstract: Fed4FIRE will deliver open and easily accessible facilities to the FIRE experimentation communities, which focus on fixed and wireless infrastructures, services and applications, and combinations thereof. The project will develop a demand-driven common federation framework, based on an open architecture and specification. It will be widely adopted by facilities and promoted internationally. This framework will provide simple, efficient, and cost effective experimental processes built around experimenters' and facility owners' requirements. Insight into technical and socio-economic metrics, and how the introduction of new technologies into Future Internet facilities influences them, will be provided by harmonized and comprehensive measurement techniques. Tools and services supporting dynamic federated identities, access control, and SLA management will increase the trustworthiness of the federation and its facilities. A FIRE portal will offer brokering, user access management and measurements. Professional technical staff will offer first-line and second-line support to make the federation simple to use. The project will use open calls to support innovative experiments from academia and industry and to adapt additional experimentation facilities for compliance with Fed4FIRE specifications. A federation authority will be established to approve facilities and to promote desirable operational policies that simplify federation. A Federation Standardization Task Force will prepare for sustainable standardization beyond the end of the project. The adoption of the Fed4FIRE common federation framework by the FIRE facilities, the widespread usage by both academic and industrial experimenters, and the strong links with other national and international initiatives such as the FI-PPP, will pave the way to sustainability towards Horizon 2020.

8.3.1.3. OPENLAB

Title: OpenLab: extending FIRE testbeds and tools

Type: COOPERATION (ICT)

Defi: ICT 2011.1.6 Future Internet Research and Experimentation (FIRE)

Instrument: Integrated Project (IP)

Duration: September 2011 - January 2014

Coordinator: Université Pierre et Marie Curie (France)

Others partners: 18 European partners (including ETH Zurich, Fraunhofer, IBBT, TUB, UAM, etc.) and Nicta from Australia.

See also: <http://www.ict-openlab.eu/>

Abstract: OpenLab brings together the essential ingredients for an open, general purpose and sustainable large scale shared experimental facility, providing advances to the early and successful prototypes serving the demands of Future Internet Research and Experimentation. OpenLab partners are deploying the software and tools that allow these advanced testbeds to support a diverse set of applications and protocols in more efficient and flexible ways. OpenLab's contribution to a portfolio that includes: PlanetLab Europe (PLE), with its over 200 partner/user institutions across Europe; the NITOS and w-iLab.t wireless testbeds; two IMS telco testbeds that can connect to the public PSTN, to IP phone services, and can explore merged media distribution; an LTE cellular wireless testbed; the ETOMIC high precision network measurement testbed; the HEN emulation testbed; and the ns-3 simulation environment. Potential experiments that can be performed over the available infrastructure go beyond what can be tested on the current internet. OpenLab extends the facilities with advanced capabilities in the area of mobility, wireless, monitoring, domain interconnections and introduces new technologies such as OpenFlow. These enhancements are transparent to existing users of each facility. Finally, OpenLab will finance and work with users who propose innovative experiments using its technologies and testbeds, via the open call mechanism developed for FIRE facilities.

8.3.2. EIT KIC funded activities

Our project team was involved in 2013 in **three activities** funded by the EIT ICT Labs KIC:

Fitting, Future Internet (of Things) facility

The goal of this activity is to develop a testbed federation architecture that combines wireless and wired networks.

Software-Defined Networking (SDN)

The objective of this activity is to explore software-defined networking at different positions on the axis between basic flow-level processing (using OpenFlow for end-to-end flows) in controlled fixed networks and cooperation between mobile end nodes in the open wireless Internet (using opportunistic networking for resources communicated hop-by-hop).

Information-centric networking (ICN) experimentation

The goal of this activity is to define and implement an early validation environment for ICN proposals.

8.4. International Initiatives

8.4.1. Inria Associate Teams

8.4.1.1. COMMUNITY

Title: Message delivery in heterogeneous networks

Inria principal investigator: Thierry Turletti

International Partner (Institution - Laboratory - Researcher):

University of California Santa Cruz (United States) - School of Engineering - Katia Obraczka

Duration: 2009 - 2014

See also: <http://inrg.cse.ucsc.edu/community/>

This Inria - UC Santa Cruz Team investigates a number of research challenges raised by message delivery in environments consisting of heterogeneous networks that may be subject to episodic connectivity.

During the first three years of the COMMUNITY associate team, we have explored solutions to enable efficient delivery mechanisms for disruption-prone and heterogeneous networks (i.e. challenged networks). In particular, we have designed the MeDeHa framework along with the Henna naming scheme, which allow communication in infrastructure and infrastructure-less networks with varying degrees of connectivity. We have also proposed efficient routing strategies adapted to environment with episodic connectivity that take into account the utility of nodes to relay messages. The various solutions have been evaluated using both simulations and real experimentations in testbeds located at Inria and UCSC. These solutions have demonstrated good performance in challenged networks. However, the ossification of the Internet prevents the deployment of such solutions in large scale. So, in 2012 we decided to extend our collaboration in two research directions: (1) The exploration of the software-defined networking paradigm to facilitate the implementation and large scale deployment of new network architectures to infrastructure-less network environments, and (2) the design of innovative information-centric communication mechanisms adapted to challenged networks. In particular, we are designing mechanisms to provide flexible, efficient, and secure capacity sharing solutions by leveraging SDN in hybrid networked environments, i.e., environments that consist of infrastructure-based as well as infrastructureless networks. We are also investigating solutions to optimize caching in infrastructure and infrastructureless networks using SDN. We have also designed a content-optimal delivery algorithm, called CODA, for distributing named data over challenged networks.

8.4.1.2. SIMULBED

Title: SIMULBED: Large-Scale Simulation Testbed for Realistic Evaluation of Network Protocols and Architectures

Inria principal investigator: Walid DABBOUS

International Partner (Institution - Laboratory - Researcher):

Keio University (Japan) - Shonan-Fujisawa Campus - Osamu Nakamura

Duration: 2012 - 2014

See also: <http://planete.inria.fr/Simulbed>

Simulators and experimental testbeds are two different approaches for the evaluation of network protocols and they provide a varying degree of repeatability, scalability, instrumentation and realism. Network simulators allow fine grained control of experimentation parameters, easy instrumentation and good scalability, but they usually lack realism. However, there is a growing need to conduct realistic experiments involving complex cross-layer interactions between many layers of the communication stack and this has led network researchers to evaluate network protocols on experimental testbeds.

The use of both simulators and testbeds to conduct experiments grants a better insight on the behavior of the evaluated network protocols and applications. In this project, we focus on the design of SIMULBED, an experimentation platform that aims to provide the best of both worlds. Our project builds on the following state-of-the-art tools and platforms: the open source ns-3 network simulator and the PlanetLab testbed. ns-3 is the first network simulator that includes a mechanism to execute directly within the simulator existing real-world Linux protocol implementations and applications. Furthermore, it can be used as a real-time emulator for mixed (simulation-experimentation) network scenarios. PlanetLab is the well-known international experimental testbed that supports the development and the evaluation of new network services. It is composed of nodes connected to the Internet across the world, and uses container-based virtualization to allow multiple experiments running independently on the same node while sharing its resources.

The overall objective of the project is to design a platform to make easier the evaluation of network protocols, applications and proposals for the future Internet architecture, and to make this platform available to the networking research community. The SIMULBED evaluation platform aims to conduct easily mixed simulation-experimentation evaluation of networking protocols in a scalable way, while maintaining a high degree of realism and increasing controllability and reproducibility. It is based on the PlanetLab testbed, the ns-3 network simulator and the NEPI unified programming environment developed in our team to help in simplifying the configuration, deployment and run of network scenarios on the platform. Within this collaboration, we are enhancing the support of emulation in the ns-3 network simulator through Direct Code Execution (DCE) and are extending the functionalities of NEPI to fit the needs of SIMULBED. For example, we extended the DCE and NEPI frameworks to conduct easily and in a more realistic way evaluation of the CCNx information-centric networking architecture through ns-3 and the PlanetLab testbed.

8.4.2. Inria International Labs

- CIRIC: Our project-team was involved in the definition of the topics for the Network and Telecom R&D line of the (the Communication and Information Research and Innovation Center - CIRIC), the Inria research and innovation centre in Chili. In this context, we will extend our collaboration with Universidad Diego Portales, Chile.

8.5. International Research Visitors

8.5.1. Visits of International Scientists

8.5.1.1. Visiting PhDs

Iliaria Cianci, Visiting PhD student (from Nov 2012 until Aug 2013)

Subject: Content Centric Networking

Institution: Politecnico di Bari, Italy

8.5.1.2. Internships

Alexandros Kouvakas (from May 2013 until Oct 2013)

Subject: An OpenFlow framework for integrated simulation and live experimentation

Institution: National and Kapodistrian University of Athens

Adel Aljalam (from Mar 2013 until Aug 2013)

Subject: Assessing Internet access quality by active measurements

Institution: Ubinet Master, University of Nice Sophia-Antipolis

Takai Eddine Kennouche (from Feb 2013 until May 2013)

Subject: Realistic Simulation of Sensor Networks - Contiki over ns-3

Institution: Institut National des Télécommunications et des TIC - Oran, Algeria.

Nicoleta Oita (from Mar 2013 until Aug 2013)

Subject: Privacy in mobile networks

Institution: Ubinet Master, University of Nice Sophia-Antipolis

Xiuhui Ye (from May 2013 until Nov 2013)

Subject: How to Network in Online Social Networks

Institution: Politecnico di Torino

8.5.2. Visits to International Teams

Alina Quereilhac, Visiting PhD student PARC in Palo Alto, USA

Period: From June to September 2013

Subject: Evaluating costs of CCNx overlays on the Internet

Thierry Turlotti and Bruno Nunes Astuto, Visiting researchers to University of California at Santa Cruz

Period: One week in March 2013

Subject: Community Associated team

Bruno Nunes Astuto Visiting researchers to University of California at Santa Cruz

Period: One month in July 2013

Subject: Community Associated team

Thierry Turlotti, Alina Quereilhac and Emilio Mancini, Visitors to NICT, Japan

Period: One week in October 2013

Subject: Simulbed associated team

DIONYSOS Project-Team

8. Partnerships and Cooperations

8.1. International Research Visitors

8.1.1. Inria International Chair

Participants: Bruno Tuffin, Pierre L'Ecuyer.

Title: Methods and Tools for Effective Stochastic Simulation

Period: Nov 2013 - Oct 2018

The activity deals with mathematical models that represent uncertainty in the dynamic behavior of complex systems, algorithms for efficient simulation of these systems on a computer, eventually with the aim of optimizing management decisions taken with respect to these systems, and computer software that concretely implements these methods efficiently. It applies to several types of systems that involve uncertainty, in all areas. The main part of the work is on general-purpose methodology and tools, and their mathematical analysis. Another part focuses on specific classes of applications in the areas of communications networks, reliability, finance, revenue management and network economics, and service systems such as call center or health care management. It has connections with computer science, operations research, industrial engineering, applied probability, statistics, and numerical analysis. Stochastic simulation is a key tool in practically all areas of science, engineering, and management. Its use keeps growing quickly, and new research issues pop up along the way, as the amount of available digital data on complex stochastic systems is literally exploding. Effective ways of using this large flow of data for better stochastic modeling, simulation, and decision making for those systems need to be developed, and this gives rise to large challenges.

8.2. European Initiatives

8.2.1. FP7 Projects

8.2.1.1. FP7 PROBE-IT

Participants: César Viho, Anthony Baire, Nanxing Chen.

PROBE-IT was a two years European project that aims at supporting exploitation of European research advances in IoT deployments. The work plan was split in three main areas : benchmarking, roadmap and interoperability testing. PROBE-IT comprised ten international partners from Europe, China, Brazil and Africa. Dionysos was leader of the work-package WP4 dedicated to testing roadmap and solutions to provide stakeholders with elements to validate technologies conformance and interoperability. The project ended in September 2013 See <http://www.probe-it.eu>

8.2.2. Collaborations with Major European Organizations

Partner 1: FTW, Vienna (Austria)

We work with FTW on network economics.

Partner2: Universidad Politécnica de Valencia

We work with UPV on network economics.

Partner 3: Vrije University (The Netherlands)

We work with Vrije University on rare event simulation.

8.3. International Initiatives

8.3.1. Inria Associate Teams

8.3.1.1. MANAP

Title: Markovian ANalysis and APplications

Inria principal investigator: Gerardo Rubino

International Partner (Institution - Laboratory - Researcher):

Technical University Federico Santa María (UTFSM), Valparaíso, Chile – Electronics Department – Prof. Reinaldo Vallejos

Starting: 2013

From the theoretical side, MANAP addresses the main problem when using Markov models today in order to analyze complex communication systems, the combinatorial explosion of the state space and its negative consequences on the cost of the associated solving procedures. We focus on the design of acceleration methods capable of reducing the computational complexity of the evaluation of metrics defined on these models. From the application viewpoint, the focus is on (i) the performance analysis of WDM communication infrastructures, taking into account the possibility of failing components, and (ii) the dependability analysis of Wireless Local Area Networks (WLANs). The activities started in 2013, where we launched a project around a new idea for solving numerically basic Markov problems: the computation of the distribution of the model in transient and in steady-state.

See also: <http://people.rennes.inria.fr/Gerardo.Rubino/RESEARCH/MANAP/manap.html>

8.3.1.2. MOCQUASIN

Title: Monte Carlo and Quasi-Monte Carlo for rare event simulation

Inria principal investigator: Bruno Tuffin

International Partner (Institution - Laboratory - Researcher):

University of Montreal (Canada) - Département d'informatique et recherche opérationnelle - Pierre L'Ecuyer

Duration: 2008 - 2013

See also: http://www.irisa.fr/dionysos/pages_perso/tuffin/MOCQUASIN/

The goal of MOCQUASIN is to design efficient Monte Carlo and quasi-Monte Carlo simulation methods and to apply them to models in telecommunications. Simulation is indeed often the only method to analyse complex and/or large systems, but also suffers from inefficiency. Two specific situations on which we will focus are rare events, and revenue management. In the two cases, we want to deal with dependent individual events or decisions, a realistic situation requiring adapted solution techniques. The inefficiency of the standard simulation is a known issue to compute the probability of rare event since getting it only once requires in average a long simulation time, but most of the literature has up to now assumed independence in the models. The other framework, revenue management in telecommunications, is the situation of providers trying to define valid offers and capacity investments in front of complex demand models. Here too, a change in the decision of an actor has an impact on the others that has to be taken into account.

8.3.2. "International activity" action from the University Rennes 1

Action funded by the University of Rennes 1 studying ads ranking (e-commerce, search engines) with their economic impact. Collaboration with Pierre L'Ecuyer (Université de Montréal).

8.3.3. Inria International Partners

Our other main international partners are:

- Peter Reichl (from FTW, Vienna, Austria), on pricing and security issues;
- Héctor Cancela and Franco Robledo (from Univ. of the Republic, Montevideo, Uruguay), on simulation issues (see [8.3.5.1](#));
- Tarik Taleb (from NEC Europe), on LTE issues;
- Alan Krinik, CalPoly, California, USA, on transient analysis of Markovian queues;
- Reinaldo Vallejo, UTFSM, Valparaíso, Chile, on networking and modeling problems (see [8.3.1.1](#) and [8.3.5.1](#)).

8.3.4. *Inria International Labs*

In the context of CIRIC, we cooperate with the team of Reinaldo Vallejo, professor at the UTFSM, Valparaíso, Chile, on different topics related to networking and modeling issues. Specifically, these activities are organized around two collaborative projects, [8.3.1.1](#) and [8.3.5.1](#), where one can find the scientific details.

8.3.5. *Participation In other International Programs*

8.3.5.1. *Stic AmSud with UDELAR, Uruguay, and UTFSM, Chile*

Program: Stic AmSud

Title: Accelerating Markov Models for analysis and design of dynamic WDM optical networks (AMMA)

Inria principal investigator: Gerardo Rubino

International Partners (Institution - Laboratory - Researcher):

University of the Republic (UDELAR), Montevideo, Uruguay – Computer Science at the Engineering Faculty – prof. Héctor Cancela

Technical University Federico Santa María (UTFSM), Valparaíso, Chile – Electronics Department – Prof. Reinaldo Vallejos

Duration: 2 years, Jan. 2013 – Dec. 2014

This project has two main scientific goals: (i) to develop methods capable of solving Markov models faster than with state-of-the-art techniques, and (ii) to apply these techniques to the design of fault-tolerant optical networks. The rationale behind (i) is that the group has ideas and some preliminary promising unpublished results that makes it expect that its approach will be effective in producing new nice solving procedures. Concerning (ii), we have already produced results in simpler cases (without taking into account failures), and we also have results on all the associated areas (dependability analysis, combinatorial optimization, etc.). These main research lines are completed with other goals all concerned with the quantitative analysis of such complex communication systems.

8.3.5.2. *Math AmSud with UDELAR, Uruguay, and UV, Chile*

Program: Math AmSud

Title: Stochastic Analysis, Statistics Inference, Numerical Analysis (SIN)

Inria principal investigator: Gerardo Rubino

Main International Partners (Institution - Laboratory - Researcher):

University of the Republic (UDELAR), Montevideo, Uruguay – Computer Science at the Engineering Faculty – prof. Paola Bermolen

University of Valparaíso, Chile — Prof. Soledad Torres

Duration: 2 years, Jan. 2013 – Dec. 2014

Stochastic calculus with respect to the standard Brownian motion or more generally with respect to semi-martingales is currently one of the most important components of international research in probability theory. The applications of this theory largely exceed the original probabilistic framework and have repercussions in various fields, including differential geometry, differential partial equations, theoretical physics, modeling in finance, hydrology, telecommunications and biology. Recently, many authors have been interested in developing a stochastic calculus with respect to Gaussian processes which are not necessarily semi-martingales, as for instance the well known fractional Brownian motion. This research project is articulated around the analysis and the applications of stochastic differential equations driven by long memory processes.

SIN is a large project with many partners. Our team participates in looking at differential equations and stochastic differential equations as limits of discrete Markov processes.

8.4. International Research Visitors

8.4.1. Visits of International Scientists

8.4.1.1. Professors

Pr. Luis Guijarro

Subject: Economics of cognitive radio networks

Institution: UP Valencia (Spain)

Duration: 1/06/2013 - 31/07/2013

Pr. Héctor Cancela

Subject: network reliability (see [8.3.5.1](#))

Institution: UDELAR, Montevideo, Uruguay

Duration: 10 days, Jul 2013

Pr. Reinaldo Vallejo and Marta Barría

Subject: network modeling and Markov chain analysis (see [8.3.5.1](#) , [8.3.1.1](#) , [8.3.4](#))

Institutions: UTFSM and UV, Valparaíso, Chile

Duration: two weeks, Sep 2013

8.4.2. Visits to International Teams

- G. Rubino visited the Design and Analysis of Communication Systems (DACs) at the University of Twente, The Netherlands, where he gave a seminar.
- C. Viho visited the Institute of Computer Science at the University of Goettingen (Germany) and the Computer Science and Engineering Department of BUPT (Beijing University of Post and Telecommunications), China, where he gave seminars.

DYOGENE Project-Team

8. Partnerships and Cooperations

8.1. Regional Initiatives

DYOGENE participates in the Laboratory of Information, Networking and Communication Sciences (LINCS) <http://www.lincs.fr/> created on October 28th, 2010, by three French institutions of higher education and research: Inria, Institut Télécom and UPMC. Alcatel-Lucent joined the LINCS in February 2011 as a strategic partner.

8.2. National Initiatives

8.2.1. GdR GeoSto

Members of Dyogene participate in Research Group GeoSto (Groupement de recherche, GdR 3477) <http://gdr-geostoch.math.cnrs.fr/> on Stochastic Geometry led by Pierre Calka [Université de Rouen]. This is a collaboration framework for all French research teams working in the domain of spatial stochastic modeling, both on theory development and in applications.

8.2.2. ANR

8.2.2.1. ANR GAP

Graphs, Algorithms and Probability - PI: Marc Lelarge; started in Jan 2012 - 48 months. <http://www.di.ens.fr/~lelarge/ANR-GAP.html>

Over the last few years, several research areas have witnessed important progress through the fruitful collaboration of mathematicians, theoretical physicists and computer scientists. One of them is the cavity method. Originating from the theory of mean field spin glasses, it is key to understanding the structure of Gibbs measures on diluted random graphs, which play a key role in many applications, ranging from statistical inference to optimization, coding and social sciences.

The objective of this project is to develop mathematical tools in order to contribute to a rigorous formalization of the cavity method:

- From local to global, the cavity method on diluted graphs. We will study the extent to which the global properties of a random process defined on some graph are determined by the local properties of interactions on this graph. To this end, we will relate the cavity method to the analysis of the complex zeros of the partition function, an approach that also comes from statistical mechanics. This will allow us to apply new techniques to the study of random processes on large diluted graphs and associated random matrices.
- Combinatorial optimization, network algorithms, statistical inference and social sciences. Motivated by combinatorial optimization problems, we will attack long-standing open questions in theoretical computer science with the new tools developed in the first project. We expect to design new distributed algorithms for communication networks and new algorithms for inference in graphical models. We will also analyze networks from an economic perspective by studying games on complex networks.

8.2.2.2. ANR MARMOTE

Markovian Modeling Tools and Environments - coordinator: Alain Jean-Marie (Inria Maestro); local coordinator (partner Inria Paris-Rocquencourt): A. Bušić; 48 months; partners: Inria Paris-Rocquencourt (EPI DYOGENE), Inria Sophia Antipolis Méditerranée (EPI MAESTRO), Inria Grenoble Rhône-Alpes (EPI MESCAL), Université Versailles-St Quentin, Telecom SudParis, Université Paris-Est Creteil, Université Pierre et Marie Curie.

The aim of the project is to realize a modeling environment dedicated to Markov models. One part will develop the Perfect Simulation techniques, which allow to sample from the stationary distribution of the process. A second one will develop parallelization techniques for Monte Carlo simulation. A third one will develop numerical computation techniques for a wide class of Markov models. All these developments will be integrated into a programming environment allowing the specification of models and their solution strategy. Several applications will be studied in various scientific disciplines: physics, biology, economics, network engineering.

8.2.2.3. ANR MAGNUM

A. Bušić is a participant (within partner LIP6) of the national project ANR MAGNUM (Methodes Algorithmiques pour la Generation aleatoire Non Uniforme: Modeles et applications) (2010–2014), partners: LIP6, LIAFA, IGM. <http://www-apr.lip6.fr/anrMagnum/>.

8.3. International Initiatives

8.3.1. Inria Associate Teams

The third and last year of the Associate Team “IT-SG-WN” with the EECS department of UC Berkeley in the USA, funded from 2011 to 2014, was completed by a one month visit of Prof. Anantharam in Paris in June 2013 and a visit of F. Baccelli in Berkeley in November 2013. This Associate Team participated in the Inria@SiliconValley initiative. It led to several joint publications on Information Theory: http://www.di.ens.fr/~baccelli/IT_SG_WN_web_site.htm

8.3.2. Microsoft Research-Inria Joint Centre

DYOGENE is involved in two projects.

- **Structured Large-Scale Machine Learning**
 Project summary: Machine learning is now ubiquitous in industry, science, engineering, and personal life. While early successes were obtained by applying off-the-shelf techniques, there are two main challenges faced by machine learning in the « big data » era : structure and scale. The project proposes to explore three axes, from theoretical, algorithmic and practical perspectives: (1) large-scale convex optimization, (2) large-scale combinatorial optimization and (3) sequential decision making for structured data. The project involves two Inria sites and four MSR sites.
 As part of this project Florian Bourse (student at ENS) did an internship supervised by Marc Lelarge and Milan Vojnovic. Marc Lelarge visited MSR Cambridge and Milan Vojnovic visited Inria.
- **Social information networks**
 Project summary: Online Social networks provide a new way of accessing and collectively treating information. Their efficiency is critically predicated on the quality of information provided, the ability of users to assess such quality, and to connect to like-minded users to exchange useful content. To improve this efficiency, we develop mechanisms for assessing users’ expertise and recommending suitable content. We further develop algorithms for identifying latent user communities and recommending potential contacts to users.
 As part of this project Rui Wu (student at UIUC) did an internship supervised by Marc Lelarge and Laurent Massoulié.

8.3.3. Participation In other International Programs

Anne Bouillard is participating in the joint lab Inria-Alcatel-Lucent and collaborated with B. Ronot [18].

Anne Bouillard is collaborating with Giovanni Stea from the University of Pisa, Italy.

Marc Lelarge is part of the IFCAM project: Application of optimal control and game theory in communication networks (PIs: Rajesh Sundaresan (Indian Institute of Science) and Eitan Altman (Inria))

8.4. International Research Visitors

8.4.1. Visits of International Scientists

- Vijay Subramanian (Northwestern University), April 8-12, 2013.
- Venkatachalam Anantharam (UC Berkeley), June 2013.
- Moez Draief (Imperial College London), July 2013.
- Hermann Thorisson (University of Iceland), September-October 2013.
- Sean Meyn (University of Florida), November 24-30, 2013.
- Rajesh Sundareshan (Indian Institute of Science), December 1-5, 2013.

8.4.1.1. Internships

- Asma Ghorbel (EURECOM), August 2013 to January 2014; Subject: *LTE/LTE-A Network Optimization by Distributed Fast Algorithms*; co-advised with Chung Shue (Calvin) Chen (Alcatel-Lucent Bell Labs).
- Rémi Varloot (ENS), MPRI internship, March-August 2013; Subject: *Coupling From the Past with Oracle Skipping*.
- Rui Wu (UIUC), September-December 2013.
- Jiaming Xu (UIUC), September 16-20, 2013.

8.4.2. Visits to International Teams

Anne Bouillard was invited at Tokyo institute of Technology, Japan from March to September 2013.

B. Błaszczyszyn visited Probability and Stochastic Processes team at the University of Wrocław.

FOCUS Project-Team

7. Partnerships and Cooperations

7.1. National Initiatives

- AEOLUS (Mastering the Cloud Complexity) is an ANR-ARPEGE project started on December 2010 that will finish on December 2014. AEOLUS studies the problem of installation, maintenance and update of package-based software distributions in cloud-based distributed systems. The problem consists of representing the dependencies of packages and the inter-relationships among the services, in such a way that starting from a declarative description of the application to be deployed on the cloud, it is possible to automatically compute the resources (ie. virtual machines) to be acquired, and the allocation of such resources to the software services needed to run the application. Main persons involved: Gabbrielli, Lascu, Mauro, Sangiorgi, Zavattaro.
- REVER (Programming Reversible Recoverable Systems) is an ANR project that started on 1st December 2011 and with a 48-month duration. REVER aims to study the possibility of defining semantically well-founded and composable abstractions for dependable computing on the basis of a reversible programming language substrate, where reversibility means the ability to undo any distributed program execution, possibly step by step. The critical assumption behind REVER is that by adopting a reversible model of computation, and by combining it with appropriate notions of compensation and modularity, one can develop systematic and composable abstractions for recoverable and dependable systems. Main persons involved: Giachino, Lienhardt, Lanese, Laneve, Zavattaro.
- The ANR project PACE (Processus non-standard: Analyse, Coinduction, et Expressivité) has started in 2013. The project targets three fundamental ingredients in theories of concurrent processes, namely coinduction, expressiveness, and analysis techniques. The project aims at processes that are beyond the realm of "traditional" processes. Specifically, the models studied exhibit one or more of the following features: probabilities, higher-order, quantum, constraints, knowledge, and confidentiality. These models are becoming increasingly more important for today's applications. Coinduction is intended to play a pivotal role. Indeed, the approaches to expressiveness and the analysis techniques considered in the project are based on coinductive equalities. Main persons involved: Hirschhoff (project coordinator), Dal Lago, Lanese, Sangiorgi, Zavattaro.

7.2. European Initiatives

7.2.1. FP7 Projects

- ENVISAGE (Engineering Virtualized Services) is a EU FP7 project, with starting date October 1st, 2013, and with a 3-year duration. The project is about model-based development of virtualized services, including tool support for resource analysis. Most Focus members are involved.
- Hats (Highly Adaptable and Trustworthy Software using Formal Models) is an EU Integrated Project from FP7, started March 2009 and with a 4 year duration. Hats studies formal methods for obtaining high adaptability combined with trustworthiness in the setting of object-oriented languages and software product lines. Most Focus members are involved.
- PLATFORM (Practical Light Types for Resource Consumption) is a Marie Curie IOF project from FP7, started July 2011 with a three-year span. It involves one Focus member, Gaboardi, in research work at University of Pennsylvania and in Bologna. Project aim is the development of a practical programming language with information, in the form of dependent types, about the resources needed by programs during their execution, and where type checking a program will naturally correspond to exhibiting a certification of its resource consumption.

Gaboardi has been in Philadelphia till July 2013, and then in Bologna till October 2013. (He has then moved to Dundee, where he has obtained a tenure-track position.)

7.2.2. Collaborations in European Programs, except FP7

- The ICT COST Action BETTY (Behavioural Types for Reliable Large-Scale Software Systems), initiated in October 2012 and with a four-year duration, will use behavioural type theory as the basis for new foundations, programming languages, and software development methods for communication-intensive distributed systems. Behavioural type theory encompasses concepts such as interfaces, communication protocols, contracts, and choreography. Main persons involved: Bravetti, Giachino, Lanese, Laneve, Mauro, Sangiorgi, Zavattaro.
- In the context of the EIT activity "HCI Technologies for the Digital World", funded with 23000 euro, we have worked to the technical part of the EIT ICT Labs Summer School, Intelligent Services for Digital Cities (ISDC-2013), which has been held in Trento in September 2013 (<http://www.trentorise.eu/education/intelligent-services-digital-cities-isdc-2013-summer-school>).

In particular we developed a SaaS component, called WSOA, to our cloud oriented framework JSOA. WSOA can publish a set of APIs for external usage which are selected from those deployed into the PaaS layer (PaaSOSA). APIs are collected by exploiting the aggregation mechanism of Jolie and then deployed into a Jolie web server (Leonardo). They can be published by defining different protocols/formats such as http/soap, http/json, http/POST/xml, and so on. Thanks to WSOA we also developed a plugin for the SATIN project where the published APIs can be automatically imported into SATIN console and used for creating web based mobile applications.

To provide a comprehensive tool for the students of the smart city summer school, we developed a wrapper for the CKAN platform in order to import all the CKAN APIs into PaaSOSA. In such a way, it is now possible to perform calls to the CKAN platform by exploiting Jolie services deployed into PaaSOSA.

Main persons involved: Gabbrielli, Guidi.

7.2.3. Collaborations with Major European Organizations

We list here the cooperations and contacts with other groups, without repeating those already listed in previous sections.

- ENS Lyon (on concurrency models and resource control). Contact person(s) in Focus: Dal Lago, Gaboardi, Martini, Sangiorgi. Some visit exchanges during the year, in both directions. One joint PhD supervision (J.-M. Madiot).
- Inria EPI Spades (on models and languages for components, reversibility). Contact person(s) in Focus: Lanese.
- Laboratoire d'Informatique, Université Paris Nord, Villetaneuse (on implicit computational complexity). Contact person(s) in Focus: Dal Lago, Gaboardi, Martini. An Italian PhD student (Marco Solieri) is working on his PhD thesis with joint supervision (Martini, Guerrini).
- Institut de Mathématiques de Luminy, Marseille (on lambda-calculi, linear logic and semantics). Contact person(s) in Focus: Dal Lago, Martini. One joint PhD supervision (Michele Alberti).
- Team PPS, University of Paris-Diderot Paris 7 (on logics for processes, resource control). Contact person(s) in Focus: Dal Lago, Gaboardi, Martini, Sangiorgi. Some short visits in both directions during the year.
- IRILL Lab, Paris (on models for the representation of dependencies in distributed package based software distributions). Contact person(s) in Focus: Lascu, Mauro, Zavattaro. Some short visits in both directions during the year.
- EPI Carte, Inria-Nancy Grand Est and LORIA (on implicit computational complexity). Contact person(s) in Focus: Dal Lago, Gaboardi. Some visits during 2013.
- LMU Munich (M. Hofmann) (on Implicit computational complexity and IntML). Contact person(s) in Focus: Dal Lago.

- IMDEA Software, Madrid (G. Barthe) (on Implicit computational complexity for cryptography). Contact person(s) in Focus: Dal Lago. Some visits during 2003.
- Facultad de Informatica, Universidad Complutense de Madrid (on web services). Contact person(s) in Focus: Bravetti. Bravetti is an external collaborator in the project “ESTuDIo: ESpecificacion y Testing de sistemas altamente DIstribuidos” (Specification and Testing of Highly Distributed Systems) January 1, 2013 - December 31, 2015 (3 years). Funded by the Spanish Ministerio de Economia y Competitividad

7.3. International Initiatives

7.3.1. Inria International Partners

7.3.1.1. Informal International Partners

- Department of Computer and Information Science, University of Pennsylvania. There has been several collaborations in the past. Presently M. Gaboardi is a long-term visiting researcher in the programming language group, working on resource control and programming languages.

7.4. International Research Visitors

7.4.1. Visits of International Scientists

Among the visits below, we note the sabbatical year of Xian Xu, from East China University of Science and Technology, Shanghai (paid a scholarship from the Chinese Science Foundation).

- Xian Xu has completed in May a year sabbatical in Focus. He is lecturer at the East China University of Science and Technology in Shanghai.
- Marco Bernardo, Universita' Urbino. A couple of 2 or 3 day visits during the year. Topic: probabilistic process models.
- Simon Gay, University Glasgow. A 1-month visit, March-April. Topic: session types.
- Andrei Dorman, Paris 13. One 3-day visit in May. Topic: Concurrent Interaction Nets and Graph Rewriting
- Patrick Baillot, ENS Lyon, and Gilles Barthe, IMDEA Madrid. One joint 4-day visit in May. Topic: Security and Cryptography
- Matthew Hennessy, University College Dublin. One 3-day visit in June. Topic: probabilistic bisimulations.
- Ramyaa Ramyaa, LMU Munich. One 1-week visit in June.
- Lionel Vaux and Emmanuel Beffara, Marseille. One 3-day visit in October. Topic: Linear Logic.
- Ludovic Henrio, Inria Sophia Antipolis. One 2-day visit in December. Topic: deadlock-analysis and asynchronous object-oriented languages.
- Stefano Zacchiroli, from Paris 7, has visited us various times for a few days during the year.

7.4.2. Visits to International Teams

We only report visits that were longer than 1 month.

- Roberto Amadini: 6 months at the Optimisation Research Group of NICTA in Melbourne (<http://optimisation.nicta.com.au/>).
- Ornela Dardha: 1 year (1 November 2012 - 1 November 2013) at IT University of Copenhagen, Denmark, visiting Prof. Marco Carbone (topic: type systems for processes)
- Giulio Pellitta: 6 months at Laboratoire d'Informatique, Université Paris Nord (November 2012 - May 2013). Topic: abstract machines for resource control in the λ -calculus.
- Tudor Alexandru Lascu: 3 months at Paris 7 (PPS team). Topic: cloud computing.

FUN Project-Team

7. Partnerships and Cooperations

7.1. Regional Initiatives

7.1.1. Tracaverre

Participants: Nathalie Mitton [correspondant], Gabriele Sabatino.

Title: Tracaverre

Type: FUI

Duration: November 2012 - Avril 2015

Coordinator: Saver Glass

Others partners: Inria FUN IEMN Courbon Camus La Grande Marque LIRIS DISP

Abstract: Tracaverre studies the use of RFID for traceability of prestigious bottles.

7.2. National Initiatives

7.2.1. ANR

7.2.1.1. RESCUE

Participants: Milan Erdelj, Nathalie Mitton, Kalypso Magklara, Karen Miranda, Tahiry Razafindralambo [correspondant].

Title: Reseau Coordonne de substitution mobile

Type: VERSO

Duration: December 2010 - April 2004

Coordinator: Inria FUN

Other partners: LAAS UPMC France Telecom ENS Lyon

See also: <http://rescue.lille.inria.fr/>

Abstract: In RESCUE, we propose to exploit the controlled mobility of mobile routers to help a base network in trouble provides a better service. The base network may be any access network or metropolitan network (including wired and wireless technologies). Troubles may come from an increase of unplanned traffic, a failure of an equipment, or a power outage.

When no backup networks are available, it would be interesting to deploy, for a limited time corresponding to the period of the problem (i.e., failure or traffic overload), a substitution network to help the base network keep providing services to users. In the RESCUE project, we will investigate both the underlying mechanisms and the deployment of a substitution network composed of a fleet of dirigible wireless mobile routers. Unlike many projects and other scientific works that consider mobility as a drawback, in RESCUE we use the controlled mobility of the substitution network to help the base network reduce contention or to create an alternative network in case of failure.

7.2.1.2. F-Lab

Participants: Nathalie Mitton [correspondant], Tahiry Razafindralambo.

Title: Federating Computing Resources

Type: VERSO

Duration: November 2010 - March 2014

Coordinator: UPMC

Other partners: Inria DIANA, DANTE, FUN Thales ALU

See also: <http://f-lab.fr/>

Abstract: The F-Lab project works towards enabling an open, general-purpose and sustainable large-scale shared experimental facility that fosters the emergence of the Future Internet. F-Lab builds on a leading prototype for such a facility: the OneLab federation of testbeds. F-Lab will enhance the OneLab federation model with the addition of SensLAB's unique sensor network and LTE-based cellular systems, and develop tools to conduct experiments on these enriched facilities. Project partners include some of French top academic and industrial research institutions, working together to develop experimental facilities on the Future Internet. F-Lab presents a unique opportunity for the French community to play a stronger role in the design of federation systems; for the SensLAB testbed to reach an international visibility and use; and for the pioneering of testbeds based on LTE technology.

7.2.1.3. BinThatThinks

Participants: Tony Ducrocq, Nathalie Mitton [correspondant].

Title: BinThatThinks

Type: ECOTECH

Duration: November 2010 - November 2013

Coordinator: Inria ACES (Rennes)

Other partners: Etineo Veolia

See also: <http://binthatthink.inria.fr/>

Abstract: Efficient dust sorting is a main challenge for the current society. BinThatThinks is a research project that aims to propose a system that makes the collect and sorting easier through the use of RFID and sensors.

7.2.2. ADT

7.2.2.1. SenSas

Participants: Nathalie Mitton [correspondant], Tahiry Razafindralambo, Julien Vandaele.

Title: Sensor Network Applications (SensAS)

Type: ADT

Duration: November 2010 - November 2014

Coordinator: Inria DANTE

Others partners: Inria Non-A Inria DIANA Inria NECS Inria DEMAR Inria MADYNES Inria AMAZONE Inria SED

See also: <http://sensas.gforge.inria.fr/>

Abstract: Sensas aims to propose mainly control science application based on wireless sensor and actuator network nodes provided from the work done around senslab and senstools projects.

7.2.2.2. *SensLille*

Participants: Khalil Hammami, Nathalie Mitton [correspondant], Julien Vandaele.

Title: SensLille

Type: ADT

Duration: November 2011 - November 2013

Coordinator: Inria FUN

Abstract: SensLille is an ADT that aims to improve SensLab Lille platform by offering new functionalities as the use of electric trains to experiment mobile nodes.

7.2.2.3. *MiAOU*

Participants: Ibrahim Amadou, Rim Driss, Nathalie Mitton [correspondant], Loic Schmidt, Julien Vandaele.

Title: Middleware Application to Optimal Use (MiAOU)

Type: ADT

Duration: December 2012 - November 2014

Coordinator: Inria FUN

Abstract: Miaou is an ADT that aims to promote the AspireRFID middleware to a new level of manageability and usability.

7.2.3. *Equipements d'Excellence*

7.2.3.1. *FIT*

Participants: Nathalie Mitton [correspondant], Anne-Sophie Tonneau, Tahiry Razafindralambo, Loic Schmidt, David Simplot-Ryl, Julien Vandaele, Roberto Quilez.

Title: Future Internet of Things

Type: EquipEx

Duration: March 2010 - December 2019

Coordinator: UPMC

See also: <http://fit-equipex.fr/>

Abstract: FIT (Future Internet of Things) aims to develop an experimental facility, a federated and competitive infrastructure with international visibility and a broad panel of customers. It will provide this facility with a set of complementary components that enable experimentation on innovative services for academic and industrial users. The project will give French Internet stakeholders a means to experiment on mobile wireless communications at the network and application layers thereby accelerating the design of advanced networking technologies for the Future Internet.

FIT is one of 52 winning projects from the first wave of the French Ministry of Higher Education and Research's "Equipements d'Excellence" (Equipex) research grant program. Coordinated by Professor Serge Fdida of UPMC Sorbonne Universités and running over a nine-year period, the project will benefit from a 5.8 million euro grant from the French government.

7.3. European Initiatives

7.3.1. FP7 Projects

7.3.1.1. VITAL

Participants: Nathalie Mitton [correspondant], Riccardo Petrolo, Valeria Loscri.

Title: Virtualized programmable InTerfAces for smart, secure and cost-effective IoT depLoYments in smart cities

Type: FP7 Smart Cities

Duration: September 2013 - August 2016

Coordinator: National University of Ireland (NUIG), Digital Enterprise Research Institute (DERI)

See also: <http://vital-iot.com/>

Abstract: Internet-of-Things (IoT) applications are currently based on multiple architectures, standards and platforms, which have led to a highly fragmented IoT landscape. This fragmentation is evident in the area of smart cities, which typically comprise several technological silos (i.e. IoT systems that have been developed and deployed independently). Nowadays there is a pressing need to remove these silos in order to allow cities to share data across systems and coordinate processes across domains, thereby essentially improving sustainability and quality of life. In response to this need, VITAL will realize a radical shift in the development, deployment and operation of IoT applications, through introducing an abstract virtualized digital layer that will operate across multiple IoT architectures, platforms and business contexts. Specifically, VITAL will provide platform and business context agnostic access to Internet-Connected-Objects (ICO). Moreover, it will research virtualized filtering, complex event processing (CEP) and business process management mechanisms, which will be operational over a variety of IoT architectures/ecosystems. The mechanisms will compromise the diverse characteristics of the underlying ecosystems, thereby boosting interoperability at the technical and business levels. VITAL will also provide development and governance tools, which will leverage the project's interfaces for virtualized access to ICOs. VITAL will allow solution providers to (re)use a wider range of data streams, thereby increasing the scope of potential applications. It will also enable a more connected/integrated approach to smart city applications development, which will be validated in realistic deployments in London and Istanbul. The partners will contribute and adapt a host of readily available urban infrastructures, IoT platforms and novel IoT applications, which will ease the accomplishment of the project's goals based on an optimal value for EC money.

7.3.2. Collaborations in European Programs, except FP7

Program: CoperLink

Project acronym: Palmares

Project title: Palmares

Duration: January 2012 - July 2013

Coordinator: Universita degli Studi Mediterranea, Italy

Other partners: Inria, Stellenbosch University (South Africa)

Abstract: Internet of things, VANET and substitution networks.

7.4. International Initiatives

7.4.1. Inria International Partners

7.4.1.1. Declared Inria International Partners

Currently, the FUN team has two possible International Partners awaiting for approval: Universita mediterranea di Reggio Calabria (UNIC) in Italy and Southern University in China. See next section for details.

7.4.1.2. Informal International Partners

Universita mediterranea di Reggio Calabria (UNIC), Italy

Objective of this collaboration is the design of an innovative architecture that enables autonomic and decentralized fruition of the services offered by the network of smart objects in many heterogeneous and dynamic environments, in a way that is independent of the network topology, reliable and flexible. The result is an 'ecosystem' of objects, self-organized and self-sustained, capable of making data and services available to the users wherever and whenever required, thus supporting the fruition of an 'augmented' reality thanks to a new environmental and social awareness. This collaboration gave birth to the PALMARES project (see section International programs), students and researchers exchanges (see section international visits) and joint publications, among them for 2013: [16].

Southern University, China

The purpose of this collaboration is to study the green (or energy-efficient) communication problem in vehicular ad hoc networks (VANETs) and the application of vehicular network communication in green transportation. It gave birth to joint project submission, joint conference organization and several publications, among them for 2013: [34], [36], [38], [13], [26].

PhD co-supervision with Sfax University

Since January 2013, Nathalie Mitton co-supervises Mouna Rekik as a PhD student with Pr Zied Chtourou from Université de Sfax, Tunisia. Her topic is about swarm intelligence based multi-path geographic routing for wireless sensor and actuator networks.

7.4.2. Inria International Labs

7.4.2.1. PREDNET

Participants: Nathalie Mitton [correspondant], Milan Erdelj, Julien Vandaele, Cesar Marchal, Isabelle Simplot-Ryl.

Title: Predator network

Type: LIRIMA

Duration: January 2013 - December 2016

See also: <https://iww.inria.fr/prednet/en/>

Abstract: PREDNET (PREDator adhoc NETwork) proposes to do research on the most suitable topology and subsequent deployment of a wireless sensor network for sparsely populated outlying rural and wilderness areas, for effective monitoring and protection of resources and ecosystems.

This collaboration gave birth to joint project submission, joint conference organization and several publications, among them for 2013: [31]

7.4.2.2. CIRIC Chile

Participant: Tahiry Razafindralambo.

Tahiry Razafindralambo is in leave at Inria Chile since August 2013. Tahiry's project within Inria Chile is linked to a project developed by NIC research Labs - Chile (Dr. Javier Bustos, Ms. Carolina Sandoval, Mr. Felipe Lema and Ms. Karina Ventura) regarding Quality of Experience, the Universidad de Chile (Pr. Nelson Baloian and Pr. Gustavo Zurita Alarcon) regarding data display, Psicomédica regarding the clinical aspect regarding the wireless sensor networks aspect. The proposed project tries to evaluate the user perception regarding a wearable monitoring system. The Wearable monitoring system will be installed on patients with mental diseases to monitor their body temperatures, heart rate, ...

GANG Project-Team

7. Partnerships and Cooperations

7.1. National Initiatives

7.1.1. ANR Prose

Participants: Pierre Fraigniaud, Amos Korman, Laurent Viennot.

Managed by University Paris Diderot, P. Fraigniaud.

Online social networks are among the most popular sites on the Web and continue to grow rapidly. They provide mechanisms to establish identities, share content and information, and create relationships. With the emergence of a new generation of powerful mobile devices that enable wireless ad hoc communication, it is time to extend social networking to the mobile world. Such an ad hoc social networking environment is full of opportunities. As opposed to the use of personal computers, a mobile phone is a strictly personal device, always on, with several wireless interfaces that include a short range communication with nearby nodes. Applications such as notification of status updates, sharing of user generated content, documents tagging, rating/recommendation and bookkeeping can be deployed “on the move” on top of contacts established through short range communication. It requires to deploy social networking applications in a delay tolerant manner using opportunistic social contacts as in a peer to peer network, as well as new advanced content recommendation engines.

The Prose project is a collective and multi-disciplinary effort to design opportunistic contact sharing schemes, and characterizes the environmental conditions, the usage constraint, as well as the algorithmic and architecture principles that let them operate. The partners of the Prose project will engage in this exploration through various expertise: network measurement, traffic monitoring from a real application, system design, behavioral study, analysis of distributed algorithms, theory of dynamic graph, networking modeling, and performance evaluation. As part of this project, the partners will be involved in the analysis of the content received and accessed by users of a real commercial application (PlayAdz), and will participate to the design of a new promotion advertisement service.

7.1.2. ANR Displexity

Participants: Carole Delporte-Gallet, Hugues Fauconnier, Pierre Fraigniaud, Arfoui Heger, Amos Korman, Hung Tran-The, Laurent Viennot.

Managed by University Paris Diderot, C. Delporte and H. Fauconnier lead this project that grants 1 Ph. D.

Distributed computation keep raising new questions concerning computability and complexity. For instance, as far as fault-tolerant distributed computing is concerned, impossibility results do not depend on the computational power of the processes, demonstrating a form of undecidability which is significantly different from the one encountered in sequential computing. In the same way, as far as network computing is concerned, the impossibility of solving certain tasks locally does not depend on the computational power of the individual processes.

The main goal of DISPLEXITY (for DIStributed computing: computability and COMPLEXITY) is to establish the scientific foundations for building up a consistent theory of computability and complexity for distributed computing.

One difficulty to be faced by DISPLEXITY is to reconcile the different sub-communities corresponding to a variety of classes of distributed computing models. The current distributed computing community may indeed be viewed as two not necessarily disjoint sub-communities, one focusing on the impact of temporal issues, while the other focusing on the impact of spatial issues. The different working frameworks tackled by these two communities induce different objectives: computability is the main concern of the former, while complexity is the main concern of the latter.

Within DISPLEXITY, the reconciliation between the two communities will be achieved by focusing on the same class of problems, those for which the distributed outputs are interpreted as a single binary output: yes or no. Those are known as the yes/no-problems. The strength of DISPLEXITY is to gather specialists of the two main streams of distributed computing. Hence, DISPLEXITY will take advantage of the experience gained over the last decade by both communities concerning the challenges to be faced when building up a complexity theory encompassing more than a fragment of the field.

In order to reach its objectives, DISPLEXITY aims at achieving the following tasks:

- Formalizing yes/no-problems (decision problems) in the context of distributed computing. Such problems are expected to play an analogous role in the field of distributed computing as that played by decision problems in the context of sequential computing.
- Formalizing decision problems (yes/no-problems) in the context of distributed computing. Such problems are expected to play an analogous role in the field of distributed computing as that played by decision problems in the context of sequential computing.
- Revisiting the various explicit (e.g., failure-detectors) or implicit (e.g., a priori information) notions of oracles used in the context of distributed computing allowing us to express them in terms of decidability/complexity classes based on oracles.
- Identifying the impact of non-determinism on complexity in distributed computing. In particular, DISPLEXITY aims at a better understanding of the apparent lack of impact of non-determinism in the context of fault-tolerant computing, to be contrasted with the apparent huge impact of non-determinism in the context of network computing. Also, it is foreseen that non-determinism will enable the comparison of complexity classes defined in the context of fault-tolerance with complexity classes defined in the context of network computing.
- Last but not least, DISPLEXITY will focus on new computational paradigms and frameworks, including, but not limited to distributed quantum computing and algorithmic game theory (e.g., network formation games).

The project will have to face and solve a number of challenging problems. Hence, we have built the DISPLEXITY consortium so as to coordinate the efforts of those worldwide leaders in Distributed Computing who are working in our country. A successful execution of the project will result in a tremendous increase in the current knowledge and understanding of decentralized computing and place us in a unique position in the field.

7.1.3. Alcatel-Lucent Bell Labs and Inria Joint Research Lab

Participants: The-Dang Huynh, Leonardo Linguaglossa, Fabien Mathieu, Laurent Viennot.

Gang is participating to the joint laboratory between Alcatel-Lucent and Inria and contributes mainly in the ADR (joint research action) on content centric networking.

7.1.4. Laboratory of Information, Networking and Communication Sciences (LINCS)

Participants: The-Dang Huynh, Leonardo Linguaglossa, Fabien Mathieu, Laurent Viennot.

Gang is participating to the LINCS, a research centre co-founded by Inria, Institut Mines-Télécom, UPMC and Alcatel-Lucent Bell Labs, dedicated to research and innovation in the domains of future information and communication networks, systems and services. Most of the collaboration with Alcatel-Lucent is carried through this structure.

7.2. European Initiatives

7.2.1. FP7 Projects

7.2.1.1. EULER

Title: EULER (Experimental UpdateLess Evolutive Routing)

Type: COOPERATION (ICT)

Defi: Future Internet Experimental Facility and Experimentally-driven Research

Instrument: Specific Targeted Research Project (STREP)

Duration: October 2010 - September 2013

Coordinator: ALCATEL-LUCENT (Belgium)

Others partners:

Alcatel-Lucent Bell, Antwerpen, Belgium

3 projects from Inria: CEPAGE, GANG and MASCOTTE, France

Interdisciplinary Institute for Broadband Technology (IBBT), Belgium

Laboratoire d'Informatique de Paris 6 (LIP6), Université Pierre Marie Curie (UPMC), France

Department of Mathematical Engineering (INMA) Université Catholique de Louvain, Belgium

RACTI, Research Academic Computer Technology Institute University of Patras, Greece

CAT, Catalan Consortium: Universitat Politècnica de Catalunya, Barcelona and University of Girona, Spain

See also: <http://www-sop.inria.fr/mascotte/EULER/wiki/>

Abstract: The title of this study is "Dynamic Compact Routing Scheme". The aim of this projet is to develop new routing schemes achieving better performances than current BGP protocols. The problems faced by the inter-domain routing protocol of the Internet are numerous:

The underlying network is dynamic: many observations of bad configurations show the instability of BGP;

BGP does not scale well: the convergence time toward a legal configuration is too long, the size of routing tables is proportional to the number of nodes of network (the network size is multiplied by 1.25 each year);

The impact of the policies is so important that the many packets can oscillated between two Autonomous Systems.

Description: In this collaboration, we mainly investigate new routing paradigms so as to design, develop, and validate experimentally a distributed and dynamic routing scheme suitable for the future Internet and its evolution. The resulting routing scheme(s) is/are intended to address the fundamental limits of current stretch-1 shortest-path routing in terms of routing table scalability but also topology and policy dynamics (perform efficiently under dynamic network conditions). Therefore, this project will investigate trade-offs between routing table size (to enhance scalability), routing scheme stretch (to ensure routing quality) and communication cost (to efficiently and timely react to various failures). The driving idea of this research project is to make use of the structural and statistical properties of the Internet topology (some of which are hidden) as well as the stability and convergence properties of the Internet policy in order to specialize the design of a distributed routing scheme known to perform efficiently under dynamic network and policy conditions when these properties are met. The project will develop new models and tools to exhaustively analyse the Internet topology, to accurately and reliably measure its properties, and to precisely characterize its evolution. These models, that will better reflect the network and its policy dynamics, will be used to derive useful properties and metrics for the routing schemes and provide relevant experimental scenarios. The project will develop appropriate tools to evaluate the performance of the proposed routing schemes on large-scale topologies (order of 10k nodes). Prototype of the routing protocols as well as their functional validation and performance benchmarking on the iLAB experimental facility and/or virtual experimental facilities such as PlanetLab/OneLab will allow validating under realistic conditions the overall behaviour of the proposed routing schemes.

7.3. International Initiatives

7.3.1. *Internet Technologies and Architectures*

Participant: Fabien Mathieu.

The aim of this project is to build a community of researchers focusing on fundamental theoretical issues of future networking, including such topics as communication theory, network information theory, distributed algorithms, self-organization and game theory, modeling of large random and complex networks and structures. Partners Inria, VTT, Aalto University, Eindhoven University are gathered under EIT ICT Labs Project Fundamentals of Networking (FUN).

7.3.2. *Inria International Partners*

7.3.2.1. *Informal International Partners*

Participants: Carole Delporte, Hugues Fauconnier.

- distributed computing and synchronization: regular visits by Sam Toueg (Toronto), Rachid Guerraoui (EPFL) and Luis Rodriguez (U. Lisboa).
- consensus agreement: Last year we have shown that $(n - 1)$ -set consensus can be solved obstruction-free with 2 MWMR registers and this bound is tight. We have tried to generalize this result to the $(n - k)$ -set consensus with $k + 1$ registers; our regular cooperation with Eli Gafni (UCLA) is still ongoing.

GRAND-LARGE Project-Team

6. Partnerships and Cooperations

6.1. Regional Initiatives

- **CALIFHA project (DIM Digiteo 2011):** CALculations of Incompressible Fluid flows on Heterogeneous Architectures. Funding for a PhD student. Collaboration with LIMSI/CNRS. Participants: Marc Baboulin (Principal Investigator), Joel Falcou, Yann Fraigneau (LIMSI), Laura Grigori, Olivier Le Maître (LIMSI), Laurent Martin Witkowski (LIMSI)

6.2. National Initiatives

6.2.1. ANR

- **ANR SPADES** Coordinated by LIP-ENS Lyon. (Sylvain Peyronnet, Franck Cappello, Ala Rezmerita)
- **ANR Cosinus project PetaQCD - Towards PetaFlops for Lattice Quantum ChromoDynamics** (2009-2012) Collaboration with Lal (Orsay), Irista Rennes (Caps/Alf), IRFU (CEA Saclay), LPT (Orsay), Caps Entreprise (Rennes), Kerlabs (Rennes), LPSC (Grenoble). About the design of architecture, software tools and algorithms for Lattice Quantum Chromodynamics. (Cédric Bastoul, Christine Eisenbeis, Michael Kruse)

6.3. European Initiatives

6.3.1. Collaborations in European Programs, except FP7

Program: ITEA

Project acronym: MANY

Project title: Many-core Programming and Resource Management for High-Performance Embedded Systems

Duration: 09/2011 - 08/2014

Coordinator: XDIN

Other partners: France: Thales Communications and Security, CAPS Entreprise, Telecom SudParis; Spain: UAB; Sweden: XDIN; Korea: ETRI, TestMidas, SevenCore; Netherlands: Vector Fabrics, ST-Ericsson, TU Eindhoven; Belgium: UMONS.

Abstract: Adapting Industry for the for the disruptive landing of many-core processors in Embedded Systems in order to provide scalable, reusable and very fast software development.

6.4. International Initiatives

6.4.1. Inria International Labs

- Franck Cappello, Co-Director of the **Inria - Illinois Joint Laboratory** on PetaScale Computing, since 2009

6.4.2. Participation In other International Programs

Stic AmSud: BioCloud-EEAmSud **Participants:** Christine Eisenbeis, Alessandro Ferreira Leite, Claude Tadonki.

BioCloud-EEAmSud is a cooperation project integrated by Brazil, Chile and France following the 2012 STIC-AmSud call. Partners in Brazil are Universidade de Brasilia, Universidade Federal Fluminense, and EMBRAPA-Genetic Resources and Biotechnology (CENARGEN), through the support of the Coordination of Improvement of Senior Staff of the Ministry of Education in Brazil (CAPES). In Chile, the main partner is Universidad de Santiago de Chile, through the support of the National Commission for Scientific and Technological Research of Chile (CONICYT). In France, the institutions involved are Mines ParisTech (CRI) and Inria-Saclay, through the support of the Ministry of Foreign and European Affairs (MAEE). The international project coordinator is Pr. Maria Emília Machado Telles Walter (UnB). Alessandro Ferreira Leite' thesis work is a joint University of Brasilia - université Paris-Sud 11 thesis and is partially supported by BioCloud-EEAmSud. Maria Emilia Machado Telles Walter and Alba Cristian de Melo visited Grand-Large in 2013, as well as Taina Rajol.

6.5. International Research Visitors

6.5.1. Internships

German Schinca

Subject: Minimizing communication in scientific computing

Date: from Sep 2012 until Mar 2013

Institution: University of Buenos Aires (Argentina)

HIEPACS Project-Team

8. Partnerships and Cooperations

8.1. Regional Initiatives

8.1.1. *PlaFRIM: an experimental parallel computing platform*

PlaFRIM is an experimental platform for research in modeling, simulations and high performance computing. This platform has been set up from 2009 under the leadership of Inria Bordeaux Sud-Ouest in collaboration with computer science and mathematics laboratories, respectively Labri and IMB with a strong support in the region Aquitaine.

It aggregates different kinds of computational resources for research and development purposes. The latest technologies in terms of processors, memories and architecture are added when they are available on the market. It is now more than 1,000 cores (excluding GPU and Xeon Phi) that are available for all research teams of Inria Bordeaux, Labri and IMB. This computer is in particular used by all the engineers who work in HiePACS and are advised by F. Rue from the SED.

The PlaFRIM platform initiative is coordinated by O. Coulaud and an application for its upgrade has been accepted.

8.1.2. *Innovative simulation methods for large scale numeric prototypes on emerging architectures computers*

Participants: Emmanuel Agullo, Olivier Coulaud, Aurélien Esnard, Mathieu Faverge, Luc Giraud, Abdou Guermouche, Pierre Ramet, Jean Roman.

Grant: Regional council

Dates: 2013 – 2015

Partners: EPIs **REALOPT**, **RUNTIME** from Inria Bordeaux Sud-Ouest, CEA-CESTA and l'Institut pluridisciplinaire de recherche sur l'environnement et les matériaux (IPREM) .

Overview: Numerical simulation is now integrated into all the design levels and the scientific studies for both academic and industrial contexts. Given the increasing size and sophistication of the simulations carried out, the use of parallel computing is inescapable. The complexity of such achievements requires collaboration of multidisciplinary teams capable of mastering all the necessary scientific skills for each component constituting the chain of expertise. In this project we consider each of these elements as well as efficient methods for parallel codes coupling. All these works is intended to contribute to the design large scale parallel multi-physics simulations. In addition to this research human activities the regional council also support some innovative computing equipment that will be embedded in the PlaFRIM experimental platform, project led by Olivier Coulaud.

8.2. National Initiatives

8.2.1. Inria Project Lab

8.2.1.1. C2S@Exa - Computer and Computational Sciences at Exascale

Since January 2013, the team is participating to the **C2S@EXA** Inria Project Lab (IPL). This national initiative aims at the development of numerical modeling methodologies that fully exploit the processing capabilities of modern massively parallel architectures in the context of a number of selected applications related to important scientific and technological challenges for the quality and the security of life in our society. At the current state of the art in technologies and methodologies, a multidisciplinary approach is required to overcome the challenges raised by the development of highly scalable numerical simulation software that can exploit computing platforms offering several hundreds of thousands of cores. Hence, the main objective of **C2S@EXA** is the establishment of a continuum of expertise in the computer science and numerical mathematics domains, by gathering researchers from Inria project-teams whose research and development activities are tightly linked to high performance computing issues in these domains. More precisely, this collaborative effort involves computer scientists that are experts of programming models, environments and tools for harnessing massively parallel systems, algorithmists that propose algorithms and contribute to generic libraries and core solvers in order to take benefit from all the parallelism levels with the main goal of optimal scaling on very large numbers of computing entities and, numerical mathematicians that are studying numerical schemes and scalable solvers for systems of partial differential equations in view of the simulation of very large-scale problems.

8.2.2. ANR

8.2.2.1. SOLHAR: SOLvers for Heterogeneous Architectures over Runtime systems

Participants: Emmanuel Agullo, Mathieu Faverge, Andra Hugo, Abdou Guermouche, Xavier Lacoste, Pierre Ramet, Jean Roman, Guillaume Sylvand.

Grant: ANR-MONU

Dates: 2013 – 2017

Partners: Inria (**REALOPT**, **RUNTIME** Bordeaux Sud-Ouest et **ROMA** Rhone-Alpes), IRIT/INPT, CEA-CESTA et EADS-IW.

Overview:

During the last five years, the interest of the scientific computing community towards accelerating devices has been rapidly growing. The reason for this interest lies in the massive computational power delivered by these devices. Several software libraries for dense linear algebra have been produced; the related algorithms are extremely rich in computation and exhibit a very regular pattern of access to data which makes them extremely good candidates for GPU execution. On the contrary, methods for the direct solution of sparse linear systems have irregular, indirect memory access patterns that adversely interact with typical GPU throughput optimizations.

This project aims at studying and designing algorithms and parallel programming models for implementing direct methods for the solution of sparse linear systems on emerging computer equipped with accelerators. The ultimate aim of this project is to achieve the implementation of a software package providing a solver based on direct methods for sparse linear systems of equations. To date, the approaches proposed to achieve this objective are mostly based on a simple offloading of some computational tasks to the accelerators and rely on fine hand-tuning of the code and accurate performance modeling to achieve efficiency. This project proposes an innovative approach which relies on the efficiency and portability of runtime systems. The development of a production-quality, sparse direct solver requires a considerable research effort along three distinct axis:

- linear algebra: algorithms have to be adapted or redesigned in order to exhibit properties that make their implementation and execution on heterogeneous computing platforms efficient and reliable. This may require the development of novel methods for defining data access patterns that are more suitable for the dynamic scheduling of computational tasks on processing units with considerably different capabilities as well as techniques for guaranteeing a reliable and robust behavior and accurate solutions. In addition, it will be necessary to develop novel and efficient accelerator

implementations of the specific dense linear algebra kernels that are used within sparse, direct solvers;

- runtime systems: tools such as the **StarPU** runtime system proved to be extremely efficient and robust for the implementation of dense linear algebra algorithms. Sparse linear algebra algorithms, however, are commonly characterized by complicated data access patterns, computational tasks with extremely variable granularity and complex dependencies. Therefore, a substantial research effort is necessary to design and implement features as well as interfaces to comply with the needs formalized by the research activity on direct methods;
- scheduling: executing a heterogeneous workload with complex dependencies on a heterogeneous architecture is a very challenging problem that demands the development of effective scheduling algorithms. These will be confronted with possibly limited views of dependencies among tasks and multiple, and potentially conflicting objectives, such as minimizing the makespan, maximizing the locality of data or, where it applies, minimizing the memory consumption.

Given the wide availability of computing platforms equipped with accelerators and the numerical robustness of direct solution methods for sparse linear systems, it is reasonable to expect that the outcome of this project will have a considerable impact on both academic and industrial scientific computing. This project will moreover provide a substantial contribution to the computational science and high-performance computing communities, as it will deliver an unprecedented example of a complex numerical code whose parallelization completely relies on runtime scheduling systems and which is, therefore, extremely portable, maintainable and evolvable towards future computing architectures.

8.2.2.2. *SONGS: Simulation Of Next Generation Systems*

Participant: Abdou Guermouche.

Grant: ANR 11 INFRA 13

Dates: 2011 – 2015

Partners: Inria (Bordeaux Sud-Ouest, Nancy - Grand Est, Rhone-Alpes, Sophia Antipolis - Méditerranée), I3S, LSIIT

Overview:

The last decade has brought tremendous changes to the characteristics of large scale distributed computing platforms. Large grids processing terabytes of information a day and the peer-to-peer technology have become common even though understanding how to efficiently such platforms still raises many challenges. As demonstrated by the USS SimGrid project funded by the ANR in 2008, simulation has proved to be a very effective approach for studying such platforms. Although even more challenging, we think the issues raised by petaflop/exaflop computers and emerging cloud infrastructures can be addressed using similar simulation methodology.

The goal of the **SONGS** project is to extend the applicability of the SimGrid simulation framework from Grids and Peer-to-Peer systems to Clouds and High Performance Computation systems. Each type of large-scale computing system will be addressed through a set of use cases and lead by researchers recognized as experts in this area.

Any sound study of such systems through simulations relies on the following pillars of simulation methodology: Efficient simulation kernel; Sound and validated models; Simulation analysis tools; Campaign simulation management.

8.2.2.3. *ANEMOS: Advanced Numeric for ELMs : Modeling and Optimized Schemes*

Participants: Xavier Lacoste, Guillaume Latu, Pierre Ramet.

Grant: ANR-MN

Dates: 2012 – 2016

Partners: Univ. Nice, CEA/IRFM, CNRS/MDS.

Overview: The main goal of the project is to make a significant progress in understanding of largely unknown at present physics of active control methods of plasma edge MHD instabilities Edge Localized Modes (ELMs) which represent particular danger with respect to heat and particle loads for Plasma Facing Components (PFC) in ITER. Project is focused in particular on the numerical modelling study of such ELM control methods as Resonant Magnetic Perturbations (RMPs) and pellet ELM pacing both foreseen in ITER. The goals of the project are to improve understanding of the related physics and propose possible new strategies to improve effectiveness of ELM control techniques. The tool for the non-linear MHD modeling is the **JOREK** code which was essentially developed within previous ANR **ASTER**. **JOREK** will be largely developed within the present project to include corresponding new physical models in conjunction with new developments in mathematics and computer science strategy. The present project will put the non-linear MHD modeling of ELMs and ELM control on the solid ground theoretically, computationally, and applications-wise in order to progress in urgently needed solutions for ITER.

Regarding our contributions, the **JOREK** code is mainly composed of numerical computations on 3D data. The toroidal dimension of the tokamak is treated in Fourier space, while the poloidal plane is decomposed in Bezier patches. The numerical scheme used involves a direct solver on a large sparse matrix as a main computation of one time step. Two main costs are clearly identified: the assembly of the sparse matrix, and the direct factorization and solve of the system that includes communications between all processors. The efficient parallelization of **JOREK** is one of our main goals, to do so we will reconsider: data distribution, computation distribution or GMRES implementation. The quality of the sparse solver is also crucial, both in term of performance and accuracy. In the current release of **JOREK**, the memory scaling is not satisfactory to solve problems listed above, since at present as one increases the number of processes for a given problem size, the memory footprint on each process does not reduce as much as one can expect. In order to access finer meshes on available supercomputers, memory savings have to be done in the whole code. Another key point for improving parallelization is to carefully profile the application to understand the regions of the code that do not scale well. Depending on the timings obtained, strategies to diminish communication overheads will be evaluated and schemes that improve load balancing will be initiated. **JOREK** uses **PaStiX** sparse matrix library for matrix inversion. However, large number of toroidal harmonics and particular thin structures to resolve for realistic plasma parameters and ITER machine size still require more aggressive optimisation in numeric dealing with numerical stability, adaptive meshes etc. However many possible applications of **JOREK** code we proposed here which represent urgent ITER relevant issues related to ELM control by RMPs and pellets remain to be solved.

8.2.2.4. *OPTIDIS: OPTimisation d'un code de dynamique des DISlocations*

Participants: Olivier Coulaud, Aurélien Esnard, Arnaud Etcheverry, Luc Giraud.

Grant: ANR-COSINUS

Dates: 2010 – 2014

Partners: CEA/DEN/DMN/SRMA (leader), SIMaP Grenoble INP and ICMPE / Paris-Est.

Overview: Plastic deformation is mainly accommodated by dislocations glide in the case of crystalline materials. The behavior of a single dislocation segment is perfectly understood since 1960 and analytical formulations are available in the literature. However, to understand the behavior of a large population of dislocations (inducing complex dislocations interactions) and its effect on plastic deformation, massive numerical computation is necessary. Since 1990, simulation codes have been developed by French researchers. Among these codes, the code TRIDIS developed by the SIMAP laboratory in Grenoble is the pioneer dynamic dislocation code. In 2007, the project called NUMODIS had been set up as team collaboration between the SIMAP and the SRMA CEA Saclay in order to develop a new dynamics dislocation code using modern computer architecture and advanced numerical methods. The objective was to overcome the numerical and physical limits of the previous code TRIDIS. The version NUMODIS 1.0 came out in December 2009, which confirms the feasibility of the project. The project **OPTIDIS** is initiated when the code NUMODIS is mature enough to consider parallel computation. The objective of the project is to develop and validate the algorithms in order to optimize the numerical and performance efficiency of the NUMODIS code. We are aiming at developing a code able to tackle realistic material problems such as the interaction between dislocations and irradiation defects in a grain plastic deformation after irradiation. These kinds of studies

where “local mechanisms” are correlated with macroscopic behavior is a key issue for nuclear industry in order to understand material aging under irradiation, and hence predict power plant secured service life. To carry out such studies, massive numerical optimizations of NUMODIS are required. They involve complex algorithms lying on advanced computational science methods. The project **OPTIDIS** will develop through joint collaborative studies involving researchers specialized in dynamics dislocations and in numerical methods. This project is divided in 8 tasks over 4 years. Two PhD thesis will be directly funded by the project. One will be dedicated to numerical development, validation of complex algorithms and comparison with the performance of existing dynamics dislocation codes. The objective of the second is to carry out large scale simulations to validate the performance of the numerical developments made in **OPTIDIS**. In both cases, these simulations will be compared with experimental data obtained by experimentalists.

8.2.2.5. *RESCUE: Résilience des applications SCientifiques*

Participants: Emmanuel Agullo, Luc Giraud, Abdou Guermouche, Jean Roman, Mawussi Zounon.

Grant: ANR-Blanc (computer science theme)

Dates: 2010 – 2014

Partners: Inria EPI **ROMA** (leader) and GRAND LARGE.

Overview: The advent of exascale machines will help solve new scientific challenges only if the resilience of large scientific applications deployed on these machines can be guaranteed. With 10,000,000 core processors, or more, the time interval between two consecutive failures is anticipated to be smaller than the typical duration of a checkpoint, i.e., the time needed to save all necessary application and system data. No actual progress can then be expected for a large-scale parallel application. Current fault-tolerant techniques and tools can no longer be used. The main objective of the **RESCUE** project is to develop new algorithmic techniques and software tools to solve the exascale resilience problem. Solving this problem implies a departure from current approaches, and calls for yet-to-be-discovered algorithms, protocols and software tools.

This proposed research follows three main research thrusts. The first thrust deals with novel checkpoint protocols. This thrust will include the classification of relevant fault categories and the development of a software package for fault injection into application execution at runtime. The main research activity will be the design and development of scalable and light-weight checkpoint and migration protocols, with on-the-fly storing of key data, distributed but coordinated decisions, etc. These protocols will be validated via a prototype implementation integrated with the public-domain MPICH project. The second thrust entails the development of novel execution models, i.e., accurate stochastic models to predict (and, in turn, optimize) the expected performance (execution time or throughput) of large-scale parallel scientific applications. In the third thrust, we will develop novel parallel algorithms for scientific numerical kernels. We will profile a representative set of key large-scale applications to assess their resilience characteristics (e.g., identify specific patterns to reduce checkpoint overhead). We will also analyze execution trade-offs based on the replication of crucial kernels and on decentralized ABFT (Algorithm-Based Fault Tolerant) techniques. Finally, we will develop new numerical methods and robust algorithms that still converge in the presence of multiple failures. These algorithms will be implemented as part of a software prototype, which will be evaluated when confronted with realistic faults generated via our fault injection techniques.

We firmly believe that only the combination of these three thrusts (new checkpoint protocols, new execution models, and new parallel algorithms) can solve the exascale resilience problem. We hope to contribute to the solution of this critical problem by providing the community with new protocols, models and algorithms, as well as with a set of freely available public-domain software prototypes.

8.2.2.6. *BOOST: Building the future Of numerical methOdS for iTer*

Participants: Emmanuel Agullo, Luc Giraud, Abdou Guermouche, Jean Roman, Xavier Vasseur.

Grant: ANR-Blanc (applied math theme)

Dates: 2010 – 2014

Partners: Institut de Mathématiques de Toulouse (leader); Laboratoire d’Analyse, Topologie, Probabilités in Marseilles; Institut de Recherche sur la Fusion Magnétique, CEA/IRFM and **HIEPACS**.

Overview: This project regards the study and the development of a new class of numerical methods to simulate natural or laboratory plasmas and in particular magnetic fusion processes. In this context, we aim in giving a contribution, from the mathematical, physical and algorithmic point of view, to the ITER project.

The core of this project consists in the development, the analysis, the implementation and the testing on real physical problems of the so-called Asymptotic-Preserving methods which allow simulations over a large range of scales with the same model and numerical method. These methods represent a breakthrough with respect to the state-of-the art. They will be developed specifically to handle the various challenges related to the simulation of the ITER plasma. In parallel with this class of methodologies, we intend to design appropriate coupling techniques between macroscopic and microscopic models for all the cases in which a net distinction between different regimes can be done. This will permit to describe different regimes in different regions of the machine with a strong gain in term of computational efficiency, without losing accuracy in the description of the problem. We will develop full 3-D solver for the asymptotic preserving fluid as well as kinetic model. The Asymptotic-Preserving (AP) numerical strategy allows us to perform numerical simulations with very large time and mesh steps and leads to impressive computational saving. These advantages will be combined with the utilization of the last generation preconditioned fast linear solvers to produce a software with very high performance for plasma simulation. For **HIEPACS** this project provides in particular a testbed for our expertise in parallel solution of large linear systems.

8.3. European Initiatives

8.3.1. FP7 Projects

8.3.1.1. EXA2CT

Type: COOPERATION

Defi: Exascale computation

Instrument: Specific Targeted Research Project

Duration: September 2013 - August 2016

See also: <https://projects.imec.be/exa2ct/>.

Coordinator: Wilfried Verachtert, IMEC (Interuniversitair Micro-Electronica Centrum), Belgium

Partner: Universiteit Antwerpen, Belgium; Università della Svizzera italiana, Switzerland; Inria (**ALPINES**, **HIEPACS**, **SAGE** teams); Université de Versailles Saint-Quentin-en-Yvelines, France; T-Systems, Germany; Fraunhofer-Gesellschaft, Germany; Intel, France; NAG, UK.

Inria contact: Luc Giraud

Abstract: Numerical simulation is a crucial part of science and industry in Europe. The advancement of simulation as a discipline relies on increasingly compute intensive models that require more computational resources to run. This is the driver for the evolution to exascale. Due to limits in the increase in single processor performance, exascale machines will rely on massive parallelism on and off chip, with a complex hierarchy of resources. The large number of components and the machine complexity introduce severe problems for reliability and programmability. The former of these will require novel fault-aware algorithms and support software. In addition, the scale of the numerical models exacerbates the difficulties by making the use of more complex simulation algorithms necessary, for numerical stability reasons. A key example of this is increased reliance on linear solvers. Such solvers require global communication, which impacts scalability, and are often used with preconditioners, increasing complexity again. Unless there is a major rethink of the design of solver algorithms, components and software structure, a large class of important numerical simulations will not scale beyond petascale. This in turn will hold back the development of European science and industry that will not reap the benefits from exascale.

The **EXA2CT** project brings together experts at the cutting edge of the development of solvers, related algorithmic techniques, and HPC software architects for programming models and communication. It will take a revolutionary approach to exascale solvers and programming models, rather than

the incremental approach of other projects. We will produce modular open source proto-applications that demonstrate the algorithms and programming techniques developed in the project, to help bootstrap the creation of genuine exascale codes.

Inria is involved in that project through the IPL **C2S@ExA** initiative.

8.4. International Initiatives

8.4.1. Inria Associate Teams

8.4.1.1. MORSE

Title: Matrices Over Runtime Systems at Exascale

Inria principal investigator: Emmanuel Agullo

International Partner:

Institution: University of Tennessee Knoxville (United States)

Laboratory: Innovative Computing Lab

Researcher: George Bosilca

International Partner:

Institution: University of Colorado Denver (United States)

Laboratory: Department of Mathematics and Statistical Sciences

Researcher: Julien Langou

Duration: 2011 - 2013

See also: <http://icl.cs.utk.edu/projectsdev/morse>.

The goal of **MORSE** (Matrices Over Runtime Systems at Exascale) project is to design dense and sparse linear algebra methods that achieve the fastest possible time to an accurate solution on large-scale multicore systems with GPU accelerators, using all the processing power that future high end systems can make available. To develop software that will perform well on petascale and exascale systems with thousands of nodes and millions of cores, several daunting challenges have to be overcome, both by the numerical linear algebra and the runtime system communities. By designing a research framework for describing linear algebra algorithms at a high level of abstraction, the **MORSE** team will enable the strong collaboration between research groups in linear algebra and runtime systems needed to develop methods and libraries that fully benefit from the potential of future large-scale machines. Our project will take a pioneering step in the effort to bridge the immense software gap that has opened up in front of the High-Performance Computing (HPC) community.

8.4.1.2. FASTLA

Title: Fast and Scalable Hierarchical Algorithms for Computational Linear Algebra

Inria principal investigator: Olivier Coulaud

International Partners (Institution - Laboratory - Researcher):

Lawrence Berkeley National Laboratory (United States) - Scientific Computing Group - Esmond Ng

Stanford University (United States) - Institute for Computational and Mathematical Engineering - Eric Darve

Duration: 2012 - 2014

See also: http://people.bordeaux.inria.fr/coulaud/projets/FastLA_Website

In this project, we propose to study fast and scalable hierarchical numerical kernels and their implementations on heterogeneous manycore platforms for two major computational kernels in intensive challenging applications. Namely, fast multipole methods (FMM) and sparse hybrid linear solvers, that appear in many intensive numerical simulations in computational sciences. Regarding the FMM we plan to study novel generic formulations based on H-matrices techniques, that will be eventually validated in the field of material physics: the dislocation dynamics. For the hybrid solvers, new parallel preconditioning approaches will be designed and the use of H-matrices techniques will be first investigated in the framework of fast and monitored approximations on central components. Finally, the innovative algorithmic design will be essentially focused on heterogeneous manycore platforms. The partners, Inria **HIEPACS**, Lawrence Berkeley Nat. Lab and Stanford University, have strong, complementary and recognized experiences and backgrounds in these fields.

8.4.2. Participation In other International Programs

8.4.2.1. HOSCAR

We are involved in the Inria-CNPq **HOSCAR** project led by Stéphane Lanteri.

The general objective of the project is to setup a multidisciplinary Brazil-France collaborative effort for taking full benefits of future high-performance massively parallel architectures. The targets are the very large-scale datasets and numerical simulations relevant to a selected set of applications in natural sciences: (i) resource prospection, (ii) reservoir simulation, (iii) ecological modeling, (iv) astronomy data management, and (v) simulation data management. The project involves computer scientists and numerical mathematicians divided in 3 fundamental research groups: (i) numerical schemes for PDE models (Group 1), (ii) scientific data management (Group 2), and (iii) high-performance software systems (Group 3).

We organized the 2013 annual meeting in Bordeaux on September 2-6, 2013 and are contributing to the Group 3 activities.

8.4.2.2. G8-ECS

Title: Enabling Climate Simulations at Extreme Scale

Inria principal investigator: Luc Giraud

International Partners (Institution - Researcher):

Univ. Illinois at Urbana Champaign & Argonne National Lab. - Franck Cappello,

Univ. Tennessee at Knoxville - George Bosilca,

German Research School for Simulation Sciences - Felix Wolf,

Univ. Victoria - Andrew Weaver,

Titech - Satoshi Matsuoka,

Univ. Tsukuba - Mitsuhsa Sato,

NCAR - Rich Loft,

Barcelona Supercomputing Center - Jesus Labarta.

Duration: 2011 - 2014

See also: <https://wiki.engr.illinois.edu/display/G8/G8+ESC++--+Enabling+Climate+Simulations+at+Extreme+Scale>

Exascale systems will allow unprecedented reduction of the uncertainties in climate change predictions via ultra-high resolution models, fewer simplifying assumptions, large climate ensembles and simulation at a scale needed to predict local effects. This is essential given the cost and consequences of inaction or wrong actions about climate change. To achieve this, we need careful co-design of future exascale systems and climate codes, to handle lower reliability, increased heterogeneity, and increased importance of locality. Our effort will initiate an international collaboration of climate and computer scientists that will identify the main roadblocks and analyze and test initial solutions for

the execution of climate codes at extreme scale. This work will provide guidance to the future evolution of climate codes. We will pursue research projects to handle known roadblocks on resilience, scalability, and use of accelerators and organize international, interdisciplinary workshops to gather and disseminate information. The global nature of the climate challenge and the magnitude of the task strongly favor an international collaboration. The consortium gathers senior and early career researchers from USA, France, Germany, Spain, Japan and Canada and involves teams working on four major climate codes (CESM1, EC-EARTH, ECSM, NICAM).

HIPERCOM2 Team

8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. ANR

8.1.1.1. GETRF

Participants: Paul Muhlethaler, Pascale Minet, Cédric Adjih, Emmanuel Baccelli, Philippe Jacquet.

Period: 2012 - 2014.

Partners: DGA/MI, Inria (coordinator), Alcatel-Lucent.

The GETRF project aims at improving the effectiveness of communications mechanisms and technologies capable of functioning in extreme conditions and GETRF also aims at opening ways for solutions that are close to the optimum. The following areas will be addressed:

- Compromise time / maximum efficiency for coloring (TDMA), which can be used to take into account the asymmetry of traffic delays to optimize routing.
- Significant energy savings for opportunistic routing (in power saving mode) even where traffic control is limited and where the nodes are idle most of the time ("low-duty cycle")
- From a completely different point of view, the finding optimal network capacity for opportunistic routing variants when designed for mobile networks
- Robustness to mobility and to changes in network conditions (difficult connectivity, foes, ...) extreme network coding - which is moreover an innovative technology in itself applied here in MANETs, at the network and/or application layer, rather than at the physical/or theoretical level as in other proposals.

The project focuses on four technical approaches which are:

- Coloring for the development of a TDMA system for energy saving and delay control,
- Cross-layer (MAC/routing) mechanism for "low-duty-cycle" mode
- Network coding,
- Opportunistic routing and mobile mobility to use relays to minimize retransmissions of packets with a target time.

The first two approaches are intended to provide energy efficient sensor networks. The second two approaches try to provide mechanisms for building ad hoc networks capable of handling high node mobility.

8.1.2. Competitivity Clusters

8.1.2.1. SAHARA

Participants: Pascale Minet, Ridha Soua, Erwan Livolant.

Period: 2011 - 2014.

Partners: EADS (coordinator), Astrium, BeanAir, CNES, ECE, EPMI, Eurocopter, GlobalSys, Inria, LIMOS, Oktal SE, Reflex CES, Safran Engineering Systems.

SAHARA is a FUI project, labelled by ASTECH and PEGASE, which aims at designing a wireless sensor network embedded in an aircraft. The proposed solution should improve the embedded mass, the end-to-end delays, the cost and performance in the transfers of non critical data. Inria is in charge of coordinating the academic partners. During year 2013, we specified the protocols for layer 3. We organized demonstrations in March at Rocquencourt and in July 2013 at Suresnes to prove our concepts.

8.1.2.2. CONNEXION

Participants: Pascale Minet, Saoucene Ridene, Ines Khoufi, Erwan Livolant.

Period: 2012 - 2016.

Partners: EDF (coordinator), All4Tec, ALSTOM, AREVA, Atos WorldGrid, CEA, CNRS / CRAN, Corys TESS, ENS Cachan, Esterel Technologies, Inria, LIG, Predict, Rolls-Royce Civil Nuclear, Telecom ParisTech.

The Cluster CONNECTION (Digital Command Control for Nuclear EXport and renovation) project aims to propose and validate an innovative architecture platforms suitable control systems for nuclear power plants in France and abroad. This architecture integrates a set of technological components developed by the academic partners (CEA, Inria, CNRS / CRAN, ENS Cachan, LIG, Telecom ParisTech) and based on collaborations between major integrators such as ALSTOM and AREVA, the operator EDF in France and "techno-providers" of embedded software (Atos WorldGrid, Rolls-Royce Civil Nuclear, Corys TESS, Esterel Technologies, All4Tec, Predict). With the support of the competitiveness clusters System@tic, Minalogic and Burgundy Nuclear Partnership, the project started in April 2012. The key deliverables of the project covered several topics related demonstration concern-driven engineering models for the design and validation of large technical systems, design environments and evaluation of HMI, the implementation of Wireless Sensor Network context-nuclear, buses business object or real-time middleware facilitating the exchange of heterogeneous data and distributed data models standardized to ensure consistency of digital systems.

The HIPERCOM2 team is involved in wireless sensor networks coping with node mobility. We focused on deployment and redeployment algorithms for mobile wireless sensor networks after a disaster. We began with a state of the art. Many works in the literatures deal with this issue. We distinguish:

- Grid based approach: sensors will redeploy according to a predetermined grid.
- The computational geometry based approach uses the Voronoi diagram and the Delaunay triangulation.
- The virtual force based approach is based on virtual forces to move sensors.

The virtual force based approach presents many advantages such as simplicity and fast coverage. That is why we adopt this approach. However, the distributed version is prone to node oscillations that consume energy. We proposed two distributed algorithms to reduce node oscillations: ADVFA that adapts to the effective number of operational sensor nodes and GDVFA that takes advantage of grid to avoid these oscillations and to easily detect redundant nodes that can sleep to save energy.

8.1.2.3. SMARTMESH

Participants: Cédric Adjih, Alaeddine Weslati.

This is a joint work with Emmanuel Baccelli from Inria Saclay.

Period: 2010 - 2013.

Partners: SAGEM, CEA, Telecom SudParis, Ineo Defense, IEF, Orelia, Prodomo, Reflex CES, Evitech, Accuwatt.

SMARTMESH is a System@tic project, focused on the design of intelligent wireless sensor mesh networking for video surveillance and intrusion alarm systems.

In 2013, Inria finalized the communication subsystem comprising the following elements:

- Communication hardware using Senslab nodes (WSN430), directly connected to "SMARTMESH" nodes, with 802.15.4 radio.
- Communication software based on an extended version of the Contiki-OS
- Extensions of RPL routing protocol: P2P-RPL and MLN-RPL (Multi-Level Neighborhood RPL, for filtering appropriate links).

- Adaptation of the Contiki-OS 802.15.4 MAC layer for enabling better performance.
- Development of a cross-layering transport layer, to allow the efficient transport of large burst of data (images), on top of the 6lowpan/802.15.4 layer: a “burst-mode” communication protocol.

During the year 2013, the different components of the SMARTMESH project have been integrated to develop a specific application of area surveillance, with an easily deployable system. The system comprises a number of sensors: audio sensors, PIR sensors, infrared cameras, standard camera; a number of sophisticated signal processing algorithms (audio, video, distributed fusion and tracking, energy management); the communication subsystem itself; and a control/supervising terminal (displaying alarms, and tracks in real time).

Ten SMARTMESH prototype nodes have been created, integrating the different components. They have been tested in deployments in the military camp of Beynes (mostly from december 2012 to february 2013). The deployments had been planned with a map describing orientation and positions of the sensors of the nodes.

A demonstration of the entire SMARTMESH project was successfully conducted on 22 february, with the following application: detection of human “intruders”, and of vehicles, and tracking of their motion.

8.1.2.4. *ACRON*

Participant: Cédric Adjih.

Period: 2011 - 2013

Partners: Supélec (Télécommunications), Inria, ENS TREC, Inria HIPERCOM, Université Paris-Sud, IEF.

ACRON is a DIMLSC DIGITEO project. It deals with analysis and design of self-organized wireless networks. The HIPERCOM team project will study the theoretical limits of wireless networking.

In 2013, we finalized a protocol for diffusion in Vehicular Networks (VANETs) using network coding: the “DONC” diffusion protocol (joint work with Anthony Busson and Farhan Mirani in particular). The protocol is combining network coding with delay-based broadcast.

8.1.2.5. *SWAN*

Participants: Cédric Adjih, Claudio Greco.

Period: 2011 - 2014

Partners: CNRS, Supélec, Université Paris-Sud (L2S), LTCI, LRI, Inria and IEF.

SWAN, Source-aWAre Network coding, is a DIMLSC DIGITEO project. It deals with network coding for multimedia.

8.1.2.6. *MOBSIM*

Participants: Cédric Adjih, Paul Muhlethaler, Hana Baccouch.

Period: 2011 - 2013

Partners: Inria Sophia, Inria Grenoble.

MOBSIM is an ADT, Action of Technology Development. It aims at developing the NS3 simulation tool. The HIPERCOM team focuses on routing protocols and MAC protocol (namely the EY-NPMA protocol Elimination Yield Non-Preemptive Multiple Access). An engineer has been recruited for this project.

Thanks to the ADT, a module for the simulator ns-3 has been released: Ey-Wifi. It is available, along with a detailed tutorial explaining how to use it, at: <http://hipercom.inria.fr/Ey-Wifi>

8.2. International Initiatives

8.2.1. Participation In other International Programs

8.2.1.1. AWSN 2013

Program: **Euromediterranean 3+3**

Title: Auto-adaptivity in Wireless Sensor Networks

Inria principal investigator: Pascale Minet

International Partners:

University of Catania (Italy) - DIEEI - Lucia Lo Bello

Ecole Nationale Supérieure d'Informatique et d'Analyse des Systèmes (Morocco) - ND-SRG - Mohamed Erradi

Ecole Nationale des Sciences de l'Informatique (Tunisia) - CRISTAL - Leila Azouz Saidane

Duration: Jan 2012 - Dec 2015

See also: <http://hipercom.inria.fr/euomed/>

Wireless sensor networks (WSNs) allow the development of numerous applications in various domains, such as security and surveillance, environment protection, precision agriculture, intelligent transportation, homecare of elderly and disabled people...

Communication in such WSNs has to cope with limited capacity resources, energy depletion of sensor nodes, important fluctuations of traffic in the network, changes in the network topology (radio link breakage, interferences ...) or new application requirements. In the AWSN project, we focus on the different techniques to be introduced in the WSNs to make them auto-adaptive with regard to these various changes, while meeting the application requirements. Thus, we address:

- network deployment and redeployment in order to fulfill the application requirements,
- QoS (Quality of Service) optimization taking into account real-time traffic and dynamic bandwidth allocation,
- energy efficiency and replacement of failed sensor node,
- component generation and dynamic adaptation of the application.

In 2013, the AWSN project organized two workshops reserved to AWSN teams:

- Workshop in Rocquencourt in September 2013.
- Workshop in Catania in December 2013.

The AWSN project organized also two open workshops:

- RAWSN 2013 in Marrakech in May 2013 organized by the Moroccan team: see the program on <http://www.netys.net/rawsn2013/>, workshop held in conjunction with NETYS 2013.
- PEMWN 2013 workshop in Hammamet in November 2013, organized by the Tunisian and French teams, see the program on <https://sites.google.com/site/pemwn2013/final-program>

8.3. International Research Visitors

8.3.1. Visits of International Scientists

- **Leila Saidane**, ENSI, Tunis, Tunisia, February and September 2013,
- **Mohammed Erradi**, ENSIAS, Rabat, Morocco, September 2013,
- **Abdellatif Kobbane**, ENSIAS, Rabat, Morocco, September 2013.

KERDATA Project-Team

8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. ANR

MapReduce (2010–2014). An ANR project (ARPEGE 2010) with international partners, which focuses on optimized Map-Reduce data processing on cloud platforms. This project started in October 2010 in collaboration with Argonne National Lab, the University of Illinois at Urbana Champaign, the UIUC/Inria Joint Lab on Petascale Computing, IBM, IBCP, MEDIT and the GRAAL Inria Project-Team. URL: <http://mapreduce.inria.fr/>.

8.1.2. Other National projects

HEMERA (2010–2014). An Inria Large Wingspan Project, started in 2010. Within Hemera, G. Antoniu (KerData Inria Team) and Gilles Fedak (GRAAL Inria Project-Team) co-lead the Map-Reduce scientific challenge.

KerData also co-initiated a working group called *Efficient management of very large volumes of information for data-intensive applications*, co-led by G. Antoniu and Jean-Marc Pierson (IRIT, Toulouse).

Grid'5000. We are members of the Grid'5000 community: we make experiments on the Grid'5000 platform on a daily basis.

8.2. European Initiatives

8.2.1. FP7 Projects

The SCALUS FP7 Marie Curie Initial Training Network (2009–2013). Coordinator: André Brinkmann. Partners: Universidad Politécnica de Madrid (Spain), Barcelona Supercomputing Center (Spain), University of Paderborn (Germany), Ruprecht-Karls-Universität Heidelberg (Germany), Durham University (United Kingdom), FORTH (Greece), École des Mines de Nantes (France), XLAB (Slovenia), CERN (Switzerland), NEC (Germany), Microsoft Research (United Kingdom), Fujitsu (Germany), Sun Microsystems (Germany). Topic: scalable distributed storage. Abstract: The consortium of this Marie Curie Initial Training Network (MCITN) "SCALing by means of Ubiquitous Storage (SCALUS)" aims at elevating education, research, and development inside this exciting area with a focus on cluster, grid, and cloud storage. The vision of this MCITN is to deliver the foundation for ubiquitous storage systems, which can be scaled in arbitrary directions (capacity, performance, distance, security). We mainly collaborate with UPM (2 co-advised PhD theses).

8.3. International Initiatives

8.3.1. Inria Associate Teams

8.3.1.1. DATA@EXASCALE

Title: Ultra-scalable I/O and storage for Exascale systems

Inria principal investigator: Gabriel Antoniu

International Partners (Institution - Laboratory - Researcher):

Argonne National Laboratory (United States) - Mathematics and Computer Science Division - Rob Ross

University of Illinois at Urbana Champaign (United States) - Marc Snir

Duration: 2013 - 2015

See also: <http://www.irisa.fr/kerdata/data-at-exascale/>

Description: as the computational power used by large-scale scientific applications increases, the amount of data manipulated for subsequent analysis increases as well. Rapidly storing this data, protecting it from loss and analyzing it to understand the results are significant challenges, made more difficult by decades of improvements in computation capabilities that have been unmatched in storage. For many applications, the overall performance and scalability becomes clearly driven by the performance of the I/O subsystem. As we anticipate Exascale systems in 2020, there is a growing consensus in the scientific community that revolutionary new approaches are needed in computational science storage. These challenges are at the center of the activities of the Joint Inria-UIUC Lab for Petascale Computing, recently extended to Argonne National Lab. This project gathers researchers from Inria, Argonne National Lab and the University of Illinois at Urbana Champaign to address 3 goals: 1) investigate new storage architectures for Exascale systems; 2) investigate new approaches to the design of I/O middleware for Exascale systems to optimize data processing and visualization, leveraging dedicated I/O cores and I/O forwarding techniques; 3) explore techniques enabling adaptive cloud data services for HPC.

8.3.2. Inria International Partners

8.3.2.1. Declared Inria International Partners

Politehnica University of Bucharest (since 1 January 2013, just after the end of our former Data-Cloud@work Associate Team).

8.3.3. Inria International Labs

Joint Inria-UIUC Lab for Petascale Computing (JLPC), since 2009. Collaboration on concurrency-optimized I/O for post-Petascale platforms (see details in Section 4.1). A joint project proposal with the team of Rob Ross (Argonne National Lab) has been completed in 2012. It served to prepare the creation of the Data@Exascale Associate Team with ANL and UIUC (2013-2015).

8.3.4. Participation In other International Programs

FP3C ANR-JST project (2010–2014). This project co-funded by ANR and by JST (Japan Science and Technology Agency) started in October 2010 for 42 months. It focuses on programming issues for Post-Petascale architectures. In this framework, KerData collaborates with the University of Tsukuba on data management issues.

8.4. International Research Visitors

8.4.1. Visits of International Scientists

- Maria S. Perez (Universidad Politecnica de Madrid) and Toni Cortes (Universitat Politecnica de Catalunya) visited the KerData team for three days (December 2013) within the framework of the SCALUS project.

8.4.2. Internships

Participant: Mihaela Catalina Nita.

Subject: Smart Data Management for High-Performance Supercomputing

Date: from March 2013 until July 2013

Institution: Politehnica University of Bucharest (Romania)

Participant: Ana-Ruxandra Ion.

Subject: Enabling Map-Reduce-based Data-intensive Processing on Hybrid Cloud/Desktop Grid infrastructures

Date: from Mar 2013 until Jul 2013

Institution: Politehnica University of Bucharest (Romania)

Participant: Yue Li.

Subject: Energy Measurements for Cassandra Cloud Storage System: Exploring and improving Energy-Consistency Tradeoff

Date: from Feb 2013 until June 2013

Institution: Master student from Telecom Bretagne, Rennes (France)

Participant: Rui Wang.

Subject: Designing An Environment-Aware System for Geographically Distributed Data Transfers on Public Clouds

Date: from Feb 2013 until August 2013

Institution: Master student from Telecom Bretagne, Rennes (France)

8.4.3. Visits to International Teams

- Radu Tudoran visited ANL (Kate Keahey) for 3 months, funded by the Data@Exascale Associate Team.
- Matthieu Dorier visited ANL (Rob Ross, Tom Peterka, Phil Carns) for 2 months, funded by the Data@Exascale Associate Team.
- Radu Tudoran visited the ATL Lab at European Microsoft Innovation Center (Munich Germany) for 3 months, funded by Microsoft.

LOGNET Team

8. Partnerships and Cooperations

8.1. European Initiatives

8.1.1. Collaborations in European Programs, except FP7

Program: INTERREG ALCOTRA

Project acronym: myMed

Project title: “ a peer-to-peer programmable social network and cloud platform”

Duration: January 2010-march2014

Coordinator: Luigi Liquori

Other partners: University of Turin, Politech of Turin, Univ. of Piemonte Orientale

Founded 1.3Meur on 3 year (2010-2013)

Abstract: see above

8.2. International Initiatives

8.2.1. Inria International Partners

- University of Udine, Italy, collaborations, common papers and projects and visits since 1990.
- Politecnico di Torino, Italy, collaborations, common papers and visits since 2000.
- Politecnica de Valencia, Spain, collaborations and projects and teaching and visits since 2004.
- University of Novi Sad, Serbia, collaboration, common projects and papers and visits since 2004.

8.3. International Research Visitors

8.3.1. Visits of International Scientists

- Demis Ballis, Assistant Professor, Politecnica Valencia, one week,
- Marina Ribaud, Associate professor, Università di Genova, 2 days,
- Giovanni Chiola, Full Professor, Università di Genova, 2 days,
- Seif Aridi, Full Professor, KTH Stocholm, 3 days,
- Nguyen Huu Thanh, Associate Professor, Hanoi University of Science and Technology, one week.

8.3.1.1. Internships

- Nicolas Gauche, IUT Nice, from Apr 2013 until Jun 2013: “conception et implémentation d’un réseau social appelé myCarPooling”;
- Benjamin Lissillour, IUT Nice, from Apr 2013 until Jun 2013: “portage de la base de donnée noSQL Cassandra 0.7 versus la nouvelle release 1.2”;
- Romain Guillot, IUT Nice, from Apr 2013 until Jun 2013: “conception et implémentation d’un système de monitoring pour un cloud de PC distribués, appelé ProtectYourself”.

MADYNES Project-Team

8. Partnerships and Cooperations

8.1. Regional Initiatives

MADYNES is involved in Satelor, a regional research and development project funded by the AME (Agence de Mobilisation Economique) of Lorraine (October 2013 – September 2016). The consortium includes academic (Univ. of Lorraine, Inria), medical (OHS) and industrial (Diatelic-Pharmagest, ACS, Kapelse, Salendra, Neolinks) partners. It aims at developing innovative and easily deployable AAL solutions for their effective use in the tele-homecare systems. Madynes team is mainly involved in the data collection system development based on wireless sensors and IoT technology.

8.2. National Initiatives

8.2.1. ANR

8.2.1.1. ANR *Quasimodo*

Participants: François Despaux, Abdelkader Lahmadi, Evangelia Tsiontsiou, Ye-Qiong Song [contact].

The QUASIMODO ANR Blanc international project (<http://quasimodo.loria.fr/>) is a fundamental research project coordinated by Prof. Ye-Qiong SONG at LORIA - University of Lorraine in France and by Prof. Youxian SUN at SKLICT of Zhejiang University in China. The project started on March 2011 for duration of 36 months. It is funded by ANR grant (ANR 2010 INTB 0206 01) and NSFC grant (NSFC 61061130563). The main objective of the project is to specify, develop and evaluate algorithms and mechanisms to provide the self-adaptive QoS support for real-time applications using wireless sensor networks (WSN). We extended queue-MAC to iQueue-MAC to support multi-hop transmission [23]. We also conducted measurement based performance evaluation of IEEE802.15.4 beacon enabled WSN to assess the usefulness of the existing Markov models [15], [14] for evaluating the end-to-end delay distribution. A new routing algorithm called Operator calculus has been intensively studied and its execution time has been compared with SAMCRA, showing the great potential of OC to be used in WSN routing.

8.2.2. *PIA LAR*

Participants: Kévin Roussel, Ye-Qiong Song [contact].

LAR (Living Assistant Robot) is a national project getting together Inria (MAIA and MADYNES teams, Credit Agricole, Diatelic and Robotsoft). The aim is to develop an ambient assisted living system for elderly including both sensors and assistive robots. The task of our team is the development of a WSN based system integrating both sensors of the environment and sensors and actuators embedded on a mobile robot. The research issues include the QoS, energy and mobility management. The first step consists in identifying and developing necessary support for realizing such a system. For this purpose we investigated several OS for WSN and proposed some enhancements to ContikiMAC and RiotOS.

8.2.3. *Action de Développement Technologique*

8.2.3.1. *ADT Métroscope*

This ADT is linked to the consortium Métroscope⁵, whose goal is to understand the behavior of the Internet and its uses within a mobile environment. Through this ADT, funded by Inria, an engineer (Mohammad-Irfan Khan) was hired for 2 years (2013-2015). He will participate in the design and deployment of a distributed platform. This platform will be composed of a services providing measurement tools that collect a set of data and interact with probes located at various points of the network.

⁵ <http://metroscope.eu/>

8.2.3.2. ADT SEA

The goal of this ADT is to provide an novel security solution for Android platforms where the users will be able to evaluate the security level of their devices. The solution relies on the analysis and collection of logs and network activities of running Android applications to detect malicious activities and also the detection of vulnerable configurations of the device using an OVAL-based approach. Through, this ADT, funded by Inria, an engineer (Eric Finickel) was hired for 2 years (2013-2015). He is working on the development of Android devices embedded probes to export logs and network activities. He will also design and setup the collector and the analysis applications using a Hadoop based framework.

8.2.3.3. ADT PAL-PERCEE

The goal of this ADT (2012-2013) is to provide a multi-protocol gateway and a unified interface for easing transparent access to the heterogenous sensor data. Together with PAL partners, we specified a common data format and enriched the existing MPIGate by re-structuring all using ROS middleware. The new MPIGate is operational in the smart apartment of LORIA and serves as the base for developing large scale AAL systems.

8.2.4. Actions d'Envergure Nationale

The Inria Large-scale initiative action AEN PAL project (<http://pal.inria.fr>) aims at providing technologies and services for improving the autonomy and quality of life for elderly and fragile persons. Communication is one of the key components for ensuring real-time data gathering and exchange between heterogeneous sensors and actuators (robots). Within PAL and thanks to the associated ADT PERCEE project described above, we extended MPIGate (<http://mpigate.loria.fr>). The development and tests are conducted using LORIA's smart apartment platform developed within CPER MISN Informatique située project (<http://infositu.loria.fr>). The adoption of ROS (Robotic Operating System) also facilitates the interoperability of our services with the services of the other PAL partners since the new PALGate is based on ROS.

8.3. European Initiatives

8.3.1. FP7 Projects

8.3.1.1. Univerself

Type: COOPERATION

Defi: The Network of the Future

Instrument: Integrated Project

Objectif: The Network of the Future

Duration: September 2010 - August 2013

Coordinator: Alcatel Lucent (France)

Partner: Universiteit Twente, Alcatel Lucent Ireland, Alcatel Lucent Deutschland, Valtion Teknillinen Tutkimuskeskus (Finland), University of Piraeus, France Telecom, Telecom Italia, National University of Athens, Fraunhofer-Gesellschaft zur Foerderung der Angewandten Forschung, Interdisciplinary Institute for Broadband Technology, Telefonica Investigacion y Desarrollo, Thales Communications, Inria, Nec Europe, University of Surrey, University College London, IBBT (Belgium).

Inria contact: E. Fabre

See also: <http://www.univerself-project.eu/>

Abstract: UniverSelf unites 17 partners with the aim of overcoming the growing management complexity of future networking systems, and to reduce the barriers that complexity and ossification pose to further growth. Univerself has been launched in October 2010 and is scheduled for four years.

This FP7 European integrated project aims at consolidating the autonomic methods and techniques supporting the management of the future Internet, and at integrating these methods into a unified management framework (UMF). The objective of this framework is to address the management issues of the evolving Internet through the self-organization of the control plane and the empowerment of the management plane with cognition. Our work in the Univerself project mainly concerns the security and safety challenges posed by this unified management framework, with a special interest for the maintenance of safe configurations.

In the Year 2013, we have pursued our efforts on vulnerability management in autonomic networks and systems. In that context, we have worked on the adaptation of observation and operation methods to the specific needs of future networks and services, through the refinement of the Unified Management Framework (UMF) and its network empowerment modules (NEM). A particular focus has been given to methods for assessing past hidden vulnerable configurations [44] as well as techniques for minimizing the impact of the vulnerability assessment process on device resources [45]. We have therefore extended our vulnerability management strategy to the detection of systems compromised in the past by configuration vulnerabilities unknown at that moment, and considered a probabilistic cost-efficient assessment for dealing with resource-constrained environments by taking advantage of the statistical properties of vulnerability description sets.

We have also worked on the design of a configuration assessment service for the UMF framework. NEMs have particular requirements and specific configurations in order to work properly. The interconnections between hundreds of NEMs and the services provided by them increase the complexity of their configuration. This configuration assessment service aims at preventing configuration errors, conflicts between services and inconsistencies that can occur leading to severe operational problems as well as security issues within the framework itself. Even though operating systems where NEMs are deployed and also the NEMs themselves may have security solutions to be protected, such fact does not ensure the security of the whole framework.

8.3.1.2. FI-WARE

Type: COOPERATION

Defi: PPP FI: Technology Foundation: Future Internet Core Platform

Instrument: Integrated Project

Objectif: PPP FI: Technology Foundation:Future Internet Core Platform

Duration: September 2011 - May 2014

Coordinator: Telefonica (Spain)

Partner: Thales, SAP, Inria

Inria contact: Olivier Festor

See also: <http://www.fi-ware.eu>

Abstract: FI-WARE will deliver a novel service infrastructure, building upon elements (called Generic Enablers) which offer reusable and commonly shared functions making it easier to develop Future Internet Applications in multiple sectors. This infrastructure will bring significant and quantifiable improvements in the performance, reliability and production costs linked to Internet Applications, building a true foundation for the Future Internet.

The goal of the FI-WARE project is to advance the global competitiveness of the EU economy by introducing an innovative infrastructure for cost-effective creation and delivery of services, providing high QoS and security guarantees. FI-WARE is designed to meet the demands of key market stakeholders across many different sectors, e.g., healthcare, telecommunications, and environmental services. FI-WARE unites major European industrial actors.

The key deliverables of FI-WARE will be an open architecture and a reference implementation of a novel service infrastructure, building upon generic and reusable building blocks developed in earlier research projects. We will demonstrate how this infrastructure supports emerging Future Internet (FI) services in multiple Usage Areas, and will exhibit significant and quantifiable improvements in the productivity, reliability and cost of service development and delivery, building a true foundation for the Future Internet.

The MADYNES contributions to the FI-WARE project are:

- Sicslowfuzzer, a fuzzing framework for the Internet of Things, that allows to assess the robustness of IoT OSes and applications, networkwise. More specifically, the tool uses the Scapy library for packet manipulation, allows users to define interaction scenarios in XML and provides multiple mutation algorithms;

- Flowoid, a netflow probe for Android-based devices, which also provides a netflow location template to convey location information of the device;
- XOvaldi4Android, an OVAL interpreter for Android-based devices, that is able to retrieve OVAL definitions using a web service, use them to check the current status of the system, and publish a result, using a second web service;
- the coordination between the Security Work Package and the Inria teams involved in it. This includes the attending to weekly audio conferences, face to face meetings, and making sure deliverables and tasks were addressed in a timely manner.

8.3.1.3. Flamingo

Type: COOPERATION

Defi: Management of the Future Internet

Instrument: Network of Excellence

Objectif: Management of the Future Internet

Duration: November 2012 - October 2016

Coordinator: University of Twente (Netherlands)

Partner: University of Twente, Inria, University of Zurich, Jacobs University of Bremen, University des Bundeswehr Munich, Polytechnic University of Catalonia, Interdisciplinary Institute for Broadband Technology, University of Ghent, University College London

Inria contact: Olivier Festor

See also: <http://www.fp7-flamingo.eu>

Abstract: The FP7 FLAMINGO Network of Excellence is composed of 8 partner universities, with complementary knowledge and strong ties to industry. It covers the entire spectrum of network management core functions and application domains, which are required for building, integrating, and disseminating the knowledge of the management plane for the Future Internet.

The objectives of FLAMINGO are (a) to strongly integrate the research of leading European research groups in the area of network and service management, (b) to strengthen the European and worldwide research in this area, and (c) to bridge the gap between scientific research and industrial application. To achieve these goals, FLAMINGO performs a broad range of activities, such as to develop open source software, establish joint labs, exchange researchers, jointly supervise Ph.D. students, develop educational and training material, interact with academia and industry, organize event, and strongly contribute to (IETF and IRTF) standardization [40].

Our work on network and service monitoring [42] has focused on security attacks in RPL Networks, with a study of DODAG inconsistency attacks jointly with Jacobs University of Bremen. In a RPL network, a malicious node can create artificial DODAG inconsistencies by manipulating IPv6 header options, thereby leading to increased overhead, denial of service and even black-hole attacks that are hard to detect. Our work has consisted in evaluating the impact of DODAG attacks in a RPL network, identifying the key parameters that are required to detect these attacks, developing a mitigation strategy to reduce their effects. Efforts have also been done on a NetFlow/IPFIX Probe for android-based devices, jointly with University of Twente. The major achievements of this collaboration have been the development of a NetFlow and IPFIX metering process for Android devices, the extension of nfdump/Nfsen and SURFmap with location support, and a IETF draft describing a set of information elements for IPFIX metering process location.

We have also contributed to activities on automated configuration and repair [37], with an in-depth analysis and comparison of existing management architectures. In that context, we have elaborated a survey on autonomic vulnerability assessment, recently published in IEEE Communications Survey and Tutorial [3]. This survey introduces a classification, called D3, to structure the vulnerability assessment activity into three well-defined dimensions: Discovery, Description and Detection. Background and key concepts as well as different leading methods and current techniques have been discussed along this work. We have identified potential applications over diverse contributions that may provide a strong basis for achieving this critical goal within self-governing

systems. We have also pointed out several areas such as vulnerability integration models, collaborative vulnerability management approaches and policy-based reasoning systems where the development of novel approaches and solutions are required to provide autonomic environments with the ability of assessing their own exposure.

8.3.2. Collaborations in European Programs, except FP7

Type: COOPERATION

Defi: Crowdsourcing Services for Citizen in Digital Cities

Instrument: EIT ICT Labs

Objectif: Develop new essential services for city-grade crowd-sourcing platforms and to deploy them on different platforms dedicated to different types of crowd-sourcing activities.

Duration: January 2013 - December 2013

Coordinator: Inria (France)

Partner: Imperial College of London (UK), BME (HU), KTH (SW), SAP (GE), Cap-Digital (FR), Alcatel-Lucent (FR), Inria (FR)

Inria contact: Thomas Silverston

See also: <http://www.eitictlabs.eu>

Abstract: the EIT ICT Labs activity CityCrowdSource is composed of 7 partners, among which 4 partner universities and 3 partner industries. This project tackles the Crowdsourcing services and propose three milestones for such emerging services: trust service, privacy service and process model.

The objective of CityCrowdSource is to develop three new services that are essential for city-grade crowd-sourcing platforms and to deploy and evaluate them on five different existing platforms dedicated to different types of crowd-sourcing activities.

The activity supports to leverage the potential of crowd-based applications in urban contexts. Crowd-based data collection in combination with official data will lead to a vastly improved coverage and quality of digital information for urban areas. The added-value of the proposal is in : (1) the three services: trust, privacy and crowd processes modeling that are not present in any crowd-sourcing platform available today, (2) in the deployment and of these services on top of different crowd-sourcing platforms and (3) the experimentation of these platforms in real life city scenarios.

Our work in this activity has focused on the design, deployment and experimentation of CrowdOut, a crowdsourcing service for Road Safety. This service has been designed for Android platform and has been tested and evaluated. First, a prototype has been experimented during Futur-en-Seine, the Digital World Festival in Paris (June 2013). Second, we performed experiment in the Grand Nancy Urban Area. The CrowdOut User Interface received support from the Living Lab Inria Sophia-Antipolis.

From this work we published several papers into a national conference (Ubimob) [25].

8.3.3. Collaborations with Major European Organizations

University of Luxembourg (Luxembourg) : We have two ongoing PhD candidates with the SnT at University of Luxembourg. We collaborate on the topic of Large Scale Monitoring for Security Management. Target services are: P2P Networks, Virtual Coordinates Systems and DNS Services.

8.4. International Initiatives

8.4.1. Inria International Partners

8.4.1.1. Informal International Partners

- University of Twente, The Netherlands, joint work with Professor Aiko Pras on large scale network monitoring and attack detection

- Jacobs University Bremen, joint PhD. with Professor Schoenwaelder on security management in wireless sensor networks
- Federal University of Rio Grande do Sul (UFRGS), joint work with Professor Granville on automatic management systems
- University of the Federal Armed Forces, Munich Germany, joint work with Professor Gabi Dreo on cloud and mobile cloud security management

8.5. International Research Visitors

8.5.1. Visits of International Scientists

8.5.1.1. Internships

Younes Abid

Subject: Development of a configuration service for Wireless Sensor Networks using a content centric approach

Date: from Mar 2013 to Sep 2013

Institution: Ecole Nationale des Sciences de l'Informatique (Tunisia)

Narjess Derouiche

Monitoring of the Anonymous I2P Network

Date: from Avril 2013 to Sep 2013

Institution: Ecole supérieure des communications de Tunis (SUP'COM) (Tunisia)

Fadwa Rebhi

Subject: Development of an automated detection tool of malicious applications in Android-based smartphones

Date: from Mar 2013 to Sep 2013

Institution: Ecole Nationale des Sciences de l'Informatique (Tunisia)

Evangelia Tsiontsiou

Subject: Multi-constrained QoS routing for wireless sensor networks

Date: from March 2013 to July 2013

Institution: Université Nationale Capodistrienne d'Athènes (Greece)

Achraf Weslati

Subject: Co-Simulation applied to Networking, Driving and Pedestrian

Date: from Mar 2013 to Sep 2013

Institution: Ecole Nationale des Sciences de l'Informatique (Tunisia)

8.5.1.2. Scientific visits

Participant: Juan Caubet.

Visiting PhD student

Subject: A Distributed Authentication System for Content-Centric Networking

Date: from Aug 2013 to Nov 2013

Institution: Technical University of Catalonia (UPC) (Spain)

Visiting PhD Student Aug 2013 to Nov 2013

8.5.2. Visits to International Teams

Anthea Mayzaud visited the Jacobs University in Bremen, Germany, during August 2013, more precisely in the Computer Science department led by Jürgen Schönwälder. The purpose of the visit was to define the exact collaboration possible between the two research groups within the area of securing RPL networks by using risk mitigation approaches. A secondary purpose was to get familiar with the Contiki RPL implementation and the tools, such as Cooja, provided by Contiki in order to implement the chosen risk mitigation approach. A joint paper between the research group at Jacobs and Inria on the "Mitigation of RPL DAG Inconsistency Attacks by Dynamically Rate Limiting Local Repair" has been written as a result of this visit.

MAESTRO Project-Team

7. Partnerships and Cooperations

7.1. National Initiatives

7.1.1. ANR Marmote

Participants: Alain Jean-Marie, Issam Rabhi.

ANR Program: Modèles Numériques (MN) 2012

Project title: MARKovian MOdeling Tools and Environments

Duration: January 2013 - December 2016

Coordinator: Alain Jean Marie (Inria)

Partners: Inria (project-teams DYOGEN, MAESTRO and MESCAL), Univ. Versailles-Saint-Quentin (PRISM lab.), Telecom SudParis (SAMOVAR lab.), Univ. Paris-Est Créteil (LACL), and Univ. Pierre-et-Marie-Curie (LIP6)

Abstract: ANRMARMOTE aims at realizing the prototype of a software environment dedicated to modeling with Markov chains. It brings together seven partner teams, expert in Markovian analysis, who will develop advanced solution algorithms and applications in different scientific domains: reliability, distributed systems, biology, physics and economics.

<https://wiki.inria.fr/MARMOTE/Welcome>

7.2. European Initiatives

7.2.1. FP7 Projects

7.2.1.1. CONGAS

Participants: Eitan Altman, Konstantin Avrachenkov, Yonathan Portilla, Alexandre Reiffers.

Project title: Dynamics and coevolution in multi level strategic interaction games

Type: COOPERATION

Challenge: Future and Emerging Technologies

Instrument: Specific Targeted Research Project

Objective: FET Proactive: Dynamics of Multi-Level Complex Systems (DyM-CS)

Duration: October 2012 - September 2015

Coordinator: Francesco De Pellegrini (CREATE-NET)

Scientific Coordinator: Eitan Altman (Inria)

Other partners: Center for Research and Telecommunication Experimentation for Network Communities (Italy), Univ. d'Avignon et des Pays de Vaucluse (France), Technische Universiteit Delft (The Netherlands), Imperial College of Science, Technology and Medicine (United Kingdom), Univ. di Pisa (Italy) and Technion - Israel Institute of Technology (Israel)

Inria contact: Konstantin Avrachenkov

Abstract: CONGAS will develop new mathematical models and tools, rooted in game theory, for the analysis, prediction and control of dynamical processes in complex systems. It will provide a coherent theoretical framework for understanding the emergence of structure and patterns in these systems, accounting for interactions spanning various scales in time and space, and acting at different structural and aggregation levels.

MAESTRO's task is to develop game theoretic models to model (a) the formation of technological and social network; (b) the routing for competing agents; and (c) the competition of information in social networks.

<http://www.congas-project.eu/>

7.2.2. Collaborations in European Programs, except FP7

Program: PHC Tournesol FL - Belgium

Project title: Stochastic modelling of dissemination and epidemic processes on complex networks

Duration: January 2013 - December 2013

Coordinator: B. Prabhu (LAAS-CNRS) is coordinator for French side and D. Fiems is coordinator for Belgian side

Other partners: CNRS, LAAS (France); Ghent University, TELIN (Belgium)

More info: The role of MAESTRO is to work on information propagation models in online social network with directed links.

7.2.3. Collaborations with Major European Organizations

European Space Operations Centre: European Space Agency, Darmstadt (Germany)

Application of a BitTorrent-like data distribution model to mission operations. In the framework of this project with ESA we cooperate with Thales-Alenia Space (France) and with Teletel S.A. (Greece).

7.3. International Initiatives

7.3.1. Inria Associate Teams

7.3.1.1. GANESH

Participants: Eitan Altman, Konstantin Avrachenkov, Manjesh Kumar Hanawal, Parmod Kumar.

Title: Games, Optimization and Analysis of NETworkS Theory and Applications

Inria principal investigator: Eitan Altman

International Partners (Institution - Laboratory - Researcher):

IISc Bangalore (India) - Electrical Communication Engineering - Anurag Kumar

IIT Bombay (India) - Department of Electrical Engineering - D. Manjunath

IIT Madras (India) - Electrical Engineering - Venkatesh Ramaiyan

Duration: 2012 - 2014

See also: <http://www-sop.inria.fr/members/Eitan.Altman/Ganesh/Home.html>

This project aims at producing outstanding contributions to the foundations of the theory of networks, in game theory, team theory, optimization and analysis. Three areas in networking will be used to apply these: (a) economy of networks and network neutrality, (b) scheduling in wireless networks, and (c) distributed optimization issues in ad-hoc networks.

7.3.2. Inria International Partners

7.3.2.1. Informal International Partners

MAESTRO has continued collaborations with researchers from GERAD, Univ. Montreal (Canada), Flinders Univ. (Australia), National Univ. of Rosario (Argentina), Technion – Israel Institute of Technology (Israel), Univ. of Arizona (USA), Univ. of Illinois at Urbana-Champaign (USA), Univ. of Liverpool (UK), Univ. of Massachusetts at Amherst (USA), Univ. of Palermo (Italy), and Univ. of Twente (The Netherlands); cf. Sections [7.4.1.1](#) and [7.4.2](#).

7.4. International Research Visitors

7.4.1. Visits of International Scientists

7.4.1.1. Professors / Researchers

Koen De Turck

Subject: Information Dissemination in Directed Online Social Networks

Date: from 25 Nov 2013 until 27 Nov 2013

Institution: Ghent Univ. (Belgium)

Jocelyne Elias

Subject: Network Covering

Date: from 29 Nov 2013 until 28 Dec 2013

Institution: Paris Descartes Univ. (France)

Dieter Fiems

Subject: Information Dissemination in Directed Online Social Networks

Date: from 25 Nov 2013 until 27 Nov 2013

Institution: Ghent Univ. (Belgium)

Vladimir Gaitsgory

Subject: Singular Perturbations in Markov Decision Processes

Date: from 30 Nov 2013 until 6 Dec 2013

Institution: Flinders University (Australia)

Jasper Goseling

Subject: Random Access with Physical-layer Network Coding

Date: from 13 Oct 2013 until 16 Oct 2013

Institution: Univ. of Twente (Netherlands)

Roberto Lucchetti

Subject: Application of Cooperative Games to Networks

Date: from 10 Jul 2013 until 12 Jul 2013

Institution: Politecnico di Milano (Italy)

Natalia Markovich

Subject: Modeling Clusters of Extreme Values in Random Walk Processes

Date: from 1 Jul 2013 until 15 Aug 2013

Institution: Russian Academy of Sciences (Russia)

Fabio Martignon

Subject: Network covering

Date: from 29 Nov 2013 until 28 Dec 2013

Institution: Paris Sud Univ.(France)

Vladimir Mazalov

Subject: Networking Games and Cloud Computing Market

Date: from 17 Sep 2013 until 18 Oct 2013

Institution: Petrozavodsk State Univ. (Russia)

Leon Petrosian

Subject: Game Theoretic Models in Network Formation

Date: from 2 Aug 2013 until 9 Aug 2013

Institution: St. Petersburg State Univ. (Russia)

Bruno Ribeiro

Subject: Online Myopic Network Covering

Date: from 12 Jun 2013 until 19 Jun 2013

Institution: Univ. Massachusetts, Amherst (USA)

Don Towsley

Subject: Randomness and Wireless Security

Date: from 15 Apr 2013 until 19 Apr 2013

Institution: Univ. Massachusetts, Amherst (USA)

Kavitha Voleti Veeraruna

Subject: Performance Analysis of Social Networks Using Game Theoretical Tools

Date: from 28 May 2013 until 7 Jun 2013

Institution: IIT Bombay (india)

Piotr Wiecek

Subject: Evolutionary Game Models

Date: from 16 Sep 2013 until 27 Sep 2013

Institution: Wrocław Univ. of Technology (Poland)

Sulan Wong

Subject: European Approach to Net Neutrality

Date: from 1 Dec 2013 until 15 Jan 2014

Institution: Univ. de A Coruña (Spain)

Uri Yechiali

Subject: A Retrial System with Two Input Streams and Two Orbit Queues

Date: from 21 Apr 2013 until 4 May 2013

Institution: Tel Aviv Univ. (Israel)

7.4.1.2. Ph.D. students

Giovanni Accongiagioco

Subject: Game theoretic models applied to the Internet Economy

Date: from 14 Jan 2013 until 13 Jul 2013

Institution: Pisa Univ. (Italy)

Liudmila Ostroumova

Subject: Epidemic models on directed networks

Date: from 26 May 2013 until 9 Jun 2013

Institution: Yandex and Moscow State Univ. (Russia)

Cristina Rottondi

Subject: Privacy in smart grids

Date: from 1 Nov 2013 until 30 Nov 2013

Institution: Politecnico di Milano (Italy)

Rodrigo Vaca Ramirez

Subject: Vertical handover framework towards energy efficiency

Date: from 23 Nov 2012 until 12 Mar 2013

Institution: Univ. of Edinburgh (UK)

7.4.1.3. Internships

Xinwei Bai

Subject: Optimization of spatial caches

Date: from 15 Sep 2013 until 14 Dec 2013

Institution: Univ. of Twente (Netherlands)

Grégoire Beaudoire

Subject: Complexity Analysis of the Network Coverage Problem

Date: from 10 Jun 2013 until 26 Jul 2013

Institution: ENS Lyon (France)

Kumar Chippala

Subject: Numerical comparison of various multi-armed bandit algorithms

Date: from 2 May 2013 until 23 Jul 2013

Institution: IIT Bombay (India)

Engin Eljez

Subject: Congestion games with cost that decrease in the congestion

Date: from 1 Jun 2013 until 29 Jul 2013

Institution: Politecnico di Torino (Italy)

Simon Forest

Subject: Graphes aléatoires : génération, épidémies, applications

Date: from 10 Jun 2013 until 2 Aug 2013

Institution: ENS Paris (France)

Sushma Hanawal

Subject: Creation, Simulation and Multidiscipline Evaluation of Dynamic Mobility Models in Complex Systems

Date: from 25 Aug 2012 until 25 Mar 2013

Institution: SJCE Mysore (India)

Denys Korostii

Subject: Polls in online social networks

Date: from 1 Mar 2013 until 31 Aug 2013

Institution: Univ. Nice Sophia Antipolis (France)

Vasily Medyanikov

Subject: Graph-theoretic Models for Evolution of Social Networks

Date: from 22 Jul 2013 until 11 Aug 2013

Institution: St. Petersburg State Univ. (Russia (Russian Federation))

Tanmay Vashistha Sharma

Subject: Diffusion Processes in Networks

Date: from 6 May 2013 until 12 Jul 2013

Institution: IIT Bombay (India)

Xiuhui Ye

Subject: Raise of influential individuals in Online Social Networks

Date: from 15 May 2013 until 15 Nov 2013

Institution: Politecnico di Torino (Italy)

7.4.2. Visits to International Teams

MAESTRO members have visited (the)

- GERAD, Univ. Montreal, Canada in the period 20 October – 10 November 2013 (**A. Jean-Marie**);
- Ghent Univ., Belgium in the period 21–22 November 2013 (**K. Avrachenkov**);
- Flinders Univ., Australia in the period 20 March – 20 April 2013 (**K. Avrachenkov**);
- National Univ. of Rosario, Argentina in the period 4 – 15 March 2013 (**A. Jean-Marie**);
- Petrozavodsk State Univ., Russia in the period 26 – 28 June 2013 (**K. Avrachenkov**);
- Technical Univ. of Darmstadt, Germany in the period 5–6 October 2013 (**G. Neglia**);
- Technion – Israel Institute of Technology, Tel Aviv, Israel in the period 19–28 April 2013 (**E. Altman**);
- Univ. of Arizona, USA in the period 31 March – 2 June 2013 (**M. K. Hanawal**);
- Univ. of Illinois at Urbana-Champaign, USA in the period 1 October 2013 – 31 January 2014 (**M. El Chamie**);
- Univ. of Liverpool, UK in the period 6 – 14 February 2013 (**K. Avrachenkov**);
- Univ. of Massachusetts at Amherst, USA in the periods 1 September – 30 October 2013 (**N. Choungmo Fofack**) 1–10 May 2013 and 25–30 October 2013 (**P. Nain**);
- Univ. of Twente, The Netherlands in the period 19 – 20 June 2013 (**K. Avrachenkov**);
- Yandex Research and Institute of Control Problems, Russia in the period 21 – 30 October 2013 (**K. Avrachenkov**);

MESCAL Project-Team

8. Partnerships and Cooperations

8.1. Regional Initiatives

8.1.1. CIMENT

The CIMENT project (Intensive Computing, Numerical Modeling and Technical Experiments, <https://ciment.ujf-grenoble.fr/>) gathers a wide scientific community involved in numerical modeling and computing (from numerical physics and chemistry to astrophysics, mechanics, bio-modeling and imaging) and the distributed computer science teams from Grenoble. Several heterogeneous distributed computing platforms were set up (from PC clusters to IBM SP or alpha workstations) each being originally dedicated to a scientific domain. More than 600 processors are available for scientific computation. The MESCAL project-team provides expert skills in high performance computing infrastructures.

The Digitalis and IDPot clusters and the Bull Machine are integrated in the CIMENT Grid. More precisely, their unused resources may be exploited to execute jobs from partners of the CIMENT project. Mescal is also involved in CIMENT through the development of OAR and CiGri.

8.2. National Initiatives

8.2.1. Inria Large Scale Initiative

- *HEMERA, 2010-2012* Leading action "Completing challenging experiments on Grid'5000 (Methodology)" (see <https://www.grid5000.fr/Hemera>).

Experimental platforms like Grid'5000 or PlanetLab provide an invaluable help to the scientific community, by making it possible to run very large-scale experiments in controlled environment. However, while performing relatively simple experiments is generally easy, it has been shown that the complexity of completing more challenging experiments (involving a large number of nodes, changes to the environment to introduce heterogeneity or faults, or instrumentation of the platform to extract data during the experiment) is often underestimated.

This working group explores different complementary approaches, that are the basic building blocks for building the next level of experimentation on large scale experimental platforms.

8.2.2. ARC Inria

- *Meneur 2011-2013*: Partners: EPI Dionysos, EPI Maestro, EPI MESCAL, EPI Comore, GET/Telecom Bretagne, FTW, Vienna (Forschungszentrum Telekommunikation Wien), Columbia University, USA, Pennsylvania State University, USA, Alcatel-Lucent Bell Labs France, Orange Labs.

The goal of this project is to study the interest of network neutrality, a topic that has recently gained a lot of attention. The project aims at elaborating mathematical models that will be analyzed to investigate its impact on users, on social welfare and on providers' investment incentives, among others, and eventually propose how (and if) network neutrality should be implemented. It brings together experts from different scientific fields, telecommunications, applied mathematics, economics, mixing academy and industry, to discuss those issues. It is a first step towards the elaboration of a European project.

8.2.3. ANR

- *Clouds@home, 2009-2013*. Partners: Inria Grenoble (MESCAL, MOAIS), Inria Lyon (GRAAL), Inria Saclay (GRAND-LARGE).

The overall objective of this project is to design and develop a cloud computing platform that enables the execution of complex services and applications over unreliable volunteered resources over the Internet. In terms of reliability, these resources are often unavailable 40% of the time, and exhibit frequent churn (several times a day). In terms of "real, complex services and applications", we refer to large-scale service deployments, such as Amazon's EC2, the TeraGrid, and the EGEE, and also applications with complex dependencies among tasks. These commercial and scientific services and applications need guaranteed availability levels of 99.999% for computational, network, and storage resources in order to have efficient and timely execution.

- *ANR SONGS, 2012-2015*. Partners: Inria Nancy (Algorille), Inria Sophia (MASCOTTE), Inria Bordeaux (CEPAGE, HiePACS, RunTime), Inria Lyon (AVALON), University of Strasbourg, University of Nantes.

The last decade has brought tremendous changes to the characteristics of large scale distributed computing platforms. Large grids processing terabytes of information a day and the peer-to-peer technology have become common even though understanding how to efficiently exploit such platforms still raises many challenges. As demonstrated by the USS SimGrid project funded by the ANR in 2008, simulation has proved to be a very effective approach for studying such platforms. Although even more challenging, we think the issues raised by petaflop/exaflop computers and emerging cloud infrastructures can be addressed using similar simulation methodology.

The goal of the SONGS project (Simulation of Next Generation Systems) is to extend the applicability of the SimGrid simulation framework from grids and peer-to-peer systems to clouds and high performance computation systems. Each type of large-scale computing system will be addressed through a set of use cases and led by researchers recognized as experts in this area.

Any sound study of such systems through simulations relies on the following pillars of simulation methodology: Efficient simulation kernel; Sound and validated models; Simulation analysis tools; Campaign simulation management.

- *ANR MARMOTE, 2013-2016*. Partners: Inria Sophia (MAESTRO), Inria Rocquencourt (DIOGEN), PRiSM laboratory from University of Versailles-Saint-Quentin, Telecom SudParis (SAMOVAR), University Paris-Est Créteil (*Spécification et vérification de systèmes*), Université Pierre-et-Marie-Curie/LIP6.

The project aims at realizing a software prototype dedicated to Markov chain modeling. It gathers seven teams that will develop advanced resolution algorithms and apply them to various domains (reliability, distributed systems, biology, physics, economy).

- *ANR NETLEARN, 2013-2015*. Partners: PRiSM laboratory from University of Versailles-Saint-Quentin, Telecom ParisTech, Orange Labs, LAMSADE/University Paris Dauphine, Alcatel-Lucent, Inria (MESCAL).

The main objective of the project is to propose a novel approach of distributed, scalable, dynamic and energy efficient algorithms for managing resources in a mobile network. This new approach relies on the design of an orchestration mechanism of a portfolio of algorithms. The ultimate goal of the proposed mechanism is to enhance the user experience, while at the same time to better utilize the operator resources. User mobility and new services are key elements to take into account if the operator wants to improve the user quality of experience. Future autonomous network management and control algorithms will thus have to deal with a real-time dynamicity due to user mobility and to traffic variations resulting from various usages. To achieve this goal, we focus on two central aspects of mobile networks (the management of radio resources at the Radio Access Network level and the management of the popular contents users want to get access to) and intend to design distributed learning mechanisms in non-stationary environments, as well as an orchestration mechanism that applies the best algorithms depending on the situation.

8.2.4. National Organizations

Jean-Marc Vincent is member of the scientific committees of the CIST (Centre International des Sciences du Territoire).

8.3. European Initiatives

8.3.1. FP7 Projects

8.3.1.1. Mont-Blanc project: European scalable and power efficient HPC platform based on low-power embedded technology

Type: FP7 Programme

Objectif: ICT-2011.9.13 Exa-scale computing, software and simulation

Duration: October 2011 - October 2014

Coordinator: Alex Ramirez

Partner: BSC (Barcelone), Bull, ARM (UK), Julich (Germany), Genci, CINECA (Italy), CNRS (LIRMM, LIG)

Inria contact: Arnaud Legrand

Abstract: There is a continued need for higher computing performance: scientific grand challenges, engineering, geophysics, bioinformatics, etc. However, energy is increasingly becoming one of the most expensive resources and the dominant cost item for running a large supercomputing facility. In fact, the total energy cost of a few years of operation can almost equal the cost of the hardware infrastructure. Energy efficiency is already a primary concern for the design of any computer system and it is unanimously recognized that Exascale systems will be strongly constrained by power.

The analysis of the performance of HPC systems since 1993 shows exponential improvements at the rate of one order of magnitude every 3 years: One petaflops was achieved in 2008, one exaflops is expected in 2020. Based on a 20 MW power budget, this requires an efficiency of 50 GFLOPS/Watt. However, the current leader in energy efficiency achieves only 1.7 GFLOPS/Watt. Thus, a 30x improvement is required.

In this project, the partners believe that HPC systems developed from today's energy-efficient solutions used in embedded and mobile devices are the most likely to succeed. As of today, the CPUs of these devices are mostly designed by ARM. However, ARM processors have not been designed for HPC, and ARM chips have never used in HPC systems before, leading to a number of significant challenges.

8.3.1.2. Network of Excellence in Wireless COMMunications

Type: FP7 Programme

Objectif: 1.1 Future Networks

Duration: November 2012 - October 2015

Coordinator: Marco Louise

Partner: CNIT (IT), Aalborg University (DK), Bilkent University (TK), CNRS (FR), CTTC (ES), IASA (GR), INOV (P), Poznan University of Technology (PL), Technion (IL), Technische Universitaet Dresden (D), University of Cambridge (UK), Université de Louvain (BE), OulunYliopisto (FIN), Technische Universitaet Wien (A).

Inria contact: Panayotis Mertikopoulos

Abstract: The NEWCOM researchers will pursue long-term, interdisciplinary research on the most advanced aspects of wireless communications like Finding the Ultimate Limits of Communication Networks, Opportunistic and Cooperative Communications, Energy- and Bandwidth-Efficient Communications and Networking.

8.3.2. Collaborations in European Programs, except FP7

8.3.2.1. ESPON

Program: ESPON

Project acronym: HyperATLAS

Duration: 2007-2013

Coordinator: European Community

Abstract: The MESCAL project-team participates to the ESPON (European Spatial Planning Observation Network) <http://www.espon.lu/> It is involved in the action 3.1 on tools for analysis of socio-economical data. This work is done in the consortium hypercarte including the laboratories LIG, Géographie-cité (UMR 8504) and RIATE (UMS 2414). The Hyperatlas tools have been applied to the European context in order to study spatial deviation indexes on demographic and sociological data at nuts 3 level.

8.3.2.2. CROWN

Program: European Community and Greek General Secretariat for Research and Technology

Project acronym: CROWN

Project title: Optimal Control of Self Organized Wireless Networks

Duration: 2012-2015

Coordinator: Tassiulas Leandros

Other partners: Thales, University of Thessaly, National and Kapodistrian University of Athens, Athens University of Economics and Business

Abstract: Wireless networks are rapidly becoming highly complex systems with large numbers of heterogeneous devices interacting with each other, often in a harsh environment. In the absence of central control, network entities need to self-organize to reach an efficient operating state, while operating in a distributed fashion. Depending on whether the operating criteria are individual or global, nodes interact in an autonomic or coordinated way. Despite recent progress in autonomic networks, the fundamental understanding of the operational behaviour of large-scale networks is still lacking. This project will address these emergent network properties, by introducing new tools and concepts from other disciplines.

We will first analyze how imperfect network state information can be harvested and distributed efficiently through the network using machine learning techniques. We will design flexible methodologies to shape the competition between autonomous nodes for resources, with aim to maintain robust social optimality. Both cooperating and non-cooperating game-theoretic models will be used. We also consider networks with nodes coordinating to achieve a joint task, e.g., global optimization. Using algorithms inspired from statistical physics, we will address two representative paradigms in the context of wireless ad hoc networks, namely connectivity optimization and the localization of a network of primary sources from a sensor network.

Finally, we will explore delay tolerant networks as a case study of an emerging class of networks that, while sharing most of the characteristics of traditional autonomic or coordinated networks, they present unique challenges, due to the intermittency and constant fluctuations of the connectivity. We will study tradeoffs involving delay, the impact of mobility on information transfer, and the optimal usage of resources by using tools from information theory and stochastic evolution theory.

8.3.3. Collaborations with Major European Organizations

University of Athens: Panayotis Mertikopoulos was an invited professor for 4 months.

EPFL: Laboratoire pour les communications informatiques et leurs applications 2, Institut de systèmes de communication ISC, Ecole polytechnique fédérale de Lausanne (Switzerland). We collaborate with Jean-Yves Leboudec and Nicolas Gast on fluid limits.

BCAM: Basque Center for Applied Mathematics, Bilbao (Spain). Bruno gaujal was invited to teach several time and collaborates with Jonatha Anselmi on perfect simulation.

TU Wien: Research Group Parallel Computing, Technische Universität Wien (Austria). We collaborate with Sascha Hunold on experimental methodology and reproducibility of experiments in HPC.

8.4. International Initiatives

8.4.1. Inria Associate Teams

8.4.1.1. CLOUDSHARE

Title: Guaranteed Application Performance on Idle Data Center Resources

Inria principal investigator: Arnaud Legrand

International Partner (Institution - Laboratory - Researcher):

Walfredo Cirne (Google Inc. (United States))

David P. Anderson (University of California Berkeley - Space Sciences Laboratory)

Duration: 2009 - 2014

See also: <http://mescal.imag.fr/membres/derrick.kondo/ea/ea.html>

Data centers are often 85% idle as they must over-provision to ensure service level agreements. At the same time, high data center utilization is essential for efficient resource usage and optimal revenue. One way to improve utilization is for low-priority applications to use the idle resources of data centers, allowing high-priority applications to preempt them at any time. While users benefit from the lower costs of using these idle resources, parallel applications such as Map-Reduce can suffer severe overheads and unpredictable performance due to unexpected preemption and unavailability. The goal of this project is to enable complex applications to utilize idle data center resources with guaranteed performance. Our approach will be as follows. First, we will investigate novel statistical methods to predict the execution time of complex batch applications. Second, we will apply machine learning methods to predict idleness in data centers. Third, we will craft fair scheduling algorithms for multiple applications that compete for idle data center resources. The collaboration bridges experts in statistical modeling and simulation from the Inria MESCAL team with system and scheduling experts in the Berkeley BOINC team and the Google Infrastructure team.

8.4.2. Inria International Partners

8.4.2.1. Declared Inria International Partners

- MESCAL has strong connections with both UFRGS (Porto Alegre, Brazil) and USP (Sao Paulo, Brazil). The creation of the LICIA common laboratory (see next section) has made this collaboration even tighter.
- MESCAL has strong bounds with the University of Illinois Urbana Champaign, within the (Joint Laboratory on Petascale Computing (see next section).
- MESCAL also has long lasting collaborations with University of California in Berkeley and a new one with Google. Arnaud Legrand visited Berkeley and the Inria Grenoble hosted the yearly BOINC workshop in 2013.

8.4.3. Inria International Labs

8.4.3.1. North America

- JLPC (Joint Laboratory on Petascale Computing) with University of University of Illinois Urbana Champaign. Several members of MESCAL are partners of this laboratory, and have done several visits to Urbana-Champaign or NCSA. One Mescal Postdoc (Slim Bougherra) spent one year in Urbana-Champaign.
- Associated Team with Berkeley. MESCAL is thus involved in the Inria@SiliconValley program.

8.4.4. Participation In other International Programs

8.4.4.1. South America

- LICIA. The CNRS, Inria, the Universities of Grenoble, Grenoble INP and Universidade Federal do Rio Grande do Sul have created the LICIA (*Laboratoire International de Calcul intensif et d'Informatique Ambiante*). On the French side, the laboratory is co-directed by Yves Denneulin and Jean-Marc Vincent, both from the MESCAL team.

The main themes are artificial intelligence, high performance computing, information representation, interfaces and visualization as well as distributed systems.

More information can be found at http://www.ufrgs.br/sisinfo/?ai1ec_event=terceira-reuniao-do-licia&instance_id=.

8.5. International Research Visitors

8.5.1. Visits of International Scientists

- Wenjing Wu (Chinese Academy of Science) visited MESCAL for two weeks in September.
- Sergio Gelvez Cortes (Universidad Industrial de Santander Bucaramanga, Colombia) visited MESCAL for two months.

8.5.1.1. Internships

- Wagner Kolberg (MSc UFRGS) made a 4 months internship in MESCAL.

8.5.2. Visits to International Teams

- Panayotis Mertikopoulos was invited to work for 3 weeks at Universidade de Chile (14/01 -> 2/02)
- Panayotis Mertikopoulos was invited to work for 4 months at University of Athens (01/03 -> 30/06)
- Jean-Marc Vincent was invited to work for 3 weeks at UFRGS and PUC-RS, Porto Alegre

MOAIS Project-Team

8. Partnerships and Cooperations

8.1. Regional Initiatives

- Action OCA : Combinatorial Optimization on Accelerator. Funding by Labex PERSYVAL Grenoble.

8.2. National Initiatives

8.2.1. ANR

- **ANR grant REPDYN (2010-2013)**. High performance computing for structure and fluid computing. Partners: Inria Rhône-Alpes, CEA, ONERA, EDF, LaMSID lab from CNRS and LaMCoS lab from INSA Lyon.
- **ANR/JST grant PETAFLOW (2010-2013)**. France/Japan international program. Peta-scale data intensive computing with transnational high-speed networking: application to upper airway flow. Inria Rhône-Alpes, Gipsa-lab from UJF, NITC (Japan), Cyber Center of Osaka, DITS (Osaka) and the Visualization Lab of Kyoto.
- **ANR grant EXAVIZ (2011-2015)**. Large Scale Interactive Visual Analysis for Life Science. Partners: Inria Rhône-Alpes, Université d'Orléans, the LBT lab from IBPC, the LIMSI from Université d'Orsay, and the CEMHTI labs from CNRS.
- **ANR HPAC (2012-2015)**. High Performance Algebraic Computing. Coordinator: UJF (LJK/CASYS team). Partners: project-team MOAIS (Grenoble), project-team ARENAIRE (LIP, Lyon), project-team SALSA (LIP6, Paris), the ARITH group (LIRMM lab, Montpellier).
- **Equipex Kinovis (2012-2017)**. 2.6 Meuros. Large scale multi-camera platform (extension of the Grimage platform to 60 cameras, depth and X-ray cameras). Coordinator E Boyer, LJK Inria MORPHEO team. Partners: Inria Rhône-Alpes and the LJK, LIG, LADAF and GIPSA labs.
- **ANR-11-LABX-0025 PERSYVAL-Lab** funds the following PhD in collaboration with other labs:
 - in collaboration with Verimag: Multi-objective optimization for resource management on multicore systems, (PhD Abhinav Srivastav, since 9/2012)
 - In collaboration with Gipsa-lab and Inria BiBop: Simulations of Fibrous Materials. (PhD Gilles Daviet, since 9/2013)
 - in collaboration with Inria Privatics and Verimag: Secure Outsourcing (PhD Amrit Kumar, since 11/2013)

8.2.2. Competitivity Clusters

- SoC-Trace, Minalogic 2011-2014 contract. This project aims the development of tools for the monitoring and debug of multicores on chip. Leader: ST-Microelectronic. Partners: Inria (Mescal, Moais); UJF (TIMA, LIG/Hadas); Magilem, ProBayes. Moais contributes with technics and tools for visual aggregation of application traces. The contract funds 1 PhD thesis (Damien Dosimont) and 1 year engineer.

8.2.3. National ADT

- ADT K'STAR with cooperation between EPIS MOAIS and RUNTIME (Bordeaux). Coordinator: T. Gautier. <https://gforge.inria.fr/projects/kstar>. The main objective is to provide OpenMP-3.1 with some extension from OpenMP-4.0 standard to perform OpenMP programs on multi-CPU multi-GPU by using Kaapi and StarPU runtimes.

8.2.4. Inria Project Lab

8.2.4.1. C2S@Exa - Computer and Computational Sciences at Exascale

Participants: Olivier Aumage [RUNTIME project-team, Inria Bordeaux - Sud-Ouest], Jocelyne Erhel [SAGE project-team, Inria Rennes - Bretagne Atlantique], Philippe Helluy [TONUS project-team, Inria Nancy - Grand-Est], Laura Grigori [ALPINE project-team, Inria Saclay - Île-de-France], Jean-Yves L'Excellent [ROMA project-team, Inria Grenoble - Rhône-Alpes], Thierry Gautier [MOAIS project-team, Inria Grenoble - Rhône-Alpes], Luc Giraud [HIEPACS project-team, Inria Bordeaux - Sud-Ouest], Michel Kern [POMDAPI project-team, Inria Paris - Rocquencourt], Stéphane Lanteri [Coordinator of the project], François Pellegrini [BACCHUS project-team, Inria Bordeaux - Sud-Ouest], Christian Perez [AVALON project-team, Inria Grenoble - Rhône-Alpes], Frédéric Vivien [ROMA project-team, Inria Grenoble - Rhône-Alpes].

Since January 2013, the team is participating to the C2S@Exa http://www-sop.inria.fr/c2s_at_exa Inria Project Lab (IPL). This national initiative aims at the development of numerical modeling methodologies that fully exploit the processing capabilities of modern massively parallel architectures in the context of a number of selected applications related to important scientific and technological challenges for the quality and the security of life in our society. At the current state of the art in technologies and methodologies, a multidisciplinary approach is required to overcome the challenges raised by the development of highly scalable numerical simulation software that can exploit computing platforms offering several hundreds of thousands of cores. Hence, the main objective of C2S@Exa is the establishment of a continuum of expertise in the computer science and numerical mathematics domains, by gathering researchers from Inria project-teams whose research and development activities are tightly linked to high performance computing issues in these domains. More precisely, this collaborative effort involves computer scientists that are experts of programming models, environments and tools for harnessing massively parallel systems, algorithmists that propose algorithms and contribute to generic libraries and core solvers in order to take benefit from all the parallelism levels with the main goal of optimal scaling on very large numbers of computing entities and, numerical mathematicians that are studying numerical schemes and scalable solvers for systems of partial differential equations in view of the simulation of very large-scale problems.

T. Gautier is coordinator of the Pole 4: Programming Models.

8.3. European Initiatives

8.3.1. FP7 Projects

8.3.1.1. VISIONAIR

Type: CAPACITIES

Defi: INFRA-2010-1.1.29

Instrument: Combination of COLLABORATIVE PROJECTS and COORDINATION and SUPPORT ACTIONS

Objectif: NC

Duration: February 2011 - January 2015

Coordinator: Frédéric Noël (Inpg)

Partner: Inria (France)

Inria contact: G. Dumont

Abstract: Visionair calls for the creation of a European infrastructure for high level visualisation facilities that are open to research communities across Europe and around the world. By integrating existing facilities, Visionair aims to create a world-class research infrastructure for conducting state-of-the-art research in visualisation, thus significantly enhancing the attractiveness and visibility of the European Research Area (ERA). With over 20 members across Europe participating, VISIONAIR offers facilities for Virtual Reality, Scientific Visualisation, Ultra High Definition, Augmented Reality and Virtual Services.

8.4. International Initiatives

8.4.1. Participation In other International Programs

- The MOAIS EPI is actively participating to the international LICIA lab supporting collaborations with the UFRGG, Brazil. Bruno Raffin is member of the LICIA scientific committee.
- Moais is also leading a CAPES/COFECUB program (2013-2014) with UFRGS, Brazil.
- Moais is also leading a CAPES/COFECUB program (2013-2014) with USP, Brazil.

8.5. International Research Visitors

8.5.1. Visits of International Scientists

- Jacek Blazewicz (Professor, Polish Academy of Sciences, Poznań), invited prof INP (2 months)
- Afredo Goldman (Professor, USP Sao Paulo) (1 month)
- Daniel Cordeiro (Postdoc, USP Sao Paulo) (1 month)
- Mario Cesar Lopez Loces (UFRGS) (1 month)
- Adel Essafi (ISIG Kairouan, Tunis) (2 month)

8.5.2. Visits to International Teams

- Damien Dosimont, Oct-Dec 2013, UFRGS, Brazil
- Clement Pernet, sabbatical, Sept-Dec 2013, LIP Lyon, Aric Team

MYRIADS Project-Team

8. Partnerships and Cooperations

8.1. Regional Initiatives

8.1.1. ASYST (2010-2013)

Participants: Djawida Dib, Christine Morin, Nikos Parlavantzas.

The objective of the ASYST project (*Adaptation dynamique des fonctionnalités d'un SYSTème d'exploitation large échelle*) funded by the Brittany council is to propose building distributed operating systems as sets of adaptable services. This project funds 50% of a PhD grant (Djawida Dib). In 2013, we have worked on the design and implementation of Meryn [24], a flexible PaaS system that supports dynamically resizing virtual clusters to satisfy SLAs involving completion time and prices.

8.2. National Initiatives

8.2.1. COOP ANR COSINUS Project (2009-2013)

Participants: Yvon Jégou, Christine Morin, Yann Radenac.

The COOP project (<http://coop.gforge.inria.fr/>) funded under the ANR COSINUS program relates to multi level cooperative resource management. The two main goals of this project are to set up a cooperation as general as possible with respect to programming models and resource management systems (RMS) and to develop algorithms for efficient resource selection. Experimentations were conducted in particular with the SALOME platform and TLSE as examples of programming environments and Marcel, DIET and XtreamOS as examples of RMS. Partners involved in the COOP project are the AVALON and RUNTIME INRIA EPI, IRIT and EDF R&D. This project funds a research engineer (Yann Radenac). In 2013, we completed the design and implementation of the modifications needed in XtreamOS Grid distributed operating system in order to integrate the CoORM architecture defined by the Avalon Inria team to support dynamic applications.

8.2.2. MIHMES ANR Investissements d'Avenir (2012 - 2018)

Participants: Yvon Jégou, Christine Morin.

The MIMHES project (<http://www.inra.fr/mihmes>) led by INRA/BioEpAR aims at producing scientific knowledge and methods for the management of endemic infectious animal diseases and veterinary public health risks. Myriads team will provide software tools to efficiently manage and ease the use of a distributed computing infrastructure for the execution of different simulation applications.

In 2013, we interacted with the INRA/BioEpAR research team in order to improve the initial software prototype and to make it ready for parallelisation. The code has been re-written in C++. In 2014, Inria is in charge of developing a parallel version of the code.

8.2.3. HEMERA Inria AEN (2010-2013)

Participants: Bogdan Florin Cornea, Yvon Jégou, Christine Morin, Anne-Cécile Orgerie.

The Myriads team is involved in the HEMERA large wingspan project funded by INRIA (<http://www.grid5000.fr/mediawiki/index.php/Hemera>). This project aims at demonstrating ambitious up-scaling techniques for large scale distributed computing by carrying out several dimensioning experiments on the Grid'5000 infrastructure, at animating the scientific community around Grid'5000 and at enlarging the Grid'5000 community by helping newcomers to make use of Grid'5000. Yvon Jégou is co-chair of the "Bring Grids Power to Internet-Users thanks to Virtualization Technologies" working group. Anne-Cécile Orgerie is involved in the "Energy" working group which is currently looking at making energy-aware experiments on Grid'5000 easier for the users. This project funds Bogdan Florin Cornea's postdoc.

8.2.4. Inria ADT Aladdin (2008-2013)

Participants: Yvon Jégou, David Margery, Pascal Morillon.

The Aladdin technological development action funded by INRIA aims at the construction of a scientific instrument for experiments on large-scale parallel and distributed systems, building on the Grid'5000 platform (<http://www.grid5000.fr>).

As governing body of Grid'5000, it was superseded by a national GIS (Scientific interest group) that was signed in 2012.

As the host of engineers contributed to Grid'5000's technical team by INRIA, it finished operating in 2013. Two engineers of this technical team who are SED ⁷ members are still hosted in the Myriads team: David Margery, technical director and Pascal Morillon. Pascal Morillon is the chief engineer for all tasks automating Grid'5000 administration.

8.2.5. Inria ADT Snooze (2012-2014)

Participants: Eugen Feller, Yvon Jégou, David Margery, Christine Morin, Anne-Cécile Orgerie, Matthieu Simonin.

The Snooze technological development action funded by INRIA aims at developing an IaaS cloud environment based on the Snooze virtual machine framework developed by the team (<http://snooze.inria.fr>) and to make this new environment available to a wide community.

In 2013, we validated Snooze at large scale on the Grid'5000 testbed. A poster was presented at CCGRID 2013 [35] and the results of the study were awarded the second prize at CCGRID2013 scale challenge [26]. We introduced the Apache Cassandra system as database backend in Snooze. We have also started to refactor some parts of the code to enable the use of plugins. We implemented an EC2 interface and a web GUI. Puppet recipes were also released as well as a capistrano based deployment script for Grid'5000.

8.2.6. CNRS GDS EcoInfo

Participant: Anne-Cécile Orgerie.

The EcoInfo group deals with reducing environmental and societal impacts of Information and Communications Technologies from hardware to software aspects. This group aims at providing critical studies, lifecycle analyses and best practices in order to improve the energy efficiency of printers, servers, data centers, and any ICT equipment in use in public research organizations.

8.2.7. CominLabs EPOC project (2013-2016)

Participants: Sabbir Hasan, Yunbo Li, Anne-Cécile Orgerie, Jean-Louis Pazat.

In this project, partners aim at focusing on energy-aware task execution from the hardware to application's components in the context of a mono-site data center (all resources are in the same physical location) which is connected to the regular electric Grid and to renewable energy sources (such as windmills or solar cells). In this context, we tackle three major challenges:

- Optimizing the energy consumption of distributed infrastructures and service compositions in the presence of ever more dynamic service applications and ever more stringent availability requirements for services.
- Designing a clever cloud's resource management which takes advantage of renewable energy availability to perform opportunistic tasks, then exploring the trade-off between energy saving and performance aspects in large-scale distributed systems.
- Investigating energy-aware optical ultra high-speed interconnection networks to exchange large volumes of data (VM memory and storage) over very short periods of time.

⁷The SED is the INRIA Experimentation and Development Service.

8.2.8. IRT B-Com

Participants: Yvon Jégou, Jean-Louis Pazat, Édouard Outin.

Yvon Jégou and Jean-Louis Pazat are at IRT B-Com⁸ one day per week, Yvon Jégou since October 1st and Jean-Louis Pazat since September 1st. With Édouard Outin, B-com phd student, they contribute to the B-Com Indeed project which aims at developing a distributed cloud software stack with a high degree of adaptability.

8.3. European Initiatives

8.3.1. FP7 Projects

8.3.1.1. CONTRAIL

Type: COOPERATION

Defi: Internet of Services, Software & Virtualisation

Instrument: Integrated Project

Objectif: Internet of Services, Software and Virtualisation

Duration: October 2010 - September 2013

Coordinator: Inria

Partner: XLAB Razvoj Programske Opreme In Svetovanje d.o.o., Slovenia; Italian National Research Council, ISTI-CNR & IIT-CNR, Italy; Vrije Universiteit Amsterdam, The Netherlands; Science and Technology Facilities Council, STFC, UK; Genias Benelux bv, The Netherlands; Tiscali Italia SpA, Italy; Konrad-Zuse-Zentrum für Informationstechnik Berlin, ZIB, Germany; Hewlett Packard Italiana S.r.l - Italy Innovation Center, Italy; Country Constellation Technologies Ltd, UK; Linagora, France.

Inria contact: Christine Morin

Abstract: The goal of the Contrail project is to design, implement, evaluate and promote an open source system for Cloud Federations. Resources that belong to different operators will be integrated into a single homogeneous federated Cloud that users can access seamlessly. The Contrail project will provide a complete Cloud platform which integrates Infrastructure-as-a-Service (IaaS) and Platform-as-a-Service (PaaS) offerings [39].

In 2013, we led the evaluation of Contrail software stack [57]. We also completed the design and implementation of VEP [56], [51] advanced features such as the reservation manager and scheduler. We defined a revised version of the API and implemented the CIMI interface. We ported VEP on top of the OpenStack IaaS management system. We worked on the integration of VEP with the other Contrail components. We set up an open permanent testbed for VEP and a testbed running Contrail software stack for internal use by consortium members to allow extensive tests with applications. Christine Morin is the coordinator of Contrail project and Roberto Cascella is the technical manager. Christine Morin leads WP 10 on Contrail global architecture. Yvon Jégou leads WP 5 on VEP and WP 13 on testbeds.

8.3.1.2. BonFIRE

Type: COOPERATION

Defi: Future internet experimental facility and experimentally-driven research

Instrument: Integrated Project

Objectif: ICT-2009.1.6

Duration: June 2010 - December 2013

Coordinator: Atos Spain SA (Spain)

⁸<http://b-com.org/wp/>

Partner: The university of Edinburgh (U.K.); SAP AG (Germany); Universitaet Stuttgart (Germany); Fraunhofer-Gesellschaft zur Foerung der Angewandten Forshung E.V (Germany); Interdisciplinary Institute for Broadband Technology (Belgium); Universidad Complutense De Madrid (Spain) ; Fundacio Privada I2CAT, Internet I Innovacio Digital A Catalunya (Spain); Hewlett-Packard Limited (U.K.); The 451 Group Limited (U.K.) Technische Universitat Berlin (Germany); University of Southampton (U.K.); Inria (France); Instytut Chemii Bioorganicznej Pan (Poland); Nextworks (Italy); Redzinc Services Limited (Ireland); Cloudium systems Limited (Ireland); Fundacio Centro Tecnologico De Supercomputacion De Galicia (Spain); Centre d'Excellence en technologies de l'Information et de la communication (Belgium); University of Manchester (U.K.);

Inria contact: David Margery

Abstract: The BonFIRE (Building service testbeds for Future Internet Research and Experimentation) project has designed, built and operated a multi-site cloud facility to support applications, services and systems research targeting the Internet of Services community within the Future Internet (<http://www.bonfire-project.eu>). The Myriads team is involved in this project as it hosts the Aladdin ADT.

In the context of BonFIRE, we operate one of the five cloud sites integrated into the BonFIRE cloud federation. This cloud site is based on OpenNebula and can be extended on-request to all the machines of the local Grid'5000 site. We have also contributed to the cloud federation layer and host the integration infrastructure for the project, generated from configuration management tools using puppet.

8.3.1.3. PaaSage

Type: COOPERATION

Objectif: ICT-2011.1.2 Cloud Computing, Internet of Services and Advanced Software Engineering

Instrument: Collaborative Project

Duration: October 2012 - September 2016

Coordinator: GEIE ERCIM (France)

Partner: SINTEF (Norway), Science and Technology Facilities Council (UK), University of Stuttgart (Germany), Inria (France), Centre d'Excellence en Technologies de l'Information et de la Communication (Belgium), Foundation for Research and Technology Hellas (Greece), BE.Wan SPRL (Belgium), EVRY AS (Norway), SysFera SAS (France), Flexiant Limited (UK), Lufthansa Systems AG (Germany), Gesellschaft fur Wissenschaftliche Datenverarbeitung MBH Gottingen (Germany), Automotive Simulation Center Stuttgart (Germany), University of Ulm (Germany), Akademia Górniczo-Hutnicza im. Stanisława Staszica (Poland), University of Cyprus (Cyprus), IBSAC-Intelligent Business Solutions ltd (Cyprus), University of Oslo (Norway)

Inria contact: Nikos Parlavantzas

See also: <http://www.paasage.eu/>

Abstract: PaaSage aims to deliver an open and integrated platform to support both deployment and design of Cloud applications, together with an accompanying methodology that allows model-based application development, configuration, optimisation, and deployment on multiple Cloud infrastructures.

8.3.1.4. Fed4FIRE

Type: COOPERATION

Defi: Future internet experimental facility and experimentally-driven research

Instrument: Integrated Project

Objectif: ICT-2011.1.6 Future Internet Research and Experimentation (FIRE) with a specific focus on b) FIRE Federation

Duration: June 2010 - December 2013

Coordinator: ATOS SPAIN SA (Spain)

Partner: Interdisciplinary institute for broadband technology (iMinds, Belgium), University of Southampton (It Innovation, United Kingdom) Universite Pierre et Marie Curie - paris 6 (UPMC, France) Fraunhofer-Gesellschaft zur Foerderung der Angewandten Forschung e.v (Fraunhofer, Germany) Technische Universitat Berlin (TUB, Germany) The University of Edinburgh (UEDIN, United Kingdom) National Ict Australia Limited (NICTA, Australia) Atos Spain SA (Atos, Spain) Panepistimio Thessalias (University of Thessaly) (UTH, Greece) National Technical University of Athens (NTUA, Greece) University of Bristol (UNIVBRIS, United Kingdom) Fundacio Privada i2cat, Internet I Innovacio Digital a Catalunya (i2cat, Spain) Eurescom-European Institute for Research and Strategic Studies in Telecommunications (EUR, GmbH Germany) Delivery of Advanced Network Technology to Europe limited (DANTE limited, United Kingdom) Universidad de Cantabria (UC, Spain) National Information Society agency (NIA, Korea (republic of))

Inria contact: David Margery

Abstract: In Fed4FIRE, we investigate the means by which our experimental platforms (BonFIRE, and in a secondary way Grid'5000) could be made interoperable with a wider eco-system of experimental platforms in Europe and beyond. The baseline architectural choice for this project is to use the key concepts of the Slice Federation Architecture (SFA) to provision resources on experimental platforms, a Control and Management Framework for Networking Testbeds named OMF for experiment control and OML, the OMF Measurement library for data collection. We investigate whether these can be used to run experiments on BonFIRE and how they need to be extended to support to operating model of BonFIRE.

8.3.1.5. *ECO2Clouds*

Type: COOPERATION

Defi: Future internet experimental facility and experimentally-driven research

Instrument: Specific Targeted Research Project

Objectif: ICT-2011.1.6 – Target outcome c) FIRE Experimentation

Duration: October 2012 - September 2014

Coordinator: Atos Spain SA (Spain)

Partner: Atos Spain SA (ATOS, Spain) The University of Manchester (UNIMAN, United Kingdom) The University of Edinburgh (UEDIN, United Kingdom) Universitaet Stuttgart (USTUTT, Germany) Politecnico di Milano (POLIMI, Italy)

Inria contact: David Margery

Abstract: In ECO₂Clouds, we add to BonFIRE energy probes to be able to measure power consumption of the infrastructure, combine it with information about energy sources used to produce the power so as to be able to bill CO₂ usage to experimenters running VMs. To allow for scheduling and adaptation of running applications, CO₂ usage is not only billed after the fact but also quoted in advance for a given period for according to resource usage units.

8.3.1.6. *HARNESS*

Type: COOPERATION

Defi: Pervasive and Trusted Network and Service Infrastructures

Instrument: Small or medium-scale focused research project

Objectif: ICT-2011.1.2 Cloud Computing, Internet of Services and Advanced Software Engineering

Duration: October 2012 - September 2015

Coordinator: Imperial College London (IMP, United Kingdom)

Partner: Ecole polytechnique fédérale de Lausanne (EPFL, Switzerland), Université de Rennes 1 (UR1, France), Konrad-Zuse-Zentrum für Informationstechnik Berlin (ZIB, Germany), Maxeler Technologies (MAX, United Kingdom), SAP AG (SAP, Germany)

UR1 contact: Guillaume Pierre

Abstract: The HARNESS FP7 project aims to incorporate innovative hardware and network technologies seamlessly into data centres that provide platform-as-a-service cloud infrastructures.

The dominant approach in offering cloud services today is based on homogeneous commodity resources: large numbers of inexpensive machines, interconnected by off-the-shelf networking equipment, supported by stock disk drives. However, cloud service providers are unable to use this platform to satisfy the requirements of many important and high-value classes of applications.

Today's cloud platforms are missing out on the revolution in new hardware and network technologies for realising vastly richer computational, communication, and storage resources. Technologies such as Field Programmable Gate Arrays (FPGA), General-Purpose Graphics Processing Units (GPGPU), programmable network routers, and solid-state disks promise increased performance, reduced energy consumption, and lower cost profiles. However, their heterogeneity and complexity makes integrating them into the standard Platform as a Service (PaaS) framework a fundamental challenge.

The HARNESS project brings innovative and heterogeneous resources into cloud platforms through a rich programme of research, validated by commercial and open source case studies.

8.3.2. Collaborations in European Programs, except FP7

8.3.2.1. ICT COST

Participants: Eugen Feller, Christine Morin, Anne-Cécile Orgerie.

Program: ICT COST

Project acronym: IC0804

Project title: Energy efficiency in large scale distributed systems

Duration: 23/01/2009 - 04/05/2013

Coordinator: Professor Jean-Marc PIERSON, IRIT, France, <http://www.irit.fr/cost804/>

Other partners: 22 COST countries and 7 non-COST institutions

Abstract: The COST Action IC0804 proposes realistic energy-efficient alternate solutions to share IT distributed resources. As large scale distributed systems gather and share more and more computing nodes and storage resources, their energy consumption is exponentially increasing. While much effort is nowadays put into hardware specific solutions to lower energy consumptions, the need for a complementary approach is necessary at the distributed system level, i.e. middleware, network and applications. The Action characterizes the energy consumption and energy efficiencies of distributed applications. Then based on the current hardware adaptation possibilities and innovative algorithms it proposes adaptive and alternative approaches taking into account the energy saving dimension of the problem. The Action characterizes the trade-off between energy savings and functional and non-functional parameters, including the economic dimension.

In April 2013, Anne-Cécile Orgerie presented a demonstration of Snooze system at the final COST workshop [36].

8.3.2.2. MC-DATA

Program: EIT ICT Labs

Project acronym: MC-DATA

Project title: Multi-Cloud Data Management

Duration: Jan 2013 - Dec 2014

Coordinator: Imperial College London (IMP, United Kingdom)

Other partners: Université de Rennes 1 (UR1, France), Konrad-Zuse-Zentrum für Informationstechnik Berlin (ZIB, Germany), Swedish Institute of Computer Science (SICS, Sweden), Vodafone (Germany)

Abstract: the MC-DATA project has two main innovation objectives: (a) to provide and release a novel open-source Platform-as-a-Service (PaaS) cloud computing software stack (MC-ConPaaS) that explicitly targets cloud application deployments across multiple data centers; (b) to demonstrate the business value of the MC-ConPaaS platform through a use case of cloud-assisted real-time smartphone applications, thus affecting the future business models of mobile operators.

8.4. International Initiatives

8.4.1. Inria Associate Teams

8.4.1.1. DALHIS

Title: Data Analysis on Large Heterogeneous Infrastructures for Science

Inria principal investigator: Christine Morin

International Partner:

Lawrence Berkeley National Laboratory (United States) - Advanced Computing for Science department led by Deb Agarwal

Duration: 2013 - 2015

See also: <http://project.inria.fr/dalhis>

The worldwide scientific community is generating large datasets at increasing rates causing data analysis to emerge as one of the primary modes of science. Existing data analysis methods, tools and infrastructure are often difficult to use and unable to handle the “data deluge”. A scientific data analysis environment needs to address three key challenges: a) programmability: easily user composable and reusable programming environments for analysis algorithms and pipeline execution, b) agility: software that can adapt quickly to changing demands and resources, and, c) scalability: take advantage of all available resource environments including desktops, clusters, grids, clouds and HPC environments. The goal of the DALHIS associated team is to coordinate research and create together a software ecosystem to facilitate data analysis seamlessly across desktops, HPC and cloud environments. Specifically, our end goal is to build a dynamic environment that is user-friendly, scalable, energy-efficient and fault tolerant through coordination of existing projects. We plan to design a programming environment for scientific data analysis workflows that will allow users to easily compose their workflows in a programming environment such as Python and execute them on diverse high-performance computing (HPC) and cloud resources. We will develop an orchestration layer for coordinating resource and application characteristics. The adaptation model will use real-time data mining to support elasticity, fault-tolerance, energy efficiency and provenance. We will investigate how to provide execution environments that allow users to seamlessly execute their dynamic data analysis workflows in various research environments.

8.4.2. Inria International Partners

8.4.2.1. Informal International Partners

We collaborate on cloud computing with Stephen Scott, Professor at Tennessee Tech University (TTU) and researcher at Oak Ridge National Laboratory (ORNL). He visited Myriads team in September 2013 to investigate research directions for future joint work on cloud computing for scientific applications. We also collaborate on cloud computing with Kate Keahey from Argonne National Laboratory. She chairs the Contrail European project scientific advisory board. Nikos Parlavantzas is involved in an informal collaboration with Héctor Duran Limon, Professor at the University of Guadalajara, Mexico, who came for a 1 week visit in February 2013.

8.4.3. Inria International Labs

Christine Morin was the Inria@Silicon Valley scientific manager until August 2013. She co-organized with Eric Darve, professor at Stanford University and the Inria international relations department the Berkeley-Inria-Stanford workshop (BIS 2013) held at Stanford University in May 2013. Several Myriads team members (Eugen Feller, Christine Morin, Anne-Cécile Orgerie, Cédric Tedeschi) are involved in the DALHIS associate team on data analysis on large-scale heterogeneous infrastructures for science, which is part of the Inria@SiliconValley program. She was also involved in an informal collaboration with the CITRIS Social Apps Lab, led by James Holston and Greg Niemeyer from UC Berkeley. Collaboration opportunities between Inria and the Social Apps Lab on smart cities and social sustainability were investigated.

8.5. International Research Visitors

8.5.1. Visits to International Teams

Christine Morin was on sabbatical until August 2013 in the Advanced Computing for Science department at the Lawrence Berkeley National Laboratory (USA). Eugen Feller has been a post-doc in the Advanced Computing for Science department at the Lawrence Berkeley National Laboratory (USA) as part of the Inria@Silicon Valley program since February 2013. He is involved in the DALHIS associate team.

OASIS Project-Team

7. Partnerships and Cooperations

7.1. National Initiatives

7.1.1. ANR SocEDA

Title: SOcIal Event Driven Architecture

Program: Platform

Duration: July 2009 - October 2013

Coordinator: Linagora (ex EBM Web Sourcing)

Others partners: SMEs: ActiveEon, industry: Thales, OrangeLabs, academics: Inria, CNRS IMAG, LIRIS, ARMINES

See also: <http://www.soceda.org/display/soceda/>

Abstract: SocEDA is an ANR project of type Platform, also labelled by two competitiveness clusters, PEGASE and SCS. The aim is to provide a "Cloud based platform for large scale social aware Event-Driven Architecture (EDA)". OASIS is in charge of managing the storage and publication/subscription of events on the cloud.

7.1.2. ANR Songs

Title: Simulation of Next Generation Systems

Program: Infra 13

Duration: January 2012 - December 2015

Coordinator: Inria (Nancy, Grenoble, Bordeaux)

Others partners: IN2P3 Villeurbanne, LSIIT Strasbourg, I3S Sophia-Antipolis, LINA Nantes

See also: <http://infra-songs.gforge.inria.fr/>

Abstract: SONGS (2012-2015) is the continuity of SIMGRID project (2009-2012), in the ANR INFRA program. The aim of SONGS is to continue the development of the SimGrid simulation platform for the study of large distributed architectures, including data grids, cloud computing facilities, peer-to-peer applications and HPC/exascale architectures.

7.1.3. FUI CloudForce (now OpenCloudWare)

Program: FSN, labelled by Minalogic, Systematic and SCS.

Duration: January 2012 - December 2014

Coordinator: France-Telecom Research

Others partners: ActiveEon, Armines, Bull, eNovance, eXo Platform, France Telecom (coordinator), Inria, IRIT – INP Toulouse, Linagora, OW2, Peergreen, Télécom Paris Tech, Télécom Saint Etienne, Thales Communications, Thales Services, Université Joseph Fourier, Université de Savoie – LISTIC, UShareSoft

See also: <http://www.opencloudware.org/>

Abstract: The OpenCloudware project aims at building an open software engineering platform for the collaborative development of distributed applications to be deployed on multiple Cloud infrastructures.

The results of OpenCloudware will contain a set of software components to manage the lifecycle of such applications, from modelling (Think), developing and building images (Build), to a multi-IaaS compliant PaaS platform (Run) for their deployment, orchestration, performance testing, self-management (elasticity, green IT optimisation), and provisioning. Applications will be deployed potentially on multi IaaS (supporting either one IaaS at a time, or hybrid scenarios). The results of the project will be made available as open source components through the OW2 Open Source Cloudware initiative.

7.1.4. Oseo-Isis Spinnaker

Duration: June 2011 - May 2015

Coordinator: Tagsys-RFID

Others partners: SMEs: Inside-Secure, STIC, Legrand; Academic: IPG, ENS des Mines de St Etienne, Un. du Maine, Un. F. Rabelais Tours, AETS ESEO Angers, Un. Marne la Vallée, Un. Paris 6, Un. Rennes 1, Inria.

See also: <http://www.spinnaker-rfid.com/>

Abstract: The objective of Spinnaker is to really allow RFID technology to be widely and easily deployed. The role of the OASIS team in this project is to allow the wide scale deployment and management of the specific RFID application servers in the cloud, so to build an end-to-end robust and flexible solution using GCM technology.

7.2. European Initiatives

7.2.1. FP7 Projects

7.2.1.1. PLAY

Title: Pushing dynamic and ubiquitous interaction between services Leveraged in the future Internet by ApplYing complex event processing

Type: COOPERATION

Defi: Internet of Services, Software & Virtualisation

Instrument: Specific Targeted Research Project

Objectif: Internet of Services, Software and Virtualisation

Duration: October 2010 - September 2013

Coordinator: FZI (Germany)

Other Partners: EBM WebSourcing (Fr), Inria (OASIS and SARDES) (Fr), France Telecom/OrangeLabs (Fr), ICCS (Gr), Ecole des Mines Albi/Armines (Fr), CIM (Serbia).

Inria contact: Françoise Baude

See also: <http://www.play-project.eu/>

Abstract: The PLAY project aims to develop and validate an elastic and reliable architecture for dynamic and complex, event-driven interaction in large highly distributed and heterogeneous service systems. Such an architecture enables ubiquitous exchange of information between heterogeneous services, providing the possibilities to adapt and personalize their execution, resulting in the so-called situational-driven process adaptivity. The OASIS team is in charge of designing the key element of the PLAY Platform: the Event Cloud that is a publish/subscribe P2P based system, developed using the GCM technology.

7.2.1.2. FI-WARE

Type: COOPERATION

Defi: PPP FI: Technology Foundation: Future Internet Core Platform

Instrument: Integrated Project

Objectif: PPP FI: Technology Foundation:Future Internet Core Platform

Duration: September 2011 - May 2014

Coordinator: Telefonica (Spain)

Others partners: Thales, SAP, Inria

Inria contact: Olivier Festor

See also: <http://www.fi-ware.eu/>

Abstract: FI-WARE will deliver a novel service infrastructure, building upon elements (called Generic Enablers) which offer reusable and commonly shared functions making it easier to develop Future Internet Applications in multiple sectors. This infrastructure will bring significant and quantifiable improvements in the performance, reliability, and production costs linked to Internet applications, building a true foundation for the future Internet.

7.2.1.3. DC4Cities

Type: COOPERATION

Defi: FP7 Smartcities 2013

Instrument: Specific Targeted REsearch Project

Objectif: ICT-2013.6.2: Data Centers in an energy-efficient and environmentally friendly Internet

Duration: September 2013 - February 2016

Coordinator: Freemind Consulting (BE)

Partners: U. Mannheim (DE), U. Passau (DE), HP Italy Innovation Center (IT), Create-Net (IT), ENEA (IT), CESCO Catalunya (ES), Gas Natural SA (ES), Inst. Munic. Informatica Barcelona (ES), Inria (FR)

Inria contact: Eric Madelaine

See also:

Abstract: Data centres play two different and complementary roles in Smart Cities' energy policies: as ICT infrastructures supporting Smart City resource optimization systems - more in general, delivering ICT services to the citizens - and as large energy consumers. Therefore there are huge expectations on data centres being able to run at the highest levels of renewable energy sources: this is the great challenge of DC4Cities project.

The goal of DC4Cities is to make existing and new data centres energy adaptive, without requiring any modification to the logistics, and without impacting the quality of the services provided to their users. Finally new energy metrics, benchmarks, and measurement methodologies will be developed and proposed for the definition of new related standards. DC4Cities will promote the data centres role as an "eco-friendly" key player in the Smart Cities energy policies, and will foster the integration of a network of local renewable energy providers (also interconnected with local Smart Grids and Micro Grids) to support the pursued increase of renewable energy share.

7.2.2. Collaborations in European Programs, except FP7

Program: EIT ICTLabs

Project acronym: Activity 13 052 from Intelligent Mobility and Transportation Systems action line (IMS), renamed Future Urban Life and Mobility (ULM) mid 2013

Project title: Multimodal Mobility

Duration: 2013, January to December

Coordinator: F. Baude and B. Kwella (Fraunhofer Gesellschaft)

Other partners: Inria, BME (Hungary), TUBerlin, U. Bologna, Telecom Italia, Siemens/VMZ (Germany), DFKI (Germany)

Abstract: The activity seeks to specify the building blocks, a platform and a prototype for the provision of multimodal mobility. The main motivation is to facilitate the use of ICT to support the efficient organization of Accessible Mobility (support for people with special needs, economical optimization of mobility and transportation, trip planning, information on available transport modes, etc). It therefore provides the basis for sustainable future mobility

7.3. International Initiatives

7.3.1. Inria Associate Teams

7.3.1.1. DISSIMINET

Title: Web-Service approaches for simulation

Inria principal investigator: Olivier Dalle

International Partner (Institution - Laboratory - Researcher):

Carleton University (Canada) - Advanced Real-Time Simulation Laboratory - Gabriel Wainer

Duration: 2011 - 2013

See also: <http://www.inria.fr/en/teams/dissiminet>

This Franco-Canadian team will advance research on the definition of new algorithms and techniques for component-based simulation using a web-services based approach. On one hand, the use of web-services is expected to solve the critical issues that pave the way toward the simulation of systems of unprecedented complexity, especially (but not exclusively) in the studies involving large networks such as Peer-to-peer networks. Web-Service oriented approaches have numerous advantages, such as allowing the reuse of existing simulators, allowing non-computer experts to merge their respective knowledge, or seamless integration of complementary services (eg. on-line storage and repositories, weather forecast, traffic, etc.). One important expected outcome of this approach is to significantly improve the simulation methodology in network studies, especially by enforcing the seamless reproducibility and traceability of simulation results. On the other hand, a net-centric approach of simulation based on web-services comes at the cost of added complexity and incurs new practices, both at the technical and methodological levels. The results of this common research will be integrated into both teams' discrete-event distributed simulators: the CD++ simulator at Carleton University and the simulation middle-ware developed in the MASCOTTE EPI, called OSA, whose developments are supported by an Inria ADT starting in December 2011.

7.3.1.2. DAESD

Title: Distributed/Asynchronous, Embedded/synchronous System Development

Inria principal investigator: Eric Madelaine

International Partner (Institution - Laboratory - Researcher):

East China Normal University (ECNU) Shanghai - SEI - Yixiang Chen

Duration: 2012 - 2014

See also: <http://team.inria.fr/DAESD>

The development of concurrent and parallel systems has traditionally been clearly split in two different families; distributed and asynchronous systems on one hand, now growing very fast with the recent progress of the Internet towards large scale services and clouds; embedded, reactive, or hybrid systems on the other hand, mostly of synchronous behaviour. The frontier between these families has attracted less attention, but recent trends, e.g. in industrial systems, in "Cyber-Physical systems", or in the emerging "Internet of Things", give a new importance to research combining them.

The aim of the DAESD associate team is to combine the expertise of the Oasis and Aoste teams at Inria, the SEI-Shone team at ECNU-Shanghai, and to build models, methods, and prototype tools inheriting from synchronous and asynchronous models. We plan to address modelling formalisms and tools, for this combined model; to establish a method to analyze temporal and spatial consistency of embedded distributed real-time systems; to develop scheduling strategies for multiple tasks in embedded and distributed systems with mixed constraints.

7.3.1.3. SCADA

Title: Safe Composition of Autonomic Distributed Applications

Inria principal investigator: Ludovic Henrio

International Partner (Institution - Laboratory - Researcher):

University of Chile (Chile) - NIC Chile Research Labs - Javier Bustos

Duration: 2012 - 2014

See also: <http://team.inria.fr/scada>

The SCADA project aims at promoting the collaboration between NIC LABS (Santiago - Chile) and OASIS team (Inria Sophia Antipolis - France) in the domain of the safe composition of applications. More precisely the project will extend existing composition patterns dedicated to parallel or distributed computing to ease the reliable composition of applications. The strong interactions between formal aspects and practical implementation are a key feature of that project, where formal methods, and language theory will contribute to the practical implementation of execution platforms, development and debugging tools, and verification environments. The composition models we focus on are algorithmic skeletons, and distributed components; and we will particularly focus on the programming and verification of non-functional features. Overall, from formal specification and proofs, this project should lead to the implementation of tools for the design and execution of distributed and parallel applications with a guaranteed behavior.

7.3.2. Inria International Labs

7.3.2.1. CIRIC Chili

Ciric research line: Telecommunications

Inria principal investigator: Eric Madelaine

Duration: 2012 - 2021

This CIRIC activity is loosely coupled with our SCADA associated team with the Universidad de Chile (UdC). We have had some contacts with a software company in Santiago, and starting exploring some possible collaboration in the area of formal specification of distributed applications for Android systems, and generation of “safe by construction” android code. But the effective involvement of CIRIC manpower in this activity has not yet started.

7.3.2.2. LIAMA Shanghai

Liama project: HADES

Inria principal investigator: Robert de Simone

Oasis researchers involved: Eric Madelaine, Ludovic Henrio

Duration: 2013 - 2016

Modern computing architectures are becoming increasingly parallel, at all levels. Meanwhile, typical applications also display increasing concurrency aspects, specially streaming applications involving data and task parallelism. Cyber physical system interactions also add extra-functional requirements to this high degree of concurrency. The goal of best fitting applications onto architectures becomes a crucial problem, which must be tackled from any possible angle. Our position in the HADES LIAMA project is to consider modeling of applications using formal models of concurrent computation, and specialized model-driven engineering approaches to embody the design flow for such models (analysis, verification, mapping allocation, representation of non-functional properties and constraints). We build on various previous domains of expertise : synchronous languages for embedded system design, asynchronous languages for high-performance cloud computing, and real-time specification languages for cyber-physical interaction aspects.

In 2013, HADES and the DAESD associated team organised a joint “Spring School” at ECNU Shanghai, held in conjunction with the official inaugural LIAMA Shanghai Open day.

7.4. International Research Visitors

7.4.1. Visits of International Scientists

Participant: Ass. Pr. Xavier Défago.

Date: from 16 Sep. 2013 to 31 Jan. 2014

Institution: Dependable Distributed Systems Lab., Japan Advanced Institute of Science and Technology (JAIST), Nomi, Ishikawa, Japan

This visit is founded by CNRS and shared between the OASIS and COATI teams.

Participant: Pr. Gabriel Wainer.

Date: from 14 Jun. to 13 Jul. 2013

Institution: Carleton University, Ottawa (CA)

This visit is in the context of our DISSIMINET associated team

Participant: Pr. Yixiang Chen.

Date: 14-17 Oct. 2013

Institution: East China Normal University, Shanghai (CN)

This visit is in the context of our DAESD associated team

Participant: Ass. Pr. Min Zhang.

Date: 11-16 Sep. 2013

Institution: East China Normal University, Shanghai (CN)

This visit is in the context of our DAESD associated team

Participant: Elena Giachino.

Date: 27-29 Mar. 2013

Institution: Univ. of Bologna

Subject: Collaborative work on deadlock analysis for ABS and ASP

Participant: Pr. Mizuhito Ogawa.

Date: 26-29 Mar. 2013

Institution: Dependable Distributed Systems Lab., Japan Advanced Institute of Science and Technology (JAIST), Nomi, Ishikawa, Japan.

Subject: Collaborative work on fundamental aspects of distributed computing and theorem proving techniques.

7.4.1.1. Internships

Yanwen Chen

Subject: Programmation d'applications hétérogènes embarquées et distribuées

Date: from Jan. 2013 until Jun. 2013

Institution: East China Normal University (China)

This visit is in the context of the cotutelle PhD of Yanwen Chen, under the direction of E. Madelaine.

Dongqian Liu

Subject: Generation of behavioural models in the VerCors platform

Date: from Oct. 2013 until Dec. 2013

Institution: East China Normal University (China)

This visit is in the context of the DAESD associated team.

Michel Jackson de Souza

Subject: Distributed coherent snapshot solution for the P2P CAN-based EventCloud

Date: from July 2012 until Aug. 2013

Institution: UFBA Federal University of Bahia (Brasil), Science sans Frontière brazilian mobility program

This visit is organized after spontaneous contacts, as a complementary work for the student bachelor studies.

PHOENIX Project-Team

7. Partnerships and Cooperations

7.1. Regional Initiatives

7.1.1. *HomeAssist: Platform for Assisted Living*

The objective of this project is to provide an open platform of digital assistance dedicated to aging in place. This project is in collaboration with researchers in Cognitive Science (Bordeaux University) and the UDCCAS Gironde (Union Départementale des Centres Communaux d'Action Sociale) managing elderly care. This project includes a need analysis, the development of assistive applications and their experimental validation.

This work is funded by CARSAT Aquitaine (“Caisse d'Assurance Retraite et de la Santé au Travail”), Aquitaine Region and Conseil Général de la Gironde.

7.1.2. *Cognitive Assistance for Supporting the Autonomy of Persons with Intellectual Disabilities*

The objective of this project is to develop assistive technologies enabling people with intellectual disabilities to gain independence and to develop self-determined behaviors, such as making choices and taking decisions. This project is in collaboration with the “Handicap et Système Nerveux” research group (EA 4136, Bordeaux University), the TSA Chair of UQTR (Université du Québec à Trois-Rivières) in Psychology and the Association Trisomie 21 Gironde (Down's Syndrome). The TSA chair has recently designed and built a smart apartment that is used to conduct experimental evaluation of our assistive technologies in realistic conditions.

7.1.3. *Certification of an open platform*

The purpose of this project is to define concepts and tools for developing certifying open platforms. This certification process must ensure a set of critical properties (e.g., safety, confidentiality, security) by certifying each tier application. These guarantees are essential to ensure that openness does not come at the expense of the user's well-being. To preserve the innovation model of open platforms, this certification process should also be as automatic as possible. Indeed, the success of open platforms is mainly due to the low development cost of a new application. The case study of this thesis will be the domain of home automation. The results of this thesis will be put into practice in the DiaSuiteBox open platform.

This project is funded by Aquitaine Region.

7.2. National Initiatives

7.2.1. *Objects' World: design-driven development of large-scale smart spaces*

The goal of this project is to develop an innovative communication technology, allowing the emergence of a new economic sector for large-scale smart spaces. Our objective is to propose concepts and tools for developing reliable applications orchestrating large-scale smart spaces of networked entities. The industrial partners of the Objects' World project will provide us with real-size case studies in various application domains (e.g., smart cities, tracking of vehicles, healthcare, energy management).

This work is funded by the OSEO national agency.

7.2.2. *School Inclusion for Children with Autism*

The objective of this project is to provide children with assistive technologies dedicated to the school routines. This project is in collaboration with the “Handicap et Système Nerveux” research group (EA 4136, Bordeaux University), the PsyCLÉ research center (EA 3273, Provence Aix-Marseille University) and the “Parole et Langage” research laboratory (CNRS, Provence Aix-Marseille University).

This work is funded by the French Ministry of National Education.

7.3. European Initiatives

7.3.1. FP7 Projects

Program: FP7 - ICT - 2013.5.3

Project acronym: RAPP

Project title: Robotic Applications for Delivering Smart User Empowering Applications

Duration: From Dec-2013 until Dec-2016

Coordinator: Center For Research and Technology Hellas, CERTH/ITI, Greece

Other partners:

- Politechnika Warszawska, WUT, Poland
- Sigma Orionis SA, France
- Ortelio LTD, United Kingdom
- Idryma Ormylia, Greece
- Fundacion Instituto Gerontologico Matia - Ingema, Spain

Abstract: RAPP will provide a software platform in order to support the creation and delivery of robotics applications (RAPPs) targeted to people at risk of exclusion, especially older people. The open-source software platform will provide an API that contains the functionalities for implementing RAPPs and accessing the robot's sensors and actuators using higher level commands, by adding a middleware stack with added functionalities suitable for different kinds of robots. RAPP will expand the computational and storage capabilities of robots and enable machine learning operations, distributed data collection and processing, and knowledge sharing among robots in order to provide personalized applications based on adaptation to individuals. The use of a common API will assist developers in creating improved applications for different types of robots that target to people with different needs, capabilities and expectations, while at the same time respect their privacy and autonomy, thus the proposed RAPP Store will have a profound effect in the robotic application market. The results of RAPP will be evaluated through the development and benchmarking of social assistive RAPPs, which exploit the innovative features (RAPP API, RAPP Store, knowledge reuse, etc.) introduced by the proposed paradigm.

7.3.2. Collaborations in European Programs, except FP7

Program: SUDOE territorial cooperation program (Interreg IV B)

Project acronym: Biomassud

Project title: Mechanisms for sustainability and enhancement of solid biomass market in the space of SUDOE

Duration: July 2011 - June 2013

Coordinator: AVEBIOM

Other partners: UCE (Consumers Union of Spain), CIEMAT (Public Research Agency for excellence in energy and environment, Spain), CBE (Centro da Biomassa para a Energia, Portugal), CVR (Centro para la Valorización de Residuos, Portugal) and UCFE (Union Française de la Coopération Forestière, France)

Abstract: The goal of the Biomassud European project is to show the viability of the biomass-based energy model. The project aims to propose a certification and traceability process throughout the value chain of biofuel. Our objective is to design and implement a prototype of traceability system that will extract automatically traceability information based on sensors such as RFID tags, simplifying the certification process. This work will leverage our DIASUITE development methodology and will be evaluated by the Biomassud partners.

7.4. International Initiatives

7.4.1. Inria Associate Teams

7.4.1.1. OPALI

Title: OPen Assistive-technology platform for independent LIving

Inria principal investigator: Emilie Balland

International Partner (Institution - Laboratory - Researcher): University of Québec Trois-Rivières (Canada) - TSA Research Chair - Dany Lussier-Desrochers

Duration: 2013 - 2015

See also: <http://phoenix.inria.fr/opali>

The goal of the OPALI project is to develop an Open Platform for Assisted Living targeting users with cognitive disabilities. It is a cross-disciplinary project combining expertise in (1) Computer Science focusing in development of applications orchestrating networked devices and (2) Psychology focusing in assistive technologies for users with cognitive disabilities. Furthermore, this project will leverage a unique research vehicle created by the University of Trois-Rivières consisting of a full-fledged apartment equipped with a range of networked devices and dedicated to experimental studies. The outcome of the project will include a large catalog of assistive applications allowing to match each user's project life.

7.5. International Research Visitors

7.5.1. Visits to International Teams

- Charles Consel, sabbatical year at McGill University, Montreal, Canada (From August 2012 to July 2013)

RAP Project-Team

6. Partnerships and Cooperations

6.1. International Research Visitors

RAP team has received the following people:

- Louigi Addario-Berry (McGill)
- Jit Bose (Carleton)
- Vida Dujmovic (Carleton)
- Christina Goldschmidt (Oxford)
- Stefan Langerman (UL Bruxelles)
- Gabor Lugosi (Pompeu Fabra)
- Cecile Mailler (UVSQ)
- Kavita Ramanan (Brown)
- Yuting Wen (McGill)

6.2. National Research Visitors

RAP team has received the following people:

- Thomas Bonald (Telecom ParisTech, Paris)
- Fabrice Guillemin (Orange Labs)
- Esther le Rouzic (Orange Labs)

REGAL Project-Team

7. Partnerships and Cooperations

7.1. National Initiatives

7.1.1. *InfraJVM - (2012–2015)*

Members: LIP6 (Regal), Ecole des Mines de Nanes (Constraint), IRISA (Triskell), LaBRI (LSR).

Funding: ANR Infra.

Objectives: The design of the Java Virtual Machine (JVM) was last revised in 1999, at a time when a single program running on a uniprocessor desktop machine was the norm. Today's computing environment, however, is radically different, being characterized by many different kinds of computing devices, which are often mobile and which need to interact within the context of a single application. Supporting such applications, involving multiple mutually untrusted devices, requires resource management and scheduling strategies that were not planned for in the 1999 JVM design. The goal of InfraJVM is to design strategies that can meet the needs of such applications and that provide the good performance that is required in an MRE.

The coordinator of InfraJVM is Gaël Thomas. Infra-JVM brings a grant of 202 000 euros from the ANR to UPMC over three years.

7.1.2. *Nuage - (2012–2014)*

Members: Non Stop Systems (NSS), Oodrive, Alphalink (Init SYS), CELESTE, DotRiver, NewGeneration, LIP6 (Regal et Phare)

Funding: Fonds National pour la Société Numérique, CDC

Objectives: The Nuage project aims at designing and building an open source, energy-aware, cloud based on OpenStack. In this project, the Regal group contributes on the storage axis. In clouds, virtualization forms the basis to ensure flexibility, portability and isolation. However, the price to pay for flexibility and isolation is memory fragmentation. We thus propose to pool unused memory by allowing nodes to use memory of other nodes to extend their cache, at the kernel level.

It involves a grant of 153 000 euros over 2,5 years.

7.1.3. *ODISEA - (2011–2014)*

Members: Orange, LIP6 (Regal), UbiStorage, Technicolor, Institut Telecom

Funding: FUI project, Ile de France Region

Objectives: ODISEA aims at designing new on-line data storage and data sharing solutions. Current solutions rely on big data centers, which induce many drawbacks: (i) a high cost, (ii) proprietary solutions, (iii) inefficiency (one single location, not necessarily close to the user). The goal is to tackle these issues by designing a distributed/decentralized solution that leverage edge resources like set-top boxes.

It involves a grant of 159 000 euros from Region Ile de France over three years.

7.1.4. *Richelieu - (2012–2014)*

Members: LIP6 (Regal), Scilab Entreprise, Silkan, OCaml Pro, Inria Saclay, Arcelor Mittal, CNES, Dassault Aviation.

Funding: FUI.

Objectives: The goal of Richelieu is to design a new runtime for the Scilab language based on VMKit. Scilab is a scientific language and its runtime relies on a costly interpretation loop. In the Richelieu project, we propose to replace the interpretation loop by VMKit, which provides both an efficient Just In Time Compiler and advanced memory management techniques.

It involves a grant of 135 000 euros from Region Ile de France over two years.

7.1.5. MyCloud (2011–2014)

Members: Inria Rhones-Alpes (SARDES), LIP6 (REGAL), EMN, WeAreCloud, Elastic Cloud.

Funding: MyCloud project is funded by ANR Arpège.

Objectives: Cloud Computing is a paradigm for enabling remote, on-demand access to a set of configurable computing resources. The objective of the MyCloud project is to define and implement a novel cloud model: SLAaaS (SLA aware Service). Novel models, control laws, distributed algorithms and languages will be proposed for automated provisioning, configuration and deployment of cloud services to meet SLA requirements, while tackling scalability and dynamics issues. It involves a grant of 155 000 euros from ANR to LIP6 over three years.

7.1.6. ConcoRDanT (2010–2014)

Members: Inria Regal, project leader; LORIA, Universide Nova de Lisboa

Funding: ConcoRDanT is funded by ANR Blanc.

Objectives: CRDTs for consistency without concurrency control in Cloud and Peer-To-Peer systems. Massive computing systems and their applications suffer from a fundamental tension between scalability and data consistency. Avoiding the synchronisation bottleneck requires highly skilled programmers, makes applications complex and brittle, and is error-prone. The ConcoRDanT project investigates a promising new approach that is simple, scales indefinitely, and provably ensures eventual consistency. A Commutative Replicated Data Type (CRDT) is a data type where all concurrent operations commute. If all replicas execute all operations, they converge; no complex concurrency control is required. We have shown in the past that CRDTs can replace existing techniques in a number of tasks where distributed users can update concurrently, such as co-operative editing, wikis, and version control. However CRDTs are not a universal solution and raise their own issues (e.g., growth of meta-data). The ConcoRDanT project engages in a systematic and principled study of CRDTs, to discover their power and limitations, both theoretical and practical. Its outcome will be a body of knowledge about CRDTs and a library of CRDT designs, and applications using them. We are hopeful that significant distributed applications can be designed using CRDTs, a radical simplification of software, elegantly reconciling scalability and consistency. ConcoRDanT involves a grant of 192 637 euros from ANR to Inria over three and a half years.

7.1.7. STREAMS (2010–2014)

Members: LORIA (Score, Cassis), Inria (Regal, ASAP), Xwiki.

Funding: STREAMS is funded by ANR Arpège.

Objectives: Solutions for a peer-To-peer REAL-tiMe Social web The STREAMS project proposes to design peer-to-peer solutions that offer underlying services required by real-time social web applications and that eliminate the disadvantages of centralised architectures. These solutions are meant to replace a central authority-based collaboration with a distributed collaboration that offers support for decentralisation of services. The project aims to advance the state of the art on peer-to-peer networks for social and real-time applications. Scalability is generally considered as an inherent characteristic of peer-to-peer systems. It is traditionally achieved using replication techniques. Unfortunately, the current state of the art in peer-to-peer networks does not address replication of continuously updated content due to real-time user changes. Moreover, there exists a tension between sharing data with friends in a social network deployed in an open peer-to-peer network and ensuring privacy. One of the most challenging issues in social applications is how to balance collaboration

with access control to shared objects. Interaction is aimed at making shared objects available to all who need them, whereas access control seeks to ensure this availability only to users with proper authorisation. STREAMS project aims at providing theoretical solutions to these challenges as well as practical experimentation. It involves a grant of 57 000 euros from ANR to Inria over three and a half years.

7.1.8. ABL - (2009–2013)

Members: Gilles Muller, Julia Lawall, Gaël Thomas, Suman Saha.

Funding: ANR Blanc.

Objectives: The goal of the “A Bug’s Life” (ABL) project is to develop a comprehensive solution to the problem of finding bugs in API usage in open source infrastructure software. The ABL project has grown out of our experience in using the Coccinelle code matching and transformation tool, which we have developed as part of the former ANR project Blanc Coccinelle, and our interactions with the Linux community. Coccinelle targets the problem of documenting and automating collateral evolutions in C code, specifically Linux code. A collateral evolution is a change that is needed in the clients of an API when the API changes in some way that affects its interface. Coccinelle provides a language for expressing collateral evolutions by means of Semantic Patches, and a transformation tool for performing them automatically.

ABL concluded in 2013 with the defense of the PhD thesis of Suman Saha in March and the publication of Saha’s PhD work at the IEEE conference Dependable Systems and Networks (DSN) in June. At DSN, Saha received the William C. Carter Award for best student paper. This is the only best paper award given at DSN and was the first time that the recipient was from a French university. Saha has since taken a postdoc position jointly at Harvard and Lehigh Universities.

7.2. European Initiatives

7.2.1. FP7 Projects

7.2.1.1. SyncFree

Type: COOPERATION

Challenge: Pervasive and Trusted Network and Service Infrastructures

Instrument: Specific Targeted Research Project

Objectives: ICT-2013.1.2 “Software Engineering, Services and Cloud Computing,” ICT-2013.1.6 “Connected and Social Media”

Duration: October 2013 - September 2016

Coordinator: Marc Shapiro (Inria)

Partners: Inria (Regal & Score), Basho Technologies Inc., Trifork A/S, Rovio Entertainment Oy, U. Nova de Lisboa, U. Catholique de Louvain, Koç U., Technische U. Kaiserslautern.

Inria contact: Marc Shapiro

Abstract: The goal of SyncFree is to enable large-scale distributed applications *without global synchronisation*, by exploiting the recent concept of *Conflict-free Replicated Data Types* (CRDTs). CRDTs allow unsynchronised concurrent updates, yet ensure data consistency. This radical new approach maximises responsiveness and availability; it enables locating data near its users, in decentralised clouds.

Global-scale applications, such as virtual wallets, advertising platforms, social networks, online games, or collaboration networks, require consistency across distributed data items. As networked users, objects, devices, and sensors proliferate, the consistency issue is increasingly acute for the software industry. Current alternatives are both unsatisfactory: either to rely on synchronisation

to ensure strong consistency, or to forfeit synchronisation and consistency altogether with ad-hoc eventual consistency. The former approach does not scale beyond a single data centre and is expensive. The latter is extremely difficult to understand, and remains error-prone, even for highly-skilled programmers.

SyncFree avoids both global synchronisation and the complexities of ad-hoc eventual consistency by leveraging the formal properties of CRDTs. CRDTs are designed so that unsynchronised concurrent updates do not conflict and have well-defined semantics. By combining CRDT objects from a standard library of proven datatypes (counters, sets, graphs, sequences, etc.), large-scale distributed programming is simpler and less error-prone. CRDTs are a practical and cost-effective approach.

The SyncFree project will develop both theoretical and practical understanding of large-scale synchronisation-free programming based on CRDTs. Project results will be new industrial applications, new application architectures, large-scale evaluation of both, programming models and algorithms for large-scale applications, and advanced scientific understanding.

7.2.2. Collaborations in European Programs, except FP7

Program: COST Action IC1001

Project acronym: Euro-TM

Project title: Transactional Memories: Foundations, Algorithms, Tools, and Applications

Duration: 2011–2014

Coordinator: Dr. Paolo Romano (INESC)

Other partners: Austria, Czech Republic, Denmark, France, Germany, Greece, Israel, Italy, Norway, Poland, Portugal, Serbia, Spain, Sweden, Switzerland, Turkey, United Kingdom.

Inria contact: Marc Shapiro

Abstract: Parallel programming (PP) used to be an area once confined to a few niches, such as scientific and high-performance computing applications. However, with the proliferation of multicore processors, and the emergence of new, inherently parallel and distributed deployment platforms, such as those provided by cloud computing, parallel programming has definitely become a mainstream concern. Transactional Memories (TMs) answer the need to find a better programming model for PP, capable of boosting developers' productivity and allowing ordinary programmers to unleash the power of parallel and distributed architectures avoiding the pitfalls of manual, lock based synchronization. It is therefore no surprise that TM has been subject to intense research in the last years. This Action aims at consolidating European research on this important field, by coordinating the European research groups working on the development of complementary, interdisciplinary aspects of Transactional Memories, including theoretical foundations, algorithms, hardware and operating system support, language integration and development tools, and applications.

7.2.3. Collaborations with Major European Organizations

Center for Informatics and Information Technologies (CITI) of Universidade Nova de Lisboa

Commutative Replicated Data Type (CRDT)

7.3. International Initiatives

7.3.1. Inria International Partners

7.3.1.1. Declared Inria International Partners

7.3.1.1.1. Dependability of dynamic distributed systems for ad-hoc networks and desktop grid (ONDINA) (2011-2013)

Members: Inria Paris Rocquencourt (REGAL), Inria Rhone-Alpes (Avalon), UFBA (Bahia, Brazil)

Funding: Inria

Objectives: Modern distributed systems deployed over ad-hoc networks, such as MANETs (wireless mobile ad-hoc networks), WSNs (wireless sensor networks) or Desktop Grid are inherently dynamic and the issue of designing reliable services which can cope with the high dynamics of these systems is a challenge. This project studies the necessary conditions, models and algorithms able to implement reliable services in these dynamic environments.

7.3.1.1.2. Enabling Collaborative Applications For Desktop Grids (ECADeG) (2011–2013)

Members: Inria Paris Rocquencourt (REGAL), USP (Sao Paulo, Brazil)

Funding: Inria

Objectives: The overall objective of the ECADeG research project is the design and implementation of a desktop grid middleware infrastructure for supporting the development of collaborative applications and its evaluation through a case study of a particular application in the health care domain.

7.3.2. Participation in other International Programs

7.3.2.1. Improving Clone Detection for Systems Software, Merlion Project - (2013)

Members: Julia Lawall, Gilles Muller, Lisong Guo, Peter Senna Tschudin.

Funding: Institut Français de Singapour.

Objectives: Clone detection is a technique for finding similar code fragments scattered across a code base. Clone detection is potentially very relevant to operating systems code, as many operating system services, such as drivers for related devices, have similar functionalities, and thus similar implementations. Nevertheless, the application of clone detection to systems code has achieved only moderate success, finding clone rates of only 10-20% in Linux kernel code. The purpose of this project is to consider how clone detection can be more effectively used in systems code development, for *e.g.*, code understanding or bug finding.

7.4. International Research Visitors

7.4.1. Visits of International Scientists

- Rachid Guerraoui, Professor, 1 month from EPFL, Switzerland.
- Kenji Kono, Professor, 3 months from University Keio, Japan.
- David Lo, Assistant Professor, 1 week, and Yuan Tian, PhD student, 1 month, both from Singapore Management University, in the context of a Merlion France-Singapore collaboration grant.
- Luis R. Rodriguez, 2 months, from Qualcomm, USA.

7.4.2. Internships

Participant: Dang Nhan Nguyen.

Subject: Scalable old-generation garbage collection for NUMA multicores.

Date: from Jan 2013 until Jun 2013

Institution: Chalmers U. (Sweden)

Participant: Mudit Verma.

Subject: Relaxed synchronization for library datatypes in NUMA multicores.

Date: from Jan 2013 until Jun 2013

Institution: Int. Masters in Distr. Computing / KTH (Sweden)

Participant: Burcu Kùlahçiođlu Özkan.

Subject: Verifying distributed systems based on CRDTs

Date: from Jan 2013 until Jun 2013

Institution: Koç U., Turquie.

7.4.3. Visits to International Teams

- Julia Lawall, 2 weeks, to Singapore Management University, in the context of a Merlion France-Singapore collaboration grant.

RMOD Project-Team

8. Partnerships and Cooperations

8.1. Regional Initiatives

We have signed a convention with the CAR team led by Noury Bouraqadi of Ecole des Mines de Douai. In such context we co-supervised two PhD students (Mariano Martinez-Peck, Nick Papoylias and Guillermo Polito). The team is also an important contributor and supporting organization of the Pharo project.

8.2. National Initiatives

8.2.1. ANR

8.2.1.1. Cutter

Participants: Stéphane Ducasse [Correspondant], Nicolas Anquetil, Damien Pollet, Muhammad Bhatti, Andre Calvante Hora.

This partnership is done with the following members from the LIRMM-D'OC-APR: Marianne Huchard, Roland Ducournau, Jean-Claude König, Rodokphe Giroudeau, Abdelhak-Djamel Seriai, and Rémi Watrigant.

CUTTER is a Basic Research project that addresses the problems of object-oriented system remodularization by developing, combining, and evaluating new techniques for analyzing and modularizing code. In particular, it will: (i) use concurrently and collaboratively four package decomposition techniques; and (ii) take into account different levels of abstractions (packages, classes).

8.3. European Initiatives

8.3.1. IAP MoVES

Participant: Stéphane Ducasse [correspondant].

The Belgium IAP (Interuniversity Attraction Poles) MoVES (Fundamental Issues in Software Engineering: Modeling, Verification and Evolution of Software) is a project whose partners are the Belgium universities (VUB, KUL, UA, UCB, ULB, FUNDP, ULg, UMH) and three European institutes (Inria, IC and TUD) respectively from France, Great Britain and Netherlands. This consortium combines the leading Belgian research teams and their neighbors in software engineering, with recognized scientific excellence in MDE, software evolution, formal modeling and verification, and AOSD. The project focusses on the development, integration and extension of state-of-the-art languages, formalisms and techniques for modeling and verifying dependable software systems and supporting the evolution of Software-intensive systems. The project has started in January 2007 and is scheduled for a 60-months period. Read more at <http://moves.vub.ac.be>.

8.3.2. ERCIM Software Evolution

We are involved in the ERCIM Software Evolution working group since its inception. We participated at his creation when we were at the University of Bern.

8.3.3. MEALS FP7 Marie Curie Research Staff Exchange Scheme

MEALS (Mobility between Europe and Argentina applying Logics to Systems) is a mobility project financed by the 7th Framework programme under Marie Curie's International Research Staff Exchange Scheme. It involves seven academic institutions from Europe and four from Argentina, and a total of about 80 researchers to be exchanged. The project started on the 1st of October, 2011, and it has a duration of 4 years. Nr: FP7-PEOPEL-2011-IRSES

<http://www.meals-project.eu>

Visits in the context of MEALS

- Guido Chari visited RMoD from 29/11/2013 to 22/12/2013
- Diego Garbervetsky visited RMoD from 16/12/2013 to 17/12/2013
- Camillo Bruni visited UBA (Buenos Aires, Argentina): 2012-09-01 - 2012-09-30

8.4. International Initiatives

8.4.1. Inria Associate Teams

8.4.1.1. PLOMO

Title: Customizable Tools and Infrastructure for Software Development and Maintenance

Inria principal investigator: Stéphane Ducasse

International Partner (Institution - Laboratory - Researcher):

University of Chile (Chile) - PLEIAD

Duration: 2011–2013

See also: <http://pleiad.dcc.uchile.cl/research/plomo>

Project Description

Software maintenance is the process of maintaining a software system by removing bugs, fixing performance issues and adapting it to keep it useful and competitive in an ever-changing environment [50]. Performing effective software maintenance and development is best achieved with effective tool support, provided by a variety of tools, each one presenting a specific kind of information supporting the task at hand [52]. The goal of PLOMO is to develop new meta tools to improve and bring synergy in the existing infrastructure of Pharo (for software development) and the Moose software analysis platform (for software maintenance).

PLOMO will (1) enhance the Opal open compiler infrastructure to support plugin definition, (2) offer an infrastructure for change and event tracking as well as model to compose and manipulate them, (3) work on a layered library of algorithms for the Mondrian visualization engine of Moose, (4) work on new ways of profiling applications. All the efforts will be performed on Pharo and Moose, two platforms heavily used by the RMoD and PLEIAD team.

The artifacts produced by PLOMO will strongly reinforce the Pharo programming language and the Moose software analysis platform. The development and progress of Pharo is structured by RMoD, which has successfully created a strong and dynamic community. Moose is being used to realize consulting activities and it is used as a research platform in about 10 Universities, worldwide. We expect PLOMO to have a strong impact in both the software products and the communities structured around them.

2013 was the third and final year of PLOMO. Due to the success of PLOMO, we have requested a prolongation for another three years (PLOMO2). The *PLOMO Associate Team Final Report* is available online [37].

In the following, we present the results from 2013:

Research Visits From RMoD to PLEIAD

- Stéphane Ducasse from November 4 until November 15, 2013.

From PLEIAD to RMoD

- Johan Fabry on 15th of July, 18th and 19th of September 2013
- Alexandre Bergel from December 12 until December 29, 2013
- Alejandro Infante from September 13 until September 21, 2013
- Ronie Salgado in January 2014

Recent Results

In the third year of execution of Plomo, work has focused on:

- GradualTalk Paper accepted at Science of Computer Programming.
- Performance Evolution Blueprint paper at VISSOFT.
- Work on the DIE domain-specific language and the definition of IDE plugins using it was submitted to a journal and is in a second round of revisions.
- Organization of a coding sprint at Santiago in January 2013 (12 participants)
- Participated to three Moose releases (4.7-4.9) (<http://www.moosetechnology.org>)
- Integrated the Opal Compiler in the Pharo3 development branch.

Future of the Partnership We really hope that the team will be prolonged for a second three year period. The synergy between the two teams is working really well - in terms of exchanges, results and future collaborations.

For more information, we refer to the report *PLOMO Associate Team Final Report* [37].

8.4.2. Inria International Partners

8.4.2.1. Uqbar - Argentina

Participants: Marcus Denker [correspondant], Stéphane Ducasse [RMoD], Nicolas Anquetil [RMoD], Diego Garbervetsky [UBA,LAFHIS], Gabriela Arevalo [Universidad Nacional de Quilmes]), Nicolas Passerini [Uqbar].

Uqbar is a foundation of researchers teaching in several universities of the Buenos Aires area. Universidad Tecnologica Nacional (FRBA) Universidad Nacional de Quilmes, Universidad Nacional de San Martin, Universidad Nacional del Oeste. LAFHIS is a research laboratory from the University of Buenos Aires. More information at (<http://www.uqbar-project.org>).

8.4.2.2. Informal International Partners

We are building an ecosystem around Pharo with international research groups, universities and companies. Several research groups (such as Software Composition Group – Bern, and Pleaid – Santiago) are using Pharo. Many universities are teaching OOP using Pharo and its books. Several companies worldwide are deploying business solutions using Pharo.

8.4.3. Participation In other International Programs

8.4.3.1. Project Pequi – Inria/CNPq Brésil

The Pequi project is a collaboration between Professor Marco T. Valente's team at the Federal University of Minas Gerais in Brazil and the RMoD team. It focuses in producing Metrics, Techniques, and Tools for Software Remodularization.

It is recognized that software systems must be continuously maintained and evolved to remain useful. However, ongoing maintenance over the years contributes to degrade the quality of a system. Thus reengineering activities, including remodularization activities, are necessary to restore or enhance the maintainability of the systems. To help in the remodularization of software systems, the project will be structured in two main research lines in which both teams have experience and participation: (i) Evaluation and Characterization of Metrics for Software Remodularization; and (ii) Tools and Techniques for Removal of Architectural Violations.

The project started in July 2011 with a visit of Dr. Nicolas Anquetil to the brazilian team. The project lasted 24 months and ended June 2013.

8.5. International Research Visitors

8.5.1. Visits of International Scientists

In the context of the PLOMO associated Team with the University of Chile:

- Johan Fabry on 15th of July, 18th and 19th of September 2013
- Alexandre Bergel from December 12 until December 29, 2013
- Alejandro Infante from September 13 until September 21, 2013
- Ronie Salgado in January 2014

In the context of the Pequi project associated Team with the Federal University of Minas Gerais:

- Marco Tulio Valente from 21/01/2013 to 25/01/2013
- Marco Tulio Valente from 22/07/2013 to 26/07/2013

In the context of MEALS:

- Guido Chari visited RMoD from 29/11/2014 to 22/12/2013.
- Diego Garbervetsky visited RMoD 16 and 17 December.

Other visitors:

- Hani Abdeen, Research Associate at Computer Science Department - Qatar University (January 2013)
- Michele Lanza, Professor at the University of Lugano (2nd of May, 2013)
- Hayatou Oumarou, Assistant Departement d'Informatique ENS Maroua Cameroun (March 2013 for 1 Month)
- David Chisnall, Research Associate at University of Cambridge, (4-5 February)
- Tommaso Dal Sasso, University of Lugano, (16-22 December)
- Yuriy Tymchuk, University of Lugano, (16-22 December)
- Roberto Minelli, University of Lugano, (16-22 December)
- Andrei Vasile, University of Bern, Switzerland (18-21 December)
- Jan Kurs, University of Bern, Switzerland, (18-21 December)

8.5.1.1. Internships

Pablo Herrero, University of Buenos Aires (Argentina): *Compressed ASTs for Pharo*, from Oct 2013.

Sebastian Tleye, University of Buenos Aires (Argentina): *A new Trait Implementation*, from Mar until Aug 2013.

Gustavo Jansen De Souza Santos, Federal University of Minas Gerais (Brasil): *Integration of Semantic Clustering in Moose*, September until November 2013.

Gisela Decuzzi, Universidad Tecnológica Nacional FRBA (Argentina): *AST Navigation for Pharo*, from March to May 2013.

Yuriy Tymchuk, Ivan Franko National University of Lviv (Ukraine): *Extending FAMIX metamodel to generate ASTs for Java and Smalltalk applications*, from January to April 2013.

Erwan Douaille, University of Lille 1: *Automatic validation of contributions from Pharo community*, From April to Jun 2013

8.5.2. Visits to International Teams

- Stéphane Ducasse from November 4 until November 15, 2013. (PLOMO).
- Stéphane Ducasse from November to University of Buenos Aires (Argentina) (MEALS).
- Stéphane Ducasse and Igor Stasenko visited the University of Lviv, Ukraine.
- Camillo Bruni visited UBA (Buenos Aires, Argentina): September (1 Month)
- Marcus Denker visited *Universitat Politecnica de Catalunya*, Barcelona, Spain, 1 week in October 2013.
- Stéphane Ducasse visited the University of Prag for one week in December, 2013

ROMA Team

8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. ANR

ANR White Project RESCUE (2010-2014), 4 years. The ANR White Project RESCUE was launched in November 2010, for a duration of 48 months. It gathers three Inria partners (ROMA, Grand-Large and Hiepacs) and is led by ROMA. The main objective of the project is to develop new algorithmic techniques and software tools to solve the *exascale resilience problem*. Solving this problem implies a departure from current approaches, and calls for yet-to-be-discovered algorithms, protocols and software tools.

This proposed research follows three main research thrusts. The first thrust deals with novel *checkpoint protocols*. The second thrust entails the development of novel *execution models*, i.e., accurate stochastic models to predict (and, in turn, optimize) the expected performance (execution time or throughput) of large-scale parallel scientific applications. In the third thrust, we will develop novel *parallel algorithms* for scientific numerical kernels.

ANR Project SOLHAR (2013-2017), 4 years. The ANR Project SOLHAR was launched in November 2013, for a duration of 48 months. It gathers five academic partners (the HiePACS, Cepage, ROMA and Runtime Inria project-teams, and CNRS-IRIT) and two industrial partners (CEA/CESTA and EADS-IW). This project aims at studying and designing algorithms and parallel programming models for implementing direct methods for the solution of sparse linear systems on emerging computers equipped with accelerators.

The proposed research is organized along three distinct research thrusts. The first objective deals with linear algebra kernels suitable for heterogeneous computing platforms. The second one focuses on runtime systems to provide efficient and robust implementation of dense linear algebra algorithms. The third one is concerned with scheduling this particular application on a heterogeneous and dynamic environment.

8.1.2. Inria Project Lab C2S@Exa - Computer and Computational Sciences at Exascale

Participants: Olivier Aumage [RUNTIME project-team, Inria Bordeaux - Sud-Ouest], Jocelyne Erhel [SAGE project-team, Inria Rennes - Bretagne Atlantique], Philippe Helluy [TONUS project-team, Inria Nancy - Grand-Est], Laura Grigori [ALPINE project-team, Inria Saclay - Île-de-France], Jean-Yves L'Excellent [ROMA project-team, Inria Grenoble - Rhône-Alpes], Thierry Gautier [MOAIS project-team, Inria Grenoble - Rhône-Alpes], Luc Giraud [HIEPACS project-team, Inria Bordeaux - Sud-Ouest], Michel Kern [POMDAPI project-team, Inria Paris - Rocquencourt], Stéphane Lanteri [Coordinator of the project], François Pellegrini [BACCHUS project-team, Inria Bordeaux - Sud-Ouest], Christian Perez [AVALON project-team, Inria Grenoble - Rhône-Alpes], Frédéric Vivien [ROMA project-team, Inria Grenoble - Rhône-Alpes].

Since January 2013, the team is participating to the C2S@Exa http://www-sop.inria.fr/c2s_at_exa Inria Project Lab (IPL). This national initiative aims at the development of numerical modeling methodologies that fully exploit the processing capabilities of modern massively parallel architectures in the context of a number of selected applications related to important scientific and technological challenges for the quality and the security of life in our society. At the current state of the art in technologies and methodologies, a multidisciplinary approach is required to overcome the challenges raised by the development of highly scalable numerical simulation software that can exploit computing platforms offering several hundreds of thousands of cores. Hence, the main objective of C2S@Exa is the establishment of a continuum of expertise in the computer science and numerical mathematics domains, by gathering researchers from Inria project-teams whose research and development activities are tightly linked to high performance computing issues

in these domains. More precisely, this collaborative effort involves computer scientists that are experts of programming models, environments and tools for harnessing massively parallel systems, algorithmists that propose algorithms and contribute to generic libraries and core solvers in order to take benefit from all the parallelism levels with the main goal of optimal scaling on very large numbers of computing entities and, numerical mathematicians that are studying numerical schemes and scalable solvers for systems of partial differential equations in view of the simulation of very large-scale problems.

8.2. European Initiatives

8.2.1. FP7 Projects

8.2.1.1. SCORPIO

Type: COOPERATION

Instrument: Specific Targeted Research Project

Duration: June 2013 - May 2016

Coordinator: Nikolaos Bellas

Partners: CERTH, Greece; EPFL, Switzerland; RWTH Aachen University, Germany; The Queen's University of Belfast, UK; IMEC, Belgium

Inria contact: Frédéric Vivien

Abstract: A new computing paradigm that exploits uncertainty to design systems that are energy-efficient and scale gracefully under hardware errors by operating below the nominal operating point, in a controlled way, without inducing massive or fatal errors.

8.3. International Initiatives

8.3.1. Inria Associate Teams

The ALOHA associate-team is a joint project of the ROMA team and of the Information and Computer science Department of the University of Hawai'i (UH) at Mānoa, Honolulu, USA. Building on a vast array of theoretical techniques and expertise developed in the field of parallel and distributed computing, and more particularly application *scheduling*, we tackle database questions from a fresh perspective. To this end, this proposal includes:

- a group that specializes in database systems research and who has both industrial and academic experience, the group of Lipyeow Lim (UH);
- a group that specializes in practical aspects of scheduling problems and in simulation for emerging platforms and applications, and who has a long experience of multidisciplinary research, the group of Henri Casanova (UH);
- a group that specializes in the theoretical aspects of scheduling problems and resource management (the ROMA team).

The research work focuses on the following three thrusts:

1. Online, multi-criteria query optimization
2. Fault-Tolerance for distributed databases
3. Query scheduling for distributed databases

8.4. International Research Visitors

8.4.1. Visits of International Scientists

Ana Gainaru (from UIUC and Argonne National Laboratory) has visited our team for three weeks in October and November 2013. She initiated a collaboration with Guillaume Aupy, Anne Benoit, Franck Cappello and Yves Robert on scheduling I/O activity to avoid congestion and increase performance when executing several scientific applications on large-scale platforms.

8.4.2. Visits to International Teams

Yves Robert has been appointed as a visiting scientist by the ICL laboratory (headed by Jack Dongarra) at the University of Tennessee Knoxville. He collaborates with several ICL researchers on high-performance linear algebra and resilience methods at scale.

RUNTIME Project-Team

8. Partnerships and Cooperations

8.1. Regional Initiatives

REGION AQUITAINE The Aquitaine Region Council is granting the PhD thesis of Andra Hugo about *Composability of parallel software over hybrid architectures*, from september 2011 to august 2014.

REGION AQUITAINE The Aquitaine Region Council is granting the PhD thesis of Bertrand Putigny about *Performance Models for Heterogeneous Parallel Architectures*.

REGION AQUITAINE - CEA The Aquitaine Region Council together with CEA is funding PhD thesis of Marc Sergent (2013-2016) on *Scalability for Task-based Runtimes* (See also Section Bilateral Grants with Industry)

8.2. National Initiatives

8.2.1. ANR

ANR COOP Multi-level Cooperative Resource Management (<http://coop.gforge.inria.fr/>).

ANR COSINUS 2009 Program, 12/2009 - 06/2013 (42 months)

Identification: ANR-09-COSI-001

Coordinator: Christian Pérez (Inria Rhône-Alpes)

Other partners: Inria Bordeaux, Inria Rennes, IRIT, EDF R&D.

Abstract: COOP aims at establishing generic cooperation mechanisms between resource management, runtime systems, and application programming frameworks to simplify programming models, and improve performance through adaptation to the resources.

ANR SOLHAR (<http://solhar.gforge.inria.fr/doku.php?id=start>).

ANR MONU 2013 Program, 2013 - 2016 (36 months)

Identification: ANR-13-MONU-0007

Coordinator: Inria Bordeaux/LaBRI

Other partners: CNRS-IRIT, Inria-LIP Lyon, CEA/CESTA, EADS-IW

Abstract: This project aims at studying and designing algorithms and parallel programming models for implementing direct methods for the solution of sparse linear systems on emerging computers equipped with accelerators. The ultimate aim of this project is to achieve the implementation of a software package providing a solver based on direct methods for sparse linear systems of equations. Several attempts have been made to accomplish the porting of these methods on such architectures; the proposed approaches are mostly based on a simple offloading of some computational tasks (the coarsest grained ones) to the accelerators and rely on fine hand-tuning of the code and accurate performance modeling to achieve efficiency. This project proposes an innovative approach which relies on the efficiency and portability of runtime systems, such as the StarPU tool developed in the runtime team (Bordeaux). Although the SOLHAR project will focus on heterogeneous computers equipped with GPUs due to their wide availability and affordable cost, the research accomplished on algorithms, methods and programming models will be readily applicable to other accelerator devices such as ClearSpeed boards or Cell processors.

ANR Songs Simulation of next generation systems (<http://infra-songs.gforge.inria.fr/>).

ANR INFRA 2011, 01/2012 - 12/2015 (48 months)

Identification: ANR-11INFR01306

Coordinator: Martin Quinson (Inria Nancy)

Other partners: Inria Nancy, Inria Rhône-Alpes, IN2P3, LSIT, Inria Rennes, I3S.

Abstract: The goal of the SONGS project is to extend the applicability of the SIMGRID simulation framework from Grids and Peer-to-Peer systems to Clouds and High Performance Computation systems. Each type of large-scale computing system will be addressed through a set of use cases and lead by researchers recognized as experts in this area.

ANR MOEBUS Scheduling in HPC (<http://moebus.gforge.inria.fr/doku.php>).

ANR INFRA 2013, 10/2013 - 9/2017 (48 months)

Coordinator: Denis Trystram (Inria Rhône-Alpes)

Other partners: Inria Bordeaux.

Abstract: This project focuses on the efficient execution of parallel applications submitted by various users and sharing resources in large-scale high-performance computing environments

8.2.2. Inria Project Lab

8.2.2.1. C2S@Exa - Computer and Computational Sciences at Exascale

Participant: Olivier Aumage [RUNTIME project-team, Inria Bordeaux - Sud-Ouest].

Since January 2013, the team is participating to the C2S@Exa http://www-sop.inria.fr/c2s_at_exa Inria Project Lab (IPL). This national initiative aims at the development of numerical modeling methodologies that fully exploit the processing capabilities of modern massively parallel architectures in the context of a number of selected applications related to important scientific and technological challenges for the quality and the security of life in our society. At the current state of the art in technologies and methodologies, a multidisciplinary approach is required to overcome the challenges raised by the development of highly scalable numerical simulation software that can exploit computing platforms offering several hundreds of thousands of cores. Hence, the main objective of C2S@Exa is the establishment of a continuum of expertise in the computer science and numerical mathematics domains, by gathering researchers from Inria project-teams whose research and development activities are tightly linked to high performance computing issues in these domains. More precisely, this collaborative effort involves computer scientists that are experts of programming models, environments and tools for harnessing massively parallel systems, algorithmists that propose algorithms and contribute to generic libraries and core solvers in order to take benefit from all the parallelism levels with the main goal of optimal scaling on very large numbers of computing entities and, numerical mathematicians that are studying numerical schemes and scalable solvers for systems of partial differential equations in view of the simulation of very large-scale problems.

8.2.2.2. MULTICORE - Large scale multicore virtualization for performance scaling and portability

Participant: Emmanuel Jeannot [RUNTIME project-team, Inria Bordeaux - Sud-Ouest].

Multicore processors are becoming the norm in most computing systems. However supporting them in an efficient way is still a scientific challenge. This large-scale initiative introduces a novel approach based on virtualization and dynamicity, in order to mask hardware heterogeneity, and to let performance scale with the number and nature of cores. It aims to build collaborative virtualization mechanisms that achieve essential tasks related to parallel execution and data management. We want to unify the analysis and transformation processes of programs and accompanying data into one unique virtual machine. We hope delivering a solution for compute-intensive applications running on general-purpose standard computers.

8.3. European Initiatives

8.3.1. FP7 Projects

HPC-GA

Program: FP7 IRSES Marie-Curie

Project acronym: HPC-GA

Project title: High Performance Computing for Geophysics Applications

Duration: Jan 2012 - Dec 2014

Coordinator: Jean-François Méhaut (UJF, France)

Other partners: UFRGS, Inria, BCAM et UNAM.

Abstract: The design and implementation of geophysics applications on top of nowadays supercomputers requires a strong expertise in parallel programming and the use of appropriate runtime systems able to efficiently deal with heterogeneous architectures featuring many-core nodes typically equipped with GPU accelerators. The HPC-GA project aims at evaluating the functionalities provided by current runtime systems in order to point out their limitations. It also aims at designing new methods and mechanisms for an efficient scheduling of processes/threads and a clever data distribution on such platforms. The HPC-GA project is unique in gathering an international, pluridisciplinary consortium of leading European and South American researchers featuring complementary expertise to face the challenge of designing high performance geophysics simulations for parallel architectures.

MontBlanc2

Program: FP7 ICT-2013, Exascale Computing Platforms

Project acronym: MontBlanc2

Project title: European scalable and power efficient HPC platform based on low-power embedded technology

Duration: Oct 2013 - Nov 2016

Coordinator: Alex Ramirez (BSC, Spain)

Other partners: Inria, Bull, ST, ARM, Gnodal, Juelich, BADW-LRZ, HLRS, CNRS, CEA, CINECA, Bristol, Allinea

Abstract: The Mont-Blanc project aims to develop a European Exascale approach leveraging on commodity power-efficient embedded technologies. The project has developed a HPC system software stack on ARM, and will deploy the first integrated ARM-based HPC prototype by 2014, and is also working on a set of 11 scientific applications to be ported and tuned to the prototype system. The rapid progress of Mont-Blanc towards defining a scalable power efficient Exascale platform has revealed a number of challenges and opportunities to broaden the scope of investigations and developments. Particularly, the growing interest of the HPC community in accessing the Mont-Blanc platform calls for increased efforts to setup a production-ready environment. The Mont-Blanc 2 proposal has 4 objectives:

1. To complement the effort on the Mont-Blanc system software stack, with emphasis on programmer tools (debugger, performance analysis), system resiliency (from applications to architecture support), and ARM 64-bit support
2. To produce a first definition of the Mont-Blanc Exascale architecture, exploring different alternatives for the compute node (from low-power mobile sockets to special-purpose high-end ARM chips), and its implications on the rest of the system

3. To track the evolution of ARM-based systems, deploying small cluster systems to test new processors that were not available for the original Mont-Blanc prototype (both mobile processors and ARM server chips)
4. To provide continued support for the Mont-Blanc consortium, namely operations of the original Mont-Blanc prototype, the new small scale prototypes and hands-on support for our application developers

Mont-Blanc 2 contributes to the development of extreme scale energy-efficient platforms, with potential for Exascale computing, addressing the challenges of massive parallelism, heterogeneous computing, and resiliency. Mont-Blanc 2 has great potential to create new market opportunities for successful EU technology, by placing embedded architectures in servers and HPC..

8.3.2. Collaborations in European Programs, except FP7

COST ComplexHPC <http://complexhpc.org>

Program: COST Action IC0805

Project acronym: ComplexHPC

Project title: Open European Network for High-Performance Computing in Complex Environments

Duration: May 2009 - June 2013

Coordinator: Emmanuel Jeannot

Other partners: This Action gathers more than 20 countries and 30 partners in Europe.

Abstract: The goal of the Action is to establish a European research network focused on high performance heterogeneous computing in order to address the whole range of challenges posed by these new platforms including models, algorithms, programming tools and applications. The network will aim at contributing to exchange information, identify synergies and pursue common research activities, therefore reinforcing the strength of European research groups and the leadership of Europe in this field.

8.4. International Initiatives

8.4.1. Inria Associate Teams

MORSE Matrices Over Runtime Systems at Exascale

Inria Associate-Teams program: 2011-2016

Coordinator: Emmanuel Agullo (Hiepac)

Partners: Inria (Runtime & Hiepac), University of Tennessee Knoxville, University of Colorado Denver and KAUST.

Abstract: The Matrices Over Runtime Systems at Exascale (MORSE) associate team has vocation to design dense and sparse linear algebra methods that achieve the fastest possible time to an accurate solution on large-scale multicore systems with GPU accelerators, using all the processing power that future high end systems can make available. To develop software that will perform well on petascale and exascale systems with thousands of nodes and millions of cores, several daunting challenges have to be overcome both by the numerical linear algebra and the runtime system communities. With Inria Hiepac, University of Tennessee, Knoxville and University of Colorado, Denver.

8.4.2. Inria International Labs

JLPC on Petascale Computing [Inria joint-Lab](#)

Coordinators: Franck Cappello and Marc Snir.

Other partners: Argonne National Lab, Inria, University of Urbana Champaign.

Abstract: The Joint Laboratory is based at Illinois and includes researchers from Inria, Illinois' Center for Extreme-Scale Computation, and the National Center for Supercomputing Applications. It focuses on software challenges found in complex high-performance computers.

8.4.3. Participation in other International Programs

ANR-JST FP3C **Framework and Programming for Post Petascale Computing.**

ANR-JST 2010 Program, 01/09/2010 - 31/03/2014

Identification: ANR-10-JST-002

Coordinator: Serge Petiton (Inria Saclay)

Other partners: CNRS IRIT, CEA DEN Saclay, Inria Bordeaux, CNRS-Prism, Inria Rennes, University of Tsukuba, Tokyo Institute of Technology, University of Tokyo, Kyoto University.

Abstract: Post-petascale systems and future exascale computers are expected to have an ultra large-scale and highly hierarchical architecture with nodes of many-core processors and accelerators. That implies that existing systems, language, programming paradigms and parallel algorithms would have, at best, to be adapted. The overall structure of the FP3C project represents a vertical stack from a high level language for end users to low level architecture considerations, in addition to more horizontal runtime system researches.

HPC-GA High Performance Computing for Geophysics Applications (<http://project.inria.fr/HPC-GA/>)

European FP7 Programme, "Marie Curie" Action, PIRSES Scheme, 01/2012 - 12/2014 (36 months)

Identification: PIRSES-GA-2011-295217

Coordinator: Jean-François Méhaut (UJF)

Other Partners: Inria Grenoble, Inria Bordeaux, Basque Center for Applied Mathematics (BCAM, Bilbao, Spain), Federal University of Rio Grande do Sul (UFRGS, Porto Alegre, Brazil), Universidad Nacional Autónoma de México (UNAM, Mexico, Mexico), Bureau de Recherche Géologique et Minière (BRGM, Orléans, France), Grand Équipement National de Calcul Intensif (GENCI, France).

Abstract: The HPC-GA project is unique in gathering an international, pluridisciplinary consortium of leading European and South American researchers featuring complementary expertise to face the challenge of designing high performance geophysics simulations for parallel architectures: UFRGS, Inria, BCAM and UNAM. Results of this project will be validated using data collected from real sensor networks. Results will be widely disseminated through high-quality publications, workshops and summer-schools.

SEHLOC Scheduling evaluation in heterogeneous systems with hwloc

STIC-AmSud 2012 Program, 01/2013 - 12/2014 (24 months)

Coordinator: Brice Goglin

Other Partners: Universidad Nacional de San Luis (Argentina), Universidad de la República (Uruguay).

Abstract: This project focuses on the development of runtime systems that combine application characteristics with topology information to automatically offer scheduling hints that try to respect hardware and software affinities. Additionally we want to analyze the convergence of the obtained performance from our algorithms with the recently proposed Multi-BSP model which considers nested levels of computations that correspond to natural layers of nowadays hardware architectures.

NextGN Preparing for Next Generation Numerical Simulation Platforms

PUF (Partner University Fund) - France USA, 01/2013 - 12-2016 (3 years)

Coordinator: Franck Capello, Marc Snir and Yves Robert

Other Partners: Inria, Argonne National Lab and University of Urbanna Champaign

This PUF proposal builds on the existing successful joint laboratory between Inria and UIUC that has produced in past three years and half many top-level publications, some of which resulted in student awards; and several software packages that are making their way to production in Europe and USA. The proposal extends the collaboration to Argonne National Laboratory (ANL) and CNRS researchers who will bring their unique expertise and their skills to help addressing the scalability issue of simulation platforms.

SCORE Team

6. Partnerships and Cooperations

6.1. National Initiatives

6.1.1. ANR ConcoRDanT ANR-10-BLAN-0208 (2010–2014)

Participants: Pascal Urso [contact], Mehdi Ahmed-Nacer, Claudia-Lavinia Ignat, Gérald Oster.

Partners: REGAL project-team (Inria Paris - Rocquencourt / LIP6, coordinator), CITI institute (Universidade Nova de Lisboa, Portugal), GDD team (University of Nantes) and SCORE team.

Website: <http://concordant.lip6.fr/>

Massive computing systems and their applications suffer from a fundamental tension between scalability and data consistency. Avoiding the synchronisation bottleneck requires highly skilled programmers, makes applications complex and brittle, and is error-prone.

The ConcoRDanT project (oct. 2010 – apr. 2014) investigates a promising new approach that is simple, scales, and provably ensures eventual consistency. A Commutative Replicated Data Type (CRDT) is a data type where all concurrent operations commute. If all replicas execute all operations, they converge; no complex concurrency control is required. We have shown in the past that CRDTs can replace existing techniques in a number of tasks where distributed users can update concurrently, such as co-operative editing, wikis, and version control. However CRDTs are not a universal solution and raise their own issues (e.g., growth of meta-data).

The ConcoRDanT project engages in a systematic and principled study of CRDTs, to discover their power and limitations, both theoretical and practical. Its outcome will be a body of knowledge about CRDTs and a library of CRDT designs, and applications using them. We are hopeful that significant distributed applications can be designed using CRDTs, a radical simplification of software, elegantly reconciling scalability and consistency.

6.1.2. ANR STREAMS ANR-10-SEGI-010 (2010–2014)

Participants: Gérald Oster [coordinator], Luc André, Claudia-Lavinia Ignat, Stéphane Martin, Pascal Urso, Hien Thi Thu Truong.

Partners: SCORE team (coordinator), ASAP project-team (University of Rennes 1 / Inria Rennes - Bretagne Atlantique), CASSIS project-team (Inria Nancy - Grand Est / Nancy University), REGAL project-team (Inria Paris - Rocquencourt / LIP6) and GDD team (University of Nantes / LINA)

Website: <http://streams.loria.fr/>

The STREAMS project (nov. 2010 – oct. 2013) proposes to design peer-to-peer solutions that offer underlying services required by real-time social web applications and that reduce the disadvantages of centralised architectures. These solutions are meant to replace a central authority-based collaboration with a distributed collaboration that offers support for decentralisation of services.

The STREAMS project aims to advance the state of the art on peer-to-peer networks for social and real-time applications. Scalability is generally considered as an inherent characteristic of peer-to-peer systems. It is traditionally achieved using replication techniques. Unfortunately, the current state of the art in peer-to-peer networks does not address replication of continuously updated content due to real-time user changes. Moreover, there exists a tension between sharing data with friends in a social network deployed in an open peer-to-peer network and ensuring privacy. One of the most challenging issue in social applications is how to balance collaboration with access control to shared objects. Interaction is aimed at making shared objects available to all who need them, whereas access control seeks to ensure this availability only to users with proper authorisation. STREAMS project aims at providing theoretical solutions to these challenges as well as practical experimentations.

6.1.3. ANR Kolflow (2011–2014)

Participant: G r me Canals.

Partners: GDD team (University of Nantes / LINA), Loria (Orpailleur and SCORE Teams), Silex Team (LIRIS, University of Lyon), Edelweiss (Inria Project).

Website: <http://kolflow.univ-nantes.fr/mediawiki/index.php>

Kolflow aims at building a social semantic space where humans collaborate with smart agents in order to produce knowledge understandable by humans and machines. Humans are able to understand the actions of smart agents. Smart agents are able to understand actions of humans. Kolflow targets the co-evolution of content and knowledge as the result of interactions of humans and machines. Our work in the Kolflow project focus on implementing knowledge base testing strategies [23].

6.1.4. FSN OpenPaaS (2012–2015)

Participants: Olivier Perrin, Ahmed Bouchami.

Partners: Samovar team (Telecom SudParis), SCORE team (Universit  de Lorraine, Loria), ARMINES (Ecole des Mines d'Albi), Brake France, Linagora.

Website: <http://www.open-paas.org>

The OpenPaaS project aims at developing a PaaS (Platform as a Service) technology dedicated to enterprise collaborative applications deployed on hybrid clouds (private/public). OpenPaaS is a platform that allows to design and deploy applications based on proven technologies provided by partners such as collaborative messaging systems, integration and workflow technologies that will be extended in order to address Cloud Computing requirements. Available as an open-source Enterprise Social Network, the OpenPaaS project innovates both at the collaborative level and by its capacity to leverage heterogeneous cloud technologies at the IaaS level (Infrastructure as a Service). This project is funded under the French FSN umbrella (Fond National pour la soci t  Num rique).

6.2. European Initiatives

6.2.1. FP7 Projects

6.2.1.1. SyncFree FP7-ICT 609551 (2013–2016)

Participants: Pascal Urso [contact], Jordi Martori.

Partners: REGAL project-team (Inria Paris - Rocquencourt / LIP6, coordinator), SCORE team, Trifork A/S (Denmark), Universidade Nova de Lisboa (Portugal), Technische Universit t Kaiserslautern (Germany), Basho Technologies (United Kingdom), Rovio Entertainment (Finland), Universit  Catholique de Louvain (Belgium), Ko  Universitesi (Turkey)

Website: <https://syncfree.lip6.fr/>

SyncFree FP7-ICT project brings together academic researchers and industrial practitioners to explore new approaches to data consistency at a massive scale. On-line services including social networks and multi-player games handle huge quantities of frequently changing shared data. Maintaining its consistency is simple in a centralised cloud, but no longer possible due to increased scalability requirements. Instead, data must be replicated across several distributed data centers, requiring new principled approaches.

In this context, SCORE team is interested in designing new and useful replicated data types and in evaluating their performance and behaviour using the massive corpus of real-usage data provided by industrial partners.

6.2.2. Collaborations in European Programs, except FP7

Program: EIT ICT Labs

Project acronym: CityCrowdSource

Project title:

Duration: 12 months 2013 - 2013

Coordinator: Thomas Silverston

Other partners: BMU (Hungary), Imperial College London (UK), SAP (Germany), Cap Digital (France)

Abstract: This activity aims at leveraging the potential of crowd-based applications in urban contexts. Crowd-based data collection in combination with official data will lead to a vastly improved coverage and quality of digital information for urban areas. The added-value of the proposal is in : (1) the three services: trust, privacy and crowd processes modelling that are not present in any crowd-sourcing platform available today, (2) the deployment and of these services on top of different crowd-sourcing platforms and (3) the experimentation of these platforms in real life city scenarios. To this end, the activity combines Test bed, Open Source and Living labs catalysts.

6.3. International Initiatives

6.3.1. Inria Associate Teams

6.3.1.1. USCOAST

Title: User Studies on Trustworthy Collaborative Systems

Inria principal investigator: Claudia-Lavinia Ignat

International Partner:

Wright State University (United States of America) - Department of Psychology - Valerie SHALIN

Duration: 2013 - 2015

See also: <http://uscoast.loria.fr/>

USCoast has, as main objective, the validation of trustworthy collaborative systems using experimental user studies. This type of validation requires the expertise of both computer scientists that designed the systems and social scientists for conceptualizing and measuring human behaviour in collaborative work. The project focuses on the real-time requirements and trust policies in collaborative editing, resulting in a theory for the effect of real-time constraints in collaborative editing and awareness management for the coordination of work in the presence of conflict and disruption. The project includes also validation of proposed light security mechanisms for decentralised collaboration, based on posted measures of voluntary compliance with data sharing restrictions. We will develop new methods for the cost-effective evaluation of collaborative work to compensate for otherwise unrealistic sample sizes and costly engineering, using game theory to inspire task analogues and simulated users along with human users.

6.4. International Research Visitors

6.4.1. Visits of International Scientists

6.4.1.1. Internships

Meagan Aldridge

Subject: Experimental user studies of real-time collaborative systems

Date: from June 2013 until October 2013

Institution: Wright State University, Department of Psychology, United States of America

6.4.1.2. Invited researchers

Participant: Valerie Shalin.

Subject: Experimental user studies of real-time collaborative editing and trust-based collaboration

Date: from May 2013 until June 2013 and from October 2013 until May 2014 (sabbatical)

Institution: Wright State University, Department of Psychology, United States of America

Participant: Weihai Yu.

Subject: Collaborative editing algorithms

Date: from September 2013 until July 2014 (sabbatical)

Institution: University of Tromsø, Department of Computer Science, Norway

SOCRATE Project-Team

8. Partnerships and Cooperations

8.1. National Actions

8.1.1. Equipex FIT- Future Internet of Things (2011-..., 1.064 k€)

The FIT projet is a national equipex (*équipement d'excellence*), headed by the Lip6 laboratory. As a member of Inria, Socrate is in charge of the development of an Experimental Cognitive Radio platform that should be used as test-bed for SDR terminals and cognitive radio experiments. This platform will be operational in 2013 for a duration of 7 years. To give a quick view, the user will have a way to configure and program through Internet several SDR platforms (MIMO, SISO, and baseband processing nodes).

8.1.2. ANR - Cormoran - “Cooperative and Mobile Wireless Body Area Networks for Group Navigation” (2012-2015, 150 keuros)

The Cormoran project targets to figure out innovative communication functionalities and radiolocation algorithms that could benefit from inter/intra-BAN cooperation. More precisely, the idea is to enable accurate nodes/body location, as well as Quality of Service management and communications reliability (from the protocol point of view), while coping with inter-BAN coexistence, low power constraints and complying with the IEEE 802.15.6 standard. The proposed solutions will be evaluated in realistic applicative scenarios, hence necessitating the development of adapted simulation tools and real-life experiments based on hardware platforms. For this sake, Cormoran will follow an original approach, mixing theoretical work (e.g. modelling activities, algorithms and cross-layer PHY/MAC/NWK design) with more practical aspects (e.g. channel and antennas measurement campaigns, algorithms interfacing with real platforms, demonstrations).

8.1.3. ANR - Idefix - “Intelligent DEsign of Future mobile Internet for enhanced eXperience” (2013-2016, 55 keuros)

The aim of IDEFIX project is to radically revisit the way technologies are evaluated and benchmarked by proposing novel performance evaluation tools, based on the latest developments in queuing theory, that are able to tackle the complexity of traffic profiles in future mobile networks. These tools are to be carefully adapted to the different technologies discussed within 3GPP, and then used to benchmark these technologies and perform pertinent choices among them. Furthermore, IDEFIX will not adopt a passive behavior limited to performance evaluation of technologies. It will, on the contrary, propose service and network control mechanisms that enforce Quality of Service (QoS) and Quality of Experience (QoE) of users of different services. For this aim, this project puts together experts on performance evaluation tools and traffic engineering, whose world class research results are recognized in the telecommunication community. This expertise is complemented by another internationally recognized expertise on service and network control mechanisms and, for the first time in this field, by an expertise on network economy and decision-making in strategic investments. These academic and industrial experts will help two top actors in the world telecommunications industry, Alcatel Lucent and Orange, in their perpetual quest for producing the most efficient technologies and deploying networks with the best QoS.

8.1.4. ADR Green - “Green Networking” (2013-2015, 70 keuros)

This action is a part of the common lab of Inria and Alcatel Lucent Bell Labs. This action groups Urbanet and Socrate teams of Inria with the Bell Labs Vx team and addresses different aspects of Green Networking. Socrate works on the 'virtual cell concept' which deals with mobile centric cells in dense small cells networks.

8.1.5. Greentouch GTT project- “Interference Alignment” (2013-2014, 63 keuros)

The Greentouch GTT (Green transmission technology) project aims at proposing new energy efficient transmission techniques, and focus specifically on the Energy efficiency - spectral efficiency (EE-SE) trade-off. Interference management is a critical issue and socrate aims at designing a dynamic and distributed approach allowing to cancel strong interferers by combining control theory and interference alignment principles.

8.1.6. FUI ECONHOME - “Energy efficient home networking” (2010-2014, 309 keuros)

The project aims at reducing the energy consumption of the home (multimedia) data networks, while maintaining the quality requirements for heterogeneous services and flows, and preserving, or even enhancing the overall system performance. the equipments under concern are residential gateways, set-top-boxes , PLC modules, Wifi extenders, NAS. The user equipment, such as smartphones, tablets or PCs are not concerned. The approach relies on combining both individual equipments IC and system level protocols that have to be eco-designed.

8.1.7. FUI SMACS - “SMart And Connected Sensors” (2013-2016, 267 keuros)

The SMACS projet targets the deployment of an innovating wireless sensor network dedicated to many domains sport, health and digital cities. The projet involves Socrate (Insavalor), HIKOB and wireless broadcasting company Euro Media France. The main goal is to develop a robust technology enabling real-time localization of mobile targets (like cyclists for instance), at a low energy (more generally low cost). The technology will be demonstrated at real cycling races (Tour de France 2013 and 2014). One of the goals is to include localisation information with new radio technology. Another subject of study is distributed wireless consensus algorithms for maintaining a neighborhood knowledge with a low energy budget that scales (more than 200 cycles together)

8.2. International Research Visitors

Jean-Marie Gorce is currently spending a sabbatical year at Vincent Poor’s lab in Princeton university. Following the Post-Doc of Samir Perlaza, Socrate is developping a regular collaboration with Princeton on network information theory and distributed radio resource allocation algorithms.

TRISKELL Project-Team

8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. ANR GEMOC

Participants: Benoit Combemale, Didier Vojtisek, Olivier Barais, Arnaud Blouin, Erwan Bousse, Benoit Baudry.

Heterogeneous modeling, model driven engineering, executable metamodeling, models of computation, simulation.

The ANR project **GEMOC** (French Agency for Research, Program INS 2012) focuses on a generic framework for heterogeneous software model execution and dynamic analysis. This work has the ambition to propose an innovative environment for the design of complex software-intensive systems by providing:

- a formal framework that integrates state-of-the-art in model-driven engineering (MDE) to build domain-specific modeling languages (DSMLs), and models of computation (MoC) to reason over the composition of heterogeneous concerns;
- an open-source design and modeling environment associated to a well-defined method for the definition of DSMLs, MoCs and rigorous composition of all concerns for execution and analysis purposes.

This requires addressing two major scientific issues: the design and verification of a formal framework to combine several different DSMLs relying on distinct MoCs; the design and validation of a methodology for DSMLs and MoC development. GEMOC aims at participating in the development of next generation MDE environments through a rigorous, tool-supported process for the definition of executable DSMLs and the simulation of heterogeneous models.

Project duration: 2012-2016

Triskell budget share: 253 keuros

Number of person/years: 2.2

Project Coordinator: Inria (Triskell)

Participants: ENSTA Bretagne, Inria, IRIT, I3S, Obeo, Thales

8.1.2. ANR INFRA-JVM

Participants: Johann Bourcier, Olivier Barais, Inti Gonzalez Herrera, Erwan Daubert, Walter Rudametkin Ivey.

JVM, Kevoree, Models@Runtime

INFRA-JVM is an ANR project whose goal is to design and provide a new Java Virtual Machine dedicated to pervasive environments. This project focuses on designing a Java Virtual Machine for embedded computing platform offering dynamic reconfiguration capabilities. The project focuses on the three following parts:

- Defining new mechanisms to provide component-based support for provisioning I/O and memory guarantee
- Defining languages and runtime support for efficient process scheduling on multi-core platform
- Optimizing the memory allocation on multi-core platforms.

Triskell mainly works this year on VMkit (the integration platform of the project) and Kevoree (our Component Based platform) to run Kevoree on top of VMkit.

Project duration: 2012-2015

Triskell budget share: 193 keuros

Number of person/years: 2

Project Coordinator: Université Paris 6

Participants: Université Paris 6, Université Bordeaux 1, Université Rennes 1 (Triskell), Ecole des Mines de Nantes

8.1.3. **BGLE2 CONNEXION**

Participants: Benoit Baudry, Arnaud Blouin, Fabien Coulon, Valéria Lelli Leitão Dantas, Nicolas Sannier.

requirement, software testing, critical system, HCI, MDE

The cluster CONNEXION (*digital command CONtroll for Nuclear EXport and renovatION*) aims to propose and validate an innovative architecture platforms suitable control systems for nuclear power plants in France and abroad. In this project the Triskell team investigates methods and tools to (i) automatically analyze and compare regulatory requirements evolutions and geographical differences; (ii) automatically generate test cases for critical interactive systems.

Project duration: 2012-2016

Triskell budget share: 515 keuros

Number of person/years: 3

Project Coordinator: EDF

Participants: Atos WorldGrid, Rolls-Royce Civil Nuclear, Corys TESS, Esterel Technologies, All4Tec, Predict, CEA, Inria, CNRS / CRAN, ENS Cachan, LIG, Telecom ParisTech

8.2. European Initiatives

8.2.1. FP7 Projects

8.2.1.1. NeSSoS

Type: COOPERATION

Defi: Trustworthy ICT

Instrument: Network of Excellence

Objectif: Trustworthy ICT

Duration: October 2010 - March 2014

Coordinator: CNR - Consiglio Nazionale delle Ricerche (Italy)

Others partners: ATOS (Spain), ETH (Switzerland), Katholieke Universiteit Leuven (Belgium), Ludwig-Maximilians-Universitaet Muenchen (Germany), IMDEA (Spain), Inria (France), University of Duisburg-Essen (Germany), University of Malaga (Spain), University of Trento (Italy), SIEMENS (Germany), SINTEF (Norway)

See also: <http://www.nessos-project.eu/>

Inria contact: V. Issarny

Abstract: The Network of Excellence on Engineering Secure Future Internet Software Services and Systems (NESSoS) aims at constituting and integrating a long lasting research community on engineering secure software-based services and systems. In light of the unique security requirements the Future Internet will expose, new results will be achieved by means of an integrated research, as to improve the necessary assurance level and to address risk and cost during the software development cycle in order to prioritize and manage investments. NESSoS will also impact training and education activities in Europe to grow a new generation of skilled researchers and practitioners in the area. NESSoS will collaborate with industrial stakeholders to improve the industry best practices and support a rapid growth of software-based service systems in the Future Internet.

Three Inria EPIs are involved in NeSSoS: ARLES, CASSIS and Triskell. Triskell leads the research workpackage on design and architecture for secured future internet applications.

Triskell budget share: 100 keuros

8.2.1.2. DIVERSIFY

Type: COOPERATION

Defi: Foundation of Collaborative Adaptive Systems

Instrument: Specific Targeted Research Project

Objectif: NC

Duration: February 2013 - January 2016

Coordinator: Inria

Partner: SINTEF (Norway), Trinity College Dublin (Ireland), Université de Rennes 1 (France)

See also: <http://www.diversify-project.eu/>

Inria contact: Benoît Baudry

Abstract: DIVERSIFY aims at favoring spontaneous diversification in software systems in order to increase their adaptive capacities. This objective is founded on three observations: software has to constantly evolve to face unpredictable changes in its requirements, execution environment or to respond to failure (bugs, attacks, etc.); the emergence and maintenance of high levels of diversity are essential to provide adaptive capacities to many forms of complex systems, ranging from ecological and biological systems to social and economical systems; diversity levels tend to be very low in software systems.

DIVERSIFY explores how the biological evolutionary mechanisms, which sustain high levels of biodiversity in ecosystems (speciation, phenotypic plasticity and natural selection) can be translated in software evolution principles. In this work, we consider evolution as a driver for diversity as a means to increase resilience in software systems. In particular, we are inspired by bipartite ecological relationships to investigate the automatic diversification of the server side of a client-server architecture. This type of software diversity aims at mitigating the risks of software monoculture. The consortium gathers researchers from the software-intensive, distributed systems and the ecology areas in order to transfer ecological concepts and processes as software design principles.

Triskell budget share: 500 keuros

8.2.1.3. HEADS

Type: COOPERATION

Defi:

Instrument: Specific Targeted Research Project

Objectif: NC

Duration: October 2013 - September 2016

Coordinator :SINTEF (Norway)

Partner: SINTEF (Norway), M2MZone (Ireland), TellU (Norway), SoftwareAG (Germany), ATC (Greece), Inria (France)

Inria contact: Benoît Baudry

Abstract: The idea of the HEADS project is to leverage model-driven software engineering and generative programming techniques to provide a new integrated software engineering approach which allow advanced exploitation the full range of diversity and specificity of the future computing continuum. The goal is to empower the software and services industry to better take advantage of the opportunities of the future computing continuum and to effectively provide new innovative services that are seamlessly integrated to the physical world making them more pervasive, more robust, more reactive and closer (physically, socially, emotionally, etc.) to their users.

Triskell budget share: 400 keuros

8.2.2. Collaborations in European Programs, except FP7

8.2.2.1. Marie-Curie Relate

Program: Marie Curie

Project acronym: Relate

Project title: Trans-European Research Training Network on Engineering and Provisioning of Service-Based Cloud Applications

Duration: February 2011 - January 2015

Triskell budget share: 730 keuros

Coordinator: Karlsruhe Institute of Technology

Other partners: Université de Rennes, IRISA (France); King's College, (UK); South East European Research Center, SEERC (Greece); Charles University (Czech Republic); CAS Software (Germany); Singular Logic (Greece)

Abstract: The RELATE Initial Training Network aims to establish a network of international academic and industrial partners for a joint research training effort in the area of engineering and provisioning service-based cloud applications. The training is intended to not only shape high-level academic researchers, but also educate next generation experts and innovators in the European software industry. Through an integrative and multidisciplinary research approach, RELATE aims to promote the advancement of the state of the art in the related areas of model-driven engineering and formal methods, service-based mash-ups and application integration, security, performance, and trust in service-based cloud applications, and quality management and business model innovation.

8.2.2.2. MERGE

Program: ITEA2

Project acronym: Merge

Project title: Trans-European Research Training Network on Engineering and Provisioning of Service-Based Cloud Applications

Duration: December 2012 - December 2015

Triskell budget share: 250 keuros

Coordinator: Thales Research and Technology

Other partners: Thales Global Services, Thales Communications and Security, OBEO, ALL4TEC, Onera, Inria, Université Paris VI, Codenomicon, STUK - Radiation and Nuclear Safety Authority, POHTO nSense Oy, University of Oulu, University of Jyväskylä, Space Applications Services NV, Melexis, E2S, Katholieke Universiteit Leuven

Abstract: MERgE stands for "Multi-Concerns Interactions System Engineering". Within the "Engineering support" theme of ITEA2 roadmap, the purpose of this project is to develop and demonstrate innovative concepts and design tools addressing in combination the "Safety" and "Security" concerns, targeting the elaboration of effective architectural solutions. MERgE will provide tools and solutions for combining safety and security concerns in systems development in a holistic way. It will provide academically solid and practice proven solutions and models for system developers and system owners to tackle the challenges of designing seamless optimal cost effective safe and secure solutions conformant to the model driven engineering paradigm. This will be done by tightly integrating the following paradigms: requirement engineering, safety, security and risk management in an over-all design process which is supported by adequate tools and methods. MERgE aims to bring a system engineering solution for Combined Safe & Secure system design. The main technical innovation of the project is the application of state of the art design tools tailors capabilities and "multi concern engineering" core technologies to the issue of interactions of "Safety" and "Security" concerns as well as other concerns like "Performance" or "Timing" in the design process.

8.3. International Initiatives

8.3.1. Participation In other International Programs

8.3.1.1. TAAS

Program: Foundation Araucaria Inria Brazil

Title: Software testing for cloud computing

Inria principal investigator: Gerson SUNYE

International Partner (Institution - Laboratory - Researcher):

Federal University of Parana (Brazil) - Gerson SUNYE

Duration: Jul 2011 - Jun 2013

8.3.1.2. SPLIT

Program: International joint supervision of PhD agreement

Title: Aspect-oriented modeling and software product line

Inria principal investigator: Jean-Marc JEZEQUEL

International Partner (Institution - Laboratory - Researcher):

University of Luxembourg (Luxembourg) - Jean-Marc JEZEQUEL

Duration: Apr 2010 - Mar 2013

See also: <http://www.fnr.lu/fr/Research-Programmes/Research-Programmes/Projects/Combine-Software-Product-Line-and-Aspect-Oriented-Software-Development-SPLIT>

Combine Software Product Line and Aspect-Oriented Software Development - SPLIT

8.3.1.3. MBSAR

Program: CNRS PICS

Title: Model-Based Security Analysis at Runtime (MBSAR)

Inria principal investigator: Benoit Combemale

International Partner (Institution - Laboratory - Researcher):

Colorado State University (USA) - Software Assurance Lab - Robert B. France

Duration: Jan 2013 - Dec 2015

See also: <http://gemoc.org/mbsar/>

MBSAR develop model-based techniques for runtime analysis and enforcement of security policies in adaptive software systems.

8.4. International Research Visitors

8.4.1. Visits of International Scientists

8.4.1.1. Internships

Ioannis Kavvouras

Subject: Spontaneous diversification in software components

Date: from Mar 2013 until Jul 2013

Institution: Université Nationale Capodistrienne d'Athènes (Greece)

Marianela Cioffi Felice

Subject: Draw your Products! A Model-based Approach

Date: from Mar 2013 until Aug 2013

Institution: National University of the Center of the Buenos Aires Province (Argentina)

Wuliang Sun

Subject: Synthesis of Feature-based Model Templates

Date: from Jun 2013 until Jul 2013

Institution: Colorado State University (United States)

8.4.2. Visits to International Teams

Participant: Arnaud Blouin.

Date: May 2013

Visited Institution: the laboratory for research on technology for ecommerce (LATECE) at the University of Québec at Montréal (UQÀM), Canada

8.4.3. Inria International Chair

Prof. Robert B. France¹¹ was granted by an Inria international chair for the period 2013-2017. Prof. France collaborate intensively with many members of the Triskell team on various joint work, e.g., the Familiar project and the GEMOC initiative. The Inria International Chair will allow Prof. France to make different long visits in the team along the period.

8.4.4. International initiative GEMOC

International initiative GEMOC

The GEMOC initiative (cf. <http://www.gemoc.org>) is an open and international initiative launched in 2013 that coordinate research partners worldwide to develop breakthrough software language engineering (SLE) approaches that support global software engineering through the use of multiple domain-specific languages. GEMOC members aim to provide effective SLE solutions to problems associated with the design and implementation of collaborative, interoperable and composable modeling languages.

The GEMOC initiative aims to provide a framework that facilitates collaborative work on the challenges of using of multiple domain-specific languages in software development projects. The framework consists of mechanisms for coordinating the work of members, and for disseminating research results and other related information on GEMOC activities. The framework also provides the required infrastructure for sharing artifacts produced by members, including publications, case studies, and tools.

The governance of the GEMOC initiative is ensured by the Advisory Board. The role of the Advisory Board is to coordinate the GEMOC work and to ensure proper dissemination of work products and information about GEMOC events (e.g., meetings, workshops).

Benoit Combemale is the co-founder and currently acts as principal coordinator of the GEMOC initiative. Benoit Combemale and Jean-Marc Jézéquel are part of the Advisory Board, and 9 Triskell members are part of the GEMOC initiative.

¹¹Colorado State University, USA. See. <http://www.cs.colostate.edu/~france/>

URBANET Team

8. Partnerships and Cooperations

8.1. Regional Initiatives

- BQR INSA CROME 12/2013-12/2016
Participants: Fabrice Valois
The partners in this project are the CITI DynaMid team and LIRIS. The project studies the coordination of a fleet of mobile robots for the multi-view analysis of complex scenes.
- BQR INSA ARBRE 12/2011-12/2013
Participants: Hervé Rivano, Fabrice Valois
The partners in this project are the LIRIS (database), EVS-ITUS (social science) and CETHIL (energetic models for buildings) . The project studies wireless sensor networks deployments from different perspectives. An objective is to provide enough data to calibrate energetic models for buildings with human activity. Another is to study the behavior of people working in monitored zones, in particular with respect to the way data are accessible, represented and navigated. Last is to obtain link quality statistics from a practical deployment with real traffic.
- Labex IMU Priva'Mov 10/2013-10/2016
Participants: Djamel Benferhat, Razvan Stanica, Hervé Rivano
The partners in this project are DRIM LIRIS, Inria Privatics, INSA EVS, and LET ENTPE. The aim of this project is to develop and deploy a crowdsensing platform to collect mobility traces from a sample of real users equipped with android devices, while carrying research on privacy preservation issues. Our contribution consists on developing the platform and using the collected data to analyze cellular network offloading strategies.
- ARC 7 animation action "Smart Cities Days" 12/2013
UrbaNet organized the Smart Cities Days are on the 17th and 18th of December 2013 - <http://www.citi-lab.fr/seminar/journees-reseaux-et-smart-cities-17-et-18-decembre-2013/>.

8.2. National Initiatives

8.2.1. ANR

- ANR Verso ECOScells 10/2009-12/2012
Participants: Anis Ouni, Hervé Rivano, Fabrice Valois
The objective of ECOScells is to study energy efficient microcells networks. Hervé Rivano is leader for Inria side and of the work package focusing on energy efficient wireless backhauling.
- ANR ARESA2 03/2010-08/2013.
Participants: Alexandre Mouradian, Isabelle Augé-Blum, Fabrice Valois
The partners in the ANR ARESA2 project are: Orange Labs, Coronis, Inria, LIG, Télécom Bretagne, VERIMAG. Our contributions focus on: resiliency of routing protocols in WSN; how to exploit the heterogeneity in wireless multi-hop network; real-time and QoS support in routing protocols for WSN. This project will end in August 2013. Alexandre Mouradian (Ph.D student) is funded by ARESA2.

- ANR ABCD 10/2013-04/2017.
Participants: Diala Naboulsi, Marco Fiore, Razvan Stanica
The partners in the ANR ABCD project are: Orange Labs, Ucopia, Inria UrbaNet, UPMC LIP6 PHARE, Telecom ParisTech. The objective of ABCD is to characterize large-scale user mobility and content consumption in urban areas via mobile data mining, so as to achieve efficient deployment and management of cloud resources via virtual machines. Our contribution in the project consists on the characterization of human mobility and service consumption at a city scale, and the design of appropriate resource allocation techniques at the cellular network level.
- ANR IDEFIX 10/2013-04/2017.
Participants: Soukaina Cherkaoui, Hervé Rivano, Fabrice Valois
The partners in the ANR IDEFIX project are: Orange Labs, Alcatel Lucent - Bell Labs, Telecom Paris Tech, Inria UrbaNet, Socrate and Dyogene.

8.2.2. Pôle ResCom

- Ongoing participation (since 2006)
Communication networks, working groups of GDR ASR, CNRS (<http://rescom.inrialpes.fr>). Hervé Rivano is member of the scientific committee of ResCom.
UrbaNet organized the ResCom non-thematic days 18-19th of december 2013 - <http://www.citi-lab.fr/seminar/journees-scientifiques-rescom/>.

8.2.3. Common Laboratory Inria/Alcatel-Lucent Bell Labs

- ADR Green
UrbaNet is part of the ADR Green of the common laboratory Inria/Alcatel-Lucent Bell Labs. This ADR provides the PhD grant of Soukaina Cherkaoui on the adaptation of wireless sensor network control protocols for optimizing the energy consumption of heterogeneous cellular LTE networks.

8.3. International Initiatives

8.3.1. Inria International Partners

8.3.1.1. Declared Inria International Partners

- **CNR - IEIIT (Italy)**. The informal cooperation with CNR - IEIIT, consisting on joint publications on mobile crowdsensing and mobile data mining, evolved this year into a strong partnership, following Dr. Marco Fiore's departure from INSA Lyon to CNR - IEIIT. Dr. Fiore remains an external collaborator of the Inria UrbaNet team, actively involved in several research projects.

8.3.1.2. Informal International Partners

- **Politecnico di Torino (Italy)**. Multiple publications co-authored with members of the Telecommunication Networks Group.
- **Universidade Federal de Minas Gerais (Brazil)**. Collaboration with Pedro Vaz de Melo and Antonio F. Loureiro on social mobility analysis.
- **Universitat Politècnica de Catalunya (Spain)**. Cooperation and joint publications on mobile malware propagation.
- **University of Waterloo (Ontario, Canada)**. Cooperation and joint publications on the optimization of wireless mesh networks.

8.4. International Research Visitors

8.4.1. Visits of International Scientists

- **Artur Ziviani**, LNCC, Brazil, 11/2013 (one week)

8.4.1.1. Internships

Sarah Allali

Subject: Network management of Floating Car Data

Date: from Feb 2013 until Jun 2013

Institution: University Claude Bernard Lyon 1 (France)

Silvia Ancona

Subject: Offloading Floating Car Data

Date: from Oct 2013 until Feb 2014

Institution: Politecnico di Bari (Italy)

Egert-Priit Arus

Subject: Integrating Electric Vehicles with Smart Grids

Date: from Oct 2012 until Jan 2013

Institution: Tallinn University of Technology (Estonia)

Julien Delaborde

Subject: From theory to experimentation: the missing link in protocols conception in WSN

Date: from Feb 2013 until Sep 2013

Institution: University Claude Bernard Lyon 1 (France)

Ibrahima Fall

Subject: Topologies des re´seaux urbains: Proprie´te´s et Impacts

Date: from Feb 2013 until Jun 2013

Institution: University Claude Bernard Lyon 1 (France)

Mohammad Irfan Khan

Subject: Information Dissemination in Vehicular Networks

Date: from Mar 2013 until Oct 2013

Institution: INSA Lyon (France)

Yufei Li

Subject: Evaluating energy saving protocols for LTE micro-cell infrastructure

Date: from Sep 2013 until Dec 2013

Institution: INSA Lyon (France)

Sorin Serban Marc

Subject: Signal propagation for vehicular communications in a large-scale urban scenario

Date: from Feb 2013 until Jun 2013

Institution: University of Oradea (Romania)

Soukaina Merzouk

Subject: Radio Propagation in an Urban Vehicular Environment

Date: from Jul 2013 until Aug 2013

Institution: EMSI Rabat (Morocco)

Keijiro Nakagawa

Subject: Multicommodity flow in delay tolerant networks

Date: from Sep 2012 until Jan 2013

Institution: Tokyo University (Japan)

Xuan Linh Nguyen

Subject: Agrégation de données temps-réel et fiable dans les réseaux de capteurs sans fil

Date: from Feb 2013 until Sep 2013

Institution: INSA Lyon (France)

Duc Khoa Pham

Subject: Characterization of Congestion Problems in Vehicular Networks

Date: from Oct 2013 until Dec 2013

Institution: INSA Lyon (France)

Stine Sondergaard

Subject: Vehicular Mobility Simulation

Date: from Oct 2013 until Jan 2014

Institution: Technical University of Denmark (Denmark)

Hamadoun Tall

Subject: Optimizing energy consumption of RPL

Date: from Apr 2013 until Oct 2013

Institution: Institution de la Francophonie pour l'Informatique (Vietnam)

Ionut Radu Toma

Subject: Signal propagation for vehicular communications in a large-scale urban scenario

Date: from Feb 2013 until Jun 2013

Institution: University of Oradea (Romania)

8.4.2. Visits to International Teams

- **Diala Naboulsi** was a visiting scholar within the Telecommunication Networks Group at Politecnico di Torino (Italy), between Sep 2013 and Jan 2014, under the CMIRA Explora'Doc programme.
- **Hervé Rivano** was a visiting researcher at University of Waterloo (Ontario, Canada), in September 2013.

ALICE Project-Team

6. Partnerships and Cooperations

6.1. Regional Initiatives

“Contrat région projet émergent” CORIDA (X. Antoine)/ALICE (B. Lévy): budget of 25 K€ shared between both teams.

6.2. National Initiatives

6.2.1. ANR BECASIM (2013 – 2016)

890 K€. X. Antoine heads the second partner, which includes Bruno Lévy. Budget for Nancy: 170 K€ of which 100 K€ are for IECL (team CORIDA). This project is managed by Inria.

6.2.2. ANR Bond (2013 – 2017)

X. Antoine is a member of ANR BOND (“projet blanc”).

6.2.3. ANR TECSER

X. Antoine is a member of ANR TECSER that stemmed from the ASTRID program (DGA). The consortium gathers Inria (S. Lantéri, Nice-Sophia, ÉPI CORIDA (X. Antoine) and HIEPACS), EADS, and Nuclétudes.

Total budget: 300 K€ of which 54 K€ are for CORIDA.

6.2.4. ANR Similar-Cities (*jeune chercheur*)

Sylvain Lefebvre has a continued collaboration with our industrial partners Algorithmic and the CSTB (Centre Scientifique et Technique du Bâtiment) through the ANR project [Similar-Cities](#). A technological transfer agreement was signed in early 2013 and the project ended on February.

6.2.5. ANR Physigraphix (*jeune chercheur*)

Rhaleb Zayer has continued the investigations on the ANR project [Physigraphix](#), which aim is to bridge the gap between acquisition and modeling in the context of deformable objects.

6.2.6. ANR Morpho

Dobrina Boltcheva and Bruno Lévy are involved in the ANR project [Morpho](#). Morpho is aimed at designing new technologies for the measure and for the analysis of dynamic surface evolutions using visual data.

6.3. European Initiatives

6.3.1. FP7 Projects

6.3.1.1. GoodShape

Title: Numerical Geometric Abstractions: from bits to equations

Type: IDEAS

Instrument: ERC Starting Grant

Duration: August 2008 – July 2013

Coordinator: Inria

Inria contact: Bruno Lévy

Abstract: GoodShape involves several fundamental aspects of 3D modeling and computer graphics. GoodShape is taking a new approach to the classic, essential problem of sampling, or the digital representation of objects in a computer. This new approach proposes to simultaneously consider the problem of approximating the solution of a partial differential equation and the optimal sampling problem. The proposed approach, based on the theory of numerical optimization, is likely to lead to new algorithms, more efficient than existing methods. Possible applications are envisioned in inverse engineering and oil exploration.

6.3.1.2. *ShapeForge*

Title: ShapeForge: By-Example Synthesis for Fabrication

Type: IDEAS

Instrument: ERC Starting Grant

Duration: December 2012 – November 2017

Coordinator: Inria

Inria contact: Sylvain Lefebvre

Abstract: Despite the advances in fabrication technologies such as 3D printing, we still lack the software allowing for anyone to easily manipulate and create useful objects. Not many people possess the required skills and time to create elegant designs that conform to precise technical specifications. 'By-example' shape synthesis methods are promising to address this problem: New shapes are automatically synthesized by assembling parts cutout of examples. The underlying assumption is that if parts are stitched along similar areas, the result will be similar in terms of its low-level representation: Any small spatial neighbourhood in the output matches a neighbourhood in the input. However, these approaches offer little control over the global organization of the synthesized shapes, which is randomized. The ShapeForge challenge is to automatically produce new objects visually similar to a set of examples, while ensuring that the generated objects can enforce a specific purpose, such as supporting weight distributed in space, affording for seating space or allowing for light to go through. This properties are crucial for someone designing furniture, lamps, containers, stairs and many of the common objects surrounding us. The originality of our approach is to cast a new view on the problem of 'by-example' shape synthesis, formulating it as the joint optimization of 'by-example' objectives, semantic descriptions of the content, as well as structural and fabrication objectives. Throughout the project, we will consider the full creation pipeline, from modeling to the actual fabrication of objects on a 3D printer. We will test our results on printed parts, verifying that they can be fabricated and exhibit the requested structural properties in terms of stability and resistance.

6.3.1.3. *VORPALINE*

Title: Vorpaline PoC

Type: IDEAS

Instrument: ERC Proof of Concept

Objectif: development of the Vorpaline software (see above)

Duration: July 2013 – June 2014

Coordinator: Inria

Inria contact: Bruno Lévy.

Abstract: The VORPALINE "Proof-of-Concept" project, funded by the European Research Council, aims at transforming the scientific results stemming from the GoodShape project into a technological component directly transferable to the industry. The funding allowed us to hire an experimented software architect, Thierry Valentin, who created the industrial software architecture and development tools (continuous integration platform, non-regression tests, software quality tools ...). The result of the project is the Vorpaline software (see section 4.1).

6.4. International Initiatives

6.4.1. Participation in Other International Programs

Xavier Antoine started two collaborations:

- E. Lorin et A.D. Bandrauk (University of Carleton, Canada) and CRM, Montréal, on numerical analysis for quantum chemistry.
- W. Bao (National University of Singapore), on numerical methods for simulating Bose-Einstein condensates.

6.5. International Research Visitors

6.5.1. Visits of International Scientists

- Klaus Hildebrandt (*Max-Planck-Institut für Informatik*) visited us and gave a talk on October 22. He was invited by Rhaleb Zayer.
- Frédéric Claux visited us during two days, from IRIT in Toulouse.

6.5.2. Visits to International Teams

Sylvain Lefebvre visited

- Niloy Mitra, University College London.
- Jérôme Darbon, CNRS & UCLA.

Xavier Antoine gave an invited talk at “EMF 2013, The Ninth International Symposium on Electric and Magnetic Fields”, Bruges, Belgium, April 2013.

ALPAGE Project-Team

8. Partnerships and Cooperations

8.1. Regional Initiatives

8.1.1. LabEx EFL (*Empirical Foundations of Linguistics*) (2011 – 2021)

Participants: Laurence Danlos, Benoît Sagot, Chloé Braud, Marie-Hélène Candito, Benoît Crabbé, Pascal Denis, Charlotte Roze, Pierre Magistry, Djamé Seddah, Juliette Thuilier, Éric Villemonte de La Clergerie.

Linguistics and related disciplines addressing language have achieved much progress in the last two decades but improved interdisciplinary communication and interaction can significantly boost this positive trend. The LabEx (excellency cluster) EFL (Empirical Foundations of Linguistics), launched in 2011 and headed by Jacqueline Vaissière, opens new perspectives by adopting an integrative approach. It groups together some of the French leading research teams in theoretical and applied linguistics, in computational linguistics, and in psycholinguistics. Through collaborations with prestigious multidisciplinary institutions (CSLI, MIT, Max Planck Institute, SOAS...) the project aims at contributing to the creation of a Paris School of Linguistics, a novel and innovative interdisciplinary site where dialog among the language sciences can be fostered, with a special focus on empirical foundations and experimental methods and a valuable expertise on technology transfer and applications.

Alpage is a very active member of the LabEx EFL together with other linguistic teams we have been increasingly collaborating with: LLF (University Paris 7 & CNRS) for formal linguistics, LIPN (University Paris 13 & CNRS) for NLP, LPNCog (University Paris 5 & CNRS) LSCP (ENS, EHESS & CNRS) for psycholinguistics, MII (University Paris 4 & CNRS) for Iranian and Indian studies. Alpage resources and tools have already proven relevant for research at the junction of all these areas of linguistics, thus drawing a preview of what the LabEx is about: experimental linguistics (see Section 4.6). Moreover, the LabEx provides Alpage with opportunities for collaborating with new teams, e.g., on language resource development with descriptive linguists (see 6.5 for example). In 2013, two post-docs funded by Labex EFL have worked at Alpage (Yves Scherrer) or jointly at Alpage and LLF (Margaret Grant).

Benoît Sagot is the head one of the 7 autonomous scientific “strands” of the LabEx EFL, namely the strand 6 on “Language Resources”. Marie-Hélène Candito and Benoît Crabbé are respectively deputy-head of strands 5 on “Computational semantic analysis” and 2 on “Experimental grammar from a cross-linguistic perspective”. Several project members are in charge of research operations within these 3 strands.

8.2. National Initiatives

8.2.1. ANR

8.2.1.1. ANR project ASFALDA (2012 – 2015)

Participants: Marie-Hélène Candito [principal investigator], Marianne Djemaa, Benoît Sagot, Éric Villemonte de La Clergerie, Laurence Danlos.

Alpage is principal investigator team for the ANR project ASFALDA, lead by Marie-Hélène Candito. The other partners are the Laboratoire d’Informatique Fondamentale de Marseille (LIF), the CEA-List, the MELODI team (IRIT, Toulouse), the Laboratoire de Linguistique Formelle (LLF, Paris Diderot) and the Ant’inno society.

The project aims to provide both a French corpus with semantic annotations and automatic tools for shallow semantic analysis, using machine learning techniques to train analyzers on this corpus. The target semantic annotations are structured following the FrameNet framework [47] and can be characterized roughly as an explicitation of “who does what when and where”, that abstracts away from word order / syntactic variation, and to some of the lexical variation found in natural language.

The project relies on an existing standard for semantic annotation of predicates and roles (FrameNet), and on existing previous effort of linguistic annotation for French (the French Treebank). The original FrameNet project provides a structured set of prototypical situations, called frames, along with a semantic characterization of the participants of these situations (called *roles*). We propose to take advantage of this semantic database, which has proved largely portable across languages, to build a French FrameNet, meaning both a lexicon listing which French lexemes can express which frames, and an annotated corpus in which occurrences of frames and roles played by participants are made explicit. The addition of semantic annotations to the French Treebank, which already contains morphological and syntactic annotations, will boost its usefulness both for linguistic studies and for machine-learning-based Natural Language Processing applications for French, such as content semantic annotation, text mining or information extraction.

To cope with the intrinsic coverage difficulty of such a project, we adopt a hybrid strategy to obtain both exhaustive annotation for some specific selected concepts (commercial transaction, communication, causality, sentiment and emotion, time), and exhaustive annotation for some highly frequent verbs. Pre-annotation of roles will be tested, using linking information between deep grammatical functions and semantic roles.

The project is structured as follows:

- Task 1 concerns the delimitation of the focused FrameNet substructure, and its coherence verification, in order to make the resulting structure more easily usable for inference and for automatic enrichment (with compatibility with the original model);
- Task 2 concerns all the lexical aspects: which lexemes can express the selected frames, how they map to external resources, and how their semantic argument can be syntactically expressed, an information usable for automatic pre-annotation on the corpus;
- Task 3 is devoted to the manual annotation of corpus occurrences (we target 20000 annotated occurrences);
- In Task 4 we will design a semantic analyzer, able to automatically make explicit the semantic annotation (frames and roles) on new sentences, using machine learning on the annotated corpus;
- Task 5 consists in testing the integration of the semantic analysis in an industrial search engine, and to measure its usefulness in terms of user satisfaction.

The scientific key aspects of the project are:

- an emphasis on the diversity of ways to express the same frame, including expression (such as discourse connectors) that cross sentence boundaries;
- an emphasis on semi-supervised techniques for semantic analysis, to generalize over the available annotated data.

8.2.1.2. ANR project EDyLex (2010 – 2013)

Participants: Benoît Sagot [principal investigator], Rosa Stern, Damien Nouvel, Virginie Mouilleron, Marion Baranes, Sarah Beniamine, Laurence Danlos.

EDYLEX was an ANR project (STIC/CONTINT) headed by Benoît Sagot, which came to an end on June 30, 2013. The focus of the project was the dynamic acquisition of new entries in existing lexical resources that are used in syntactic and semantic parsing systems: how to detect and qualify an unknown word or a new named entity in a text? How to associate it with phonetic, morphosyntactic, syntactic, semantic properties and information? Various complementary techniques will be explored and crossed (probabilistic and symbolic, corpus-based and rule-based...). Their application to the contents produced by the AFP news agency (Agence France-Presse) constitutes a context that is representative for the problems of incompleteness and lexical creativity: indexing, creation and maintenance of ontologies (location and person names, topics), both necessary for handling and organizing a massive information flow (over 4,000 news wires per day).

The participants of the project, besides Alpage, were the LIF (Université de Méditerranée), the LIMSI (CNRS team), two small companies, Syllabs and Vecsys Research, and the AFP.

In 2013, several important developments have been achieved:

- Finalization of a beta version of the first non-alpha release of the WOLF (Free French WordNet)
- Improvement or development of modules for automatic detection, classification and morphological analysis of unknown words (neologisms, new named entities) in French corpora and integration within a full-featured processing pipeline (see 6.2);
- Collaboration with Vocapia for interfacing the results of this pipeline with Vocapia's language models, in order to improve speech recognition systems used at AFP;
- Use of an EDyLex-specific version of the NewsProcess architecture, previously developed at Alpage, for meeting the expectations of the EDyLex project in terms of lexicon extension from dynamic corpora, here AFP news wires.

8.2.1.3. ANR project Polymnie (2012-2015)

Participants: Laurence Danlos, Éric Villemonte de La Clergerie.

Polymnie is an ANR research project headed by Sylvain Podogolla (Sémagramme, Inria Lorraine) with Melodi (INRIT, CNRS), Signes (LABRI, CNRS) and Alpage as partners. This project relies on the grammatical framework of Abstract Categorical Grammars (ACG). A feature of this formalism is to provide the same mathematical perspective both on the surface forms and on the more abstract forms the latter correspond to. As a consequence:

- ACG allows for the encoding of a large variety of grammatical formalisms such as context-free grammars, Tree Adjoining grammars (TAG), etc.
- ACG define two languages: an abstract language for the abstract forms, and an object language for the surface forms.

The role of Alpage in this project is to develop sentential or discursive grammars written in TAG so as to study their conversion in ACG. First results achieved in 2013 are described in 6.14.

8.2.2. Other national initiatives

8.2.2.1. "Investissements d'Avenir" project PACTE (2012 – 2014)

Participants: Benoît Sagot, Kata Gábor.

PACTE (*Projet d'Amélioration de la Capture TExtuelle*) is an "Investissements d'Avenir" project submitted within the call "Technologies de numérisation et de valorisation des contenus culturels, scientifiques et éducatifs". It started in November 2012, although the associated fundings only arrived at Alpage in July 2013.

PACTE aims at improving the performance of textual capture processes (OCR, manual script recognition, manual capture, direct typing), using NLP tools relying on both statistical (n -gram-based, with scalability issues) and hybrid techniques (involving lexical knowledge and POS-tagging models). It addresses specifically the application domain of written heritage. The project takes place in a multilingual context, and therefore aims at developing as language-independent techniques as possible.

PACTE involves 3 companies (Numen, formerly Diadeis, main partner, as well as A2IA and Isako) as well as Alpage and the LIUM (University of Le Mans). It brings together business specialists, large-scale corpora, lexical resources, as well as the scientific and technical expertise required.

The results obtained at Alpage in 2013 within PACTE are described in 6.7

8.2.3. Consortium Corpus Écrits within the TGIR Huma-Num

Participants: Benoît Sagot, Djamé Seddah.

Huma-Num is a TGIR (Very Large Research Infrastructure) dedicated to digital humanities. Among Huma-Num initiatives are a dozen of consortia, which bring together most members of various research communities. Among them is the *Corpus Écrits* consortium, which is dedicated to all aspects related to written corpora, from NLP to corpus development, corpus specification, standardization, and others. All types of written corpora are covered (French, other languages, contemporary language, medieval language, specialized text, non-standard text, etc.). The consortium Corpus Écrits is managed by the Institut de Linguistique Française, a CNRS federation of which Alpage is a member since June 2013, under the supervision of Franck Neveu.

Alpage is involved in various projects within this consortium, and especially in the development of corpora for CMC texts (blogs, forum posts, SMSs, textchat...) and shallow corpus annotation, especially with MElt.

8.3. European Initiatives

8.3.1. Collaborations in European Programs, except FP7

Program: COST

Project acronym: PARSEME

Project title: Parsing and multi-word expressions. Towards linguistic precision and computational efficiency in natural language processing

Duration: 03/2013- 03/2017

Coordinator: Agata SAVARY

Other partners: 24 participating countries

Abstract: This Action aims at increasing and enhancing the support of the European multilingual heritage from Information and Communication Technologies (ICT). This general aim is addressed through improving linguistic representativeness, precision and computational efficiency of Natural Language Processing (NLP) applications. The Action focuses on the major bottleneck of these applications: Multi-Word Expressions (MWEs), i.e. sequences of words with unpredictable properties such as “to count somebody in” or “to take a haircut.” A breakthrough in their modelling and processing can only result from a coordinated effort of multidisciplinary experts in different languages. COST is the most adequate framework answering this need. Fourteen European languages will be addressed from a cross-theoretical and cross-methodological perspective, necessary for coping with current fragmentation issues. Expected deliverables include enhanced language resources and tools, as well as recommendations of best practices for cutting-edge MWE-aware language models. The Action will lead to a better understanding of the nature of MWEs. It will establish a long-lasting collaboration within a multilingual network of MWE specialists. It will pave the way towards competitive next generation text processing tools which will pay greater attention to language phenomena.

8.4. International Initiatives

8.4.1. Inria International Partners

8.4.1.1. Informal International Partners

Alpage has active collaborations with several international teams. The most active in 2013 have been:

- collaboration with Columbia University (United States), in particular on discourse modeling (Laurence Danlos, with Owen Rambow) and on computational morphology (Benoît Sagot, with Owen Rambow and Nizar Habash)
- collaboration with the Weizmann Institute of Science (Israel) on parsing morphologically rich languages (Djamé Seddah, with Reut Tsarfaty)
- collaboration with the Indiana University (United States) on parsing morphologically rich languages (Djamé Seddah, with Sandra Kubler)
- collaboration with the Uppsala University (Sweden) on statistical parsing (Marie-Hélène Candito and sDjamé Seddah, with Joakim Nivre)

AVIZ Project-Team

8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. ANR FITOC: From Individual To Collaborative Visual Analytics

Participants: Petra Isenberg [correspondant], Jean-Daniel Fekete, Pierre Dragicevic, Wesley Willett.

The project addresses fundamental problems of technological infrastructure and the design of data representation and interaction to build a bridge between individual and team work for visual data analysis. In collaboration with the University of Magdeburg we have begun to tackle this challenge through the design of tangible widgets that help to bridge the gap between individual and collaborative information seeking.

8.1.2. ANR EASEA-Cloud

Participants: Evelyne Lutton [correspondant], Waldo Cancino, Hugo Gilbert, Pierre Collet.

The aim of the EASEA-CLOUD project is to exploit the massively parallel resources that are offered by clusters or a grid of modern GPU-equipped machines in order to find solutions to inverse problems whose evaluation function can be intrinsically sequential. Massive parallelization of generic sequential problems can be achieved by evolutionary computation, that can efficiently exploit the parallel evaluation of thousands of potential solutions (a population) for optimization or machine-learning purposes. The project consists in turning the existing EASEA (EAsy Specification of Evolutionary Algorithms, <http://easea.unistra.fr/>) research platform into an industrial-grade platform that could be exploited by running in “cloud” mode, on a large grid of computers (ISC-PIF/CREA is the current manager of the French National Grid). The necessary steps are to develop:

- a professional-grade API, development environment and human-computer interface for the existing academic EASEA platform,
- cloud-management tools (in order to launch an experiment on a grid of computers, monitor the experiment and bill the laboratories or companies that will be using EASEA-CLOUD for intensive computation,
- novel visualisation tools, in order to monitor an evolutionary run, potentially launched on several hundred heterogeneous GPU machines.

The consortium is made of three partners: LSIT/UDS (which is developing the EASEA platform), ISCIPLIR/CREA (for its experience in grid and cloud computing), AVIZ/Inria (for its experience in visualization tools for evolutionary computation) and two subcontractors: LogXLabs (a software development company in order to create industrial-grade code and interfaces) and BIOEMERGENCE-IMAGIF, the “valorisation” department of CNRS Gif s/Yvette. Valorisation will take place in strong collaboration with UNISTRA VALO, the valorisation structure of Université de Strasbourg. The project started on October 1st, 2012, for 2 years. AVIZ is in charge of developing new visualisation tools adapted to the monitoring of the optimization process.

8.2. European Initiatives

8.2.1. FP7 Projects

8.2.1.1. DREAM

Program: FP7

Project acronym: **DREAM**

Project title: Design and development of REAListic food Models with well-characterised micro- and macro-structure and composition

Duration: 2009–2013

Coordinator: INRA - CEPIA department, Monique Axelos

Other partners: Technical Research Centre of Finland, Actilait France, ADRIA Développement France, CNRS, INRA Transfert, Société de Recherche et Développement Alimentaire Bongrain, Campden BRI Magyarország Nonprofit Kft. Hungary, Central Food Research Institute Hungary, Teagasc - Agriculture and Food Development Authority Ireland, Consiglio Nazionale delle Ricerche - Istituto di Scienze delle Produzioni Alimentari Italy, Top Institute Food and Nutrition The Netherlands, Wageningen University (WUR) The Netherlands, University of Ljubljana, Biotechnical Faculty Slovenia, Institute for Food and Agricultural Research and Technology Spain, Campden BRI UK, Institute of Food Research UK, United Biscuits (UK) Limited.

Abstract:

The overall goal of DREAM (Design and development of REAListic food Models with well-characterised micro- and macro-structure and composition) is to develop realistic, physical and mathematical models to be used as standards that can be exploited across all major food categories to facilitate development of common approaches to risk assessment and nutritional quality for food research and industry.

The partnership involves 18 partners from 9 European countries, among which two multinationals. The project is led by INRA, CEPIA department, and Inria participation is managed by delegation by the ISC-PIF (CNRS-CREA, UMR 7656).

See more at <http://dream.aaeuropae.org/>.

The role of AVIZ has been to develop evolutionary techniques adapted to the modeling of agrifood process. In 2012, the work was focussed on the development:

- of robust evolutionary methods to learn the structure of Bayesian Networks when experimental data are rare (in collaboration with Alberto Tonda, Cédric Baudrit and Nathalie Perrot of INRA/GMPA and Pierre-Henri Wuillemin of LIP6/DESIR), applied to cheese making and biscuit baking process,
- of a model of milk gel based on partial differential equations, where numerical parameters were learned by artificial evolution (in collaboration with Julie Foucquier, Sébastien Gaucel Alberto Tonda, and Nathalie Perrot of INRA/GMPA).

8.2.1.2. CENDARI

Program: Infrastructures

Project acronym: **CENDARI**

Project title: Collaborative European Digital/Archival Infrastructure

Duration: 01/2012 - 12/2015

Coordinator: Trinity College, Dublin (IE),

Other partners: Freie Universität Berlin (DE), Matematički Institut Sanu u Beogradu (Serbia), University of Birmingham (UK), King's College London (UK), Georg-August-Universität Göttingen Stiftung Öffentlichen Rechts (DE), Národní knihovna České republiky (Czech Republic), Società Internazionale per lo Studio del Medioevo Latino-S.I.S.M.E.L. Associazione (IT), Fondazione Ezio Franceschini Onlus (IT), Ministerium für Wissenschaft, Forschung und Kunst Baden-Württemberg (DE), Consortium of European Research Libraries (UK), Koninklijke Bibliotheek (NL), UNIVERSITÀ DEGLI STUDI DI CASSINO (IT).

Abstract:

The Collaborative European Digital Archive Infrastructure (CENDARI) will provide and facilitate access to existing archives and resources in Europe for the study of medieval and modern European history through the development of an 'enquiry environment'. This environment will increase access to records of historic importance across the European Research Area, creating a powerful new

platform for accessing and investigating historical data in a transnational fashion overcoming the national and institutional data silos that now exist. It will leverage the power of the European infrastructure for Digital Humanities (DARIAH) bringing these technical experts together with leading historians and existing research infrastructures (archives, libraries and individual digital projects) within a programme of technical research informed by cutting edge reflection on the impact of the digital age on scholarly practice.

The enquiry environment that is at the heart of this proposal will create new ways to discover meaning, a methodology not just of scale but of kind. It will create tools and workspaces that allow researchers to engage with large data sets via federated multilingual searches across heterogeneous resources while defining workflows enabling the creation of personalized research environments, shared research and teaching spaces, and annotation trails, amongst other features. This will be facilitated by multilingual authority lists of named entities (people, places, events) that will harness user involvement to add intelligence to the system. Moreover, it will develop new visual paradigms for the exploration of patterns generated by the system, from knowledge transfer and dissemination, to language usage and shifts, to the advancement and diffusion of ideas.

See more at <http://cendari.eu/> and <http://www.aviz.fr/Research/CENDARI>.

8.2.2. Collaborations with Major European Organizations

Fraunhofer Institute, IGD (DE)

We are collaborating on visual analytics, setting up European projects and coordinating European initiatives on the subject.

University of Dresden, (DE)

We have been collaborating with Raimund Dachsel on stackable tangible devices for faceted browsing [70], [69].

8.3. International Initiatives

8.3.1. Inria International Partners

8.3.1.1. Declared Inria International Partners

AVIZ researchers collaborate with a number of international partners, including:

- Google, Mountain View, USA
- Microsoft Research, Redmond, USA
- New York University, USA
- University of Toronto, Canada
- University of Calgary, Canada
- University of British Columbia, Canada
- University of Kent, UK
- University of Konstanz, Germany
- University of Magdeburg, Germany

8.3.1.2. Informal International Partners

- Arizona State University, USA
- University of Groningen, the Netherlands
- University of Granada, Spain

8.3.2. Inria International Labs

- *Massive Data team*, Inria Chile.

8.3.3. Collaboration with Google

AVIZ collaborates with Google on several projects, related to the Google Research Grant (see Section 7.1) and to evaluation methodology in information visualization [71]. Heidi Lam from Google spent 3 months at AVIZ to collaborate more closely.

8.3.4. Collaboration with Microsoft Research

AVIZ collaborates with several researchers from Microsoft Research Redmond, in particular on the topic of new interactions for information visualization [72] and brain connectivity visualization.

8.3.5. Collaboration with New-York University

Jean-Daniel Fekete collaborates with Claudio Silva and Juliana Freire from NYU-Poly on the VisTrails workflow system for visual analytics (<http://www.vistrails.org>). Rémi Rampin, intern from the Univ. Paris-Sud Master in HCI, has spent one month at Orsay and 5 months at NYU-Poly to allow VisTrails to run Java-based applications and Toolkits. Rémi successfully connected the traditional Python-C implementation of VisTrails to the Java virtual machine using the JPype package. Jean-Daniel Fekete is not porting the Obvious Toolkit [61] in this environment to integrate all its components [64].

8.4. International Research Visitors

8.4.1. Visits of International Scientists

- Stefan Manegold, in May, from CWI Amsterdam on Big-Data Visual Analytics

8.4.1.1. Internships

- Candemir Doger, from June 2013 to September 2013
Subject: Interactive Visualization on Tablet-sized Devices
Institution: Sabanci University, Istanbul, Turkey
- Qi Lan, from April 2013 to September 2013
Subject: Multi-touch selection for data graphics
Institution: Université Paris Sud, France
- Sai Ganesh Swaminathan, from June 2013 to October 2013
Subject: Software Tools for Physical Visualizations
Institution: none – student from M1 HCID / M2R Interaction

8.4.2. Visits to International Teams

- Tobias Isenberg: University of Granada, Spain, April 2013

AYIN Team

8. Partnerships and Cooperations

8.1. Regional Initiatives

- Paula Craciun and Josiane Zerubia have been in contact with Antoine Mangin, Scientific Director at ACRI-ST (<http://www.acri-st.fr/English/index.html>), in Sophia Antipolis to discuss Paula Craciun's research on boat detection and counting in Mediterranean harbors using marked point processes.
- Zhao Liu and Josiane Zerubia met several times with Prof. Bahadoran from CHU Nice/Inserm (Faculty of Medicine, Dermatology department, at l'Archet 2 hospital in Nice) and Dr Queille-Roussel, CPCAD managing director at CHU Nice (Faculty of Medicine, Dermatology department, at l'Archet 2 hospital in Nice) to discuss Ayin's research on semi-automatic acne detection.

8.2. European Initiatives

8.2.1. Collaborations with Major European Organizations

LIRA consortium

Partners: Philips R&D (Eindhoven), CWI (Amsterdam), Fraunhofer Institutes (Berlin, Stuttgart, Darmstadt), Inria-SAM

Skincare image and signal processing: analysis, modeling and characterization of the condition of human skin.

8.3. International Initiatives

8.3.1. Informal International Partners

Qiyin Fang.

Subject: New optical sensors for skin imaging and their biomedical applications.

Institution: McMaster University (Canada).

Zoltan Kato.

Subject: Multi-layer Markovian models for change detection in aerial and satellite images.

Institution: Szeged University (Hungary).

Gabriele Moser, Sebastiano Serpico.

Subject: Hierarchical Markov random fields for multi-temporal and multi-resolution classification in remote sensing.

Institution: Genoa University (Italy).

Anuj Srivastava.

Subject: Statistical shape analysis of functions, curves, and surfaces.

Institution: Florida State University (USA).

Zoltan Kato.

Subject: Random field models of shape.

Institution: Szeged University (Hungary).

Jochen Einbeck, Stuart Jones.

Subject: Statistical shape modelling for geology.

Institution: Durham University (UK).

8.4. International Research Visitors

8.4.1. Visits of International Scientists

- Qiyin Fang (McMaster University, Canada, one week in May 2013).
- Zoltan Kato (Szeged University, Hungary, from Jul 2013 until Aug 2013).
- Gregoire Mercier (Telecom Bretagne, Brest, one week in June 2013 and one week in December 2013).
- Gabriele Moser (Genoa University, Italy, one week in July 2013).

8.4.2. Internships

Claudio Price González (from January 2013 until March 2013)

Subject: Graph-based model for multitemporal segmentation of sea ice floes from satellite data.

Institution: Federico Santa Maria Technical University and Inria Chile.

DAHU Project-Team

6. Partnerships and Cooperations

6.1. European Initiatives

6.1.1. FP7 Projects

6.1.1.1. Webdam

Title: WebDam

Type: IDEAS

Instrument: ERC Advanced Grant (Advanced)

Duration: December 2008 - November 2013

Coordinator: Serge Abiteboul, Inria (France)

Others partners: Pierre Senellart, Telecom Paristech.

See also: <http://webdam.inria.fr>

Abstract: The goal is to develop a formal model for Web data management. This model will open new horizons for the development of the Web in a well-principled way, enhancing its functionality, performance, and reliability. Specifically, the goal is to develop a universally accepted formal framework for describing complex and flexible interacting Web applications featuring notably data exchange, sharing, integration, querying and updating. We also propose to develop formal foundations that will enable peers to concurrently reason about global data management activities, cooperate in solving specific tasks and support services with desired quality of service.

6.2. International Initiatives

6.2.1. Inria International Partners

6.2.1.1. Declared Inria International Partners

Victor Vianu, UC San Diego, USA.

6.3. International Research Visitors

6.3.1. Visits of International Scientists

- Benoît Larose

Subject: Constraint Satisfaction Problems

Institution: concordia Univeresity, Montreal, Canada.

DREAM Project-Team

8. Partnerships and Cooperations

8.1. Regional Initiatives

8.1.1. *Projet RTR: Coupling observation/simulation for decision-aid in environment complex systems*

Participants: Sid Ahmed Benabderrahmane, Marie-Odile Cordier, Thomas Guyet, Simon Malinowski, René Quiniou.

This RTR (Réseaux Thématiques de Recherche - Thematic Research Networks) project is a collaboration between COSTEL (UMR LETG, Rennes), the team Obelix (IRISA, Vannes), UMR SAS (INRA, Rennes) and the EPI Dream. The project began in 2013 and has been funded for one year. It aims at studying the relationships between observations and simulations. The objective is to better understand what one side can provide to the other side in order to improve decision-making. This project gathers partners having expertise and skills in teledetection and image analysis, in modeling and simulation, and in knowledge acquisition for aiding decision in environmental research. The targeted applications belong to the domain of hydrology and agriculture. A final workshop (<http://tinyurl.com/k3smbox>) has been organized in november.

8.2. National Initiatives

8.2.1. *ACASSYA: Supporting the agro ecological evolution of breeding systems in coastal watersheds*

Participants: Marie-Odile Cordier, Véronique Masson, René Quiniou.

The ACASSYA project (ACcompagner l'évolution Agro-écologique deS SYstèmes d'élevage dans les bassins versants côtiers) is funded by ANR/ADD. It started at the beginning of 2009 and will end in June 2013. The main partners are our colleagues from INRA (SAS from Rennes. One of the objectives is to develop modeling tools supporting the management of ecosystems, and more precisely the agro ecological evolution of breeding systems in coastal watersheds. In this context, the challenge is to transform existing simulation tools (as SACADEAU or TNT2 into decision-aid tools, able to answer queries or scenarios about the future evolution of ecosystems. (<http://tinyurl.com/ptzdqo5>)

8.2.2. *Asterix : spatio-temporal analysis of remote sensing images*

Participant: Thomas Guyet.

The ASTERIX project (Analyse Spatio-temporelle pour la Télédétection de l'Environnement par Reconnaissance dans les Images complexeS) is funded by ANR/JCJC. The project leader is S. Lefèvre from the IRISA/Vannes Team Obelix. The other partners are OSUR/University of Rennes-2, the Laboratory Image, Ville, Environnement (LIVE), University of Strasbourg, DYNAFOR (INRA/ENSAT), Toulouse and Institut de Physique du Globe de Strasbourg (IPGS), University of Strasbourg. The project started at the end of 2013 (<http://anr-asterix.irisa.fr/>) and will end in 2017.

The goal of the ASTERIX project is to provide methods, algorithms and software in the field of image analysis and machine learning/data mining to support the analysis of remote sensing images. The project addresses the specific issues of such data: dimensionality, heterogeneity, volume, spatio-temporal nature and the temporal evolution. It is dedicated to the field of environmental remote sensing and deals with concrete applications such as the evolution of the coastline or the colonization of grasslands by ash.

Our contribution to this project will be the proposition of data mining algorithms to deal with the spatio-temporal dimensions of satellite image time series.

8.3. International Initiatives

8.3.1. Inria International Partners

8.3.1.1. Declared Inria International Partners

- University of Potsdam, Germany. Prof. Torsten Schaub has been awarded an Inria international senior grant from 2103 to 2017.

8.3.1.2. Informal International Partners

- University of Calgary, Canada. Dr Edouard Timsit, Dept. of production Animal Health, Faculty of Veterinary, Medicine.
- University di Torino, Italy, Dr Roberto Micalizio, Dept. of Computer Science.

E-MOTION Project-Team

7. Partnerships and Cooperations

7.1. European Initiatives

7.1.1. FP7 Projects

European Project (Strep) Bambi (Bottom-up Approaches to Machines dedicated to Bayesian Inference). The Bambi project started January 1st 2014 for a period of three years. The participant to this project are CNRS, HUJI (ISRAEL), ULG (Belgique), ISR(Portugal) ProbaYes(France). We propose a theory and a hardware implementation of probabilistic computation inspired by biochemical cell signaling. We will study probabilistic computation following three axes: algebra, biology, and hardware. In each case, we will develop a bottom-up hierarchical approach starting from the elementary components, and study how to combine them to build more complex systems. We propose Bayesian gates operating on probability distributions on binary variables as the building blocks of our probabilistic algebra. These Bayesian gates can be seen as a generalization of logical operators in Boolean algebra. We propose to interpret elementary cell signalling pathways as biological implementation of these probabilistic gates. In turn, the key features of biochemical processes give new insights for new probabilistic hardware implementation. We propose to associate conventional electronics and novel stochastic nano-devices to build the required hardware elements. Combining them will lead to new artificial information processing systems, which could, in the future, outperform classical computers in tasks involving a direct interaction with the physical world. For this purpose, this project associates research in Bayesian probability theory, molecular biology, nanophysics, computer science and electronics. The e-motion team is mainly concerned by : The development of Stochastic temporal coding of probabilistic information and the adaptation and learning in probabilistic machines

7.1.2. Major European Organizations with which you have followed Collaborations

Department of Electrical & Computer Engineering: University of Thrace, Xanthi (GREECE)

Subject: 3D coverage based on Stochastic Optimization algorithms

BlueBotics: BlueBotics Company, Lausanne (Switzerland)

Subject: Implementation of self-calibration strategies for wheeled robots and SLAM algorithms for industrial purposes

Autonomous System laboratory: ETHZ, Zurich (Switzerland)

Subject: Vision and IMU data Fusion for 3D navigation in GPS denied environment.

Robotics and Perception Group: University of Zurich (Switzerland)

Subject: Vision and IMU data Fusion for 3D navigation in GPS denied environment.

Universidade de Aveiro (Portugal)

Subject: Leader following. Co-directed PhD.

Centro De Automatica y Robotica, UPM-CSIC, Madrid (Spain)

Subject: Target interception.

Social Robotics Laboratory, Freiburg (Germany)

Subject: Human behavior understanding.

7.2. International Initiatives

7.2.1. “PRETIV”

[November 2011- October 2014]

Multimodal Perception and REasoning for Transnational Intelligent Vehicles" (PRETIV) is a three-year ANR project accepted in the framework of the Blanc International II Programme with participants from France (e-Motion of Inria, Heudiasyc of CNRS, PSA Peugeot Citroen DRIA in Velizy) and China (Peking University, PSA Peugeot Citroen Technical Center in Shanghai). The project aims at developing of an online multimodal perception system for a vehicle and offline reasoning methods, dealing with incompleteness and uncertainties in the models and sensor data, as well as at conducting experiments in typical traffic scenarios in France and China to create an open comparative dataset for traffic scene understanding. The perception system will incorporate vehicle localization, mapping of static environmental objects, detecting and tracking of dynamic objects in probabilistic frameworks through multimodal sensing data and knowledge fusion. The reasoning methods are based on sensor data to learn semantics, activity and interaction patterns (vehicle - other objects, vehicle - infrastructure) to be used as a priori information to devise effective online perception algorithms toward situation awareness. The comparative dataset will contain experimental data of typical traffic scenarios with ground-truth, which will be used to learn country-specific traffic semantics and it will be open to the public.

7.2.2. Visits of International Scientists

Mario Garzon, PhD at Universidade de Madrid was in our team from february 2013 to april 2013.

7.2.3. Inria International Labs

7.2.3.1. "iCeIRA"

[Jan 2013- Jan 2018] The e-Motion project-team has won (in cooperation with the CNRS laboratories LAAS and ISIR) a major partnership with Taiwan in the scope of the call "International Excellence Laboratories" (I-RiCE program) launched by the National Science Council (NSC) of Taiwan. The laboratory is hosted by the National University of Taiwan, it is supported for 5 years, and the collaborative research is focusing on Human centered Robotics.

7.2.4. Participation In other International Programs

7.2.4.1. "ict-PAMM"

[September 2011 - September 2013]

ict-PAMM is an ICT-ASIA project accepted in 2011 for 2 years. It is funded by the French Ministry of Foreign Affairs and Inria. This project aims at conducting common research activities in the areas of robotic mobile service and robotic assistance of human in different contexts of human life. French partners are Inria-emotion from Grenoble, Inria-IMARA from Rocquencourt and Institut Blaise Pascal from Clermont-Ferrand. Asian Partners are IRA-Lab from Taiwan, ISRC-SKKU from Suwon in Korea, ITS-Lab from Kumamoto in Japan and Mica Institute from Hanoi in Vietnam.

7.2.4.2. "Predimap"

[September 2011 - September 2013]

Predimap is an ICT-ASIA project accepted in 2011 for 2 years. It is funded by the French Ministry of Foreign Affairs and Inria. This project aims at conducting common research activities in the area of perception in road environment. The main objective is the simultaneous use of local perception and Geographical Information Systems (GIS) in order to reach a global improvement in understanding road environment. Thus the research topics included in the project are: local perception, precise localization, map-matching and understanding of the traffic scenes. French partners are Inria-emotion from Grenoble, Heudiasyc team from CNRS/UTC, and Matis team from IGN. Foreign partners are Peking University and Shanghai Jiao Tong University in China, CSIS lab from Tokyo University in Japan and AIT Geoinformatics Center in Thailand.

7.3. International Research Visitors

7.3.1. Visits to International Teams

- In relation with the Bambi project, Emmanuel Mazer visited Dr. Vickash Masinghka at the Mit Computer science department to establish an academic collaboration around probabilistic computation (Bambi Project). On the same subject but more related to the industrial side, Emmanuel Mazer visited the research center of AMAZON in Berlin and the Microsoft research center in Cambridge to evaluate future collaboration.
- Chiara Troiani spent 6 month at the University of Zurich, in the Robotics and Perception Group (Switzerland).
- Gregoire Vignon spent 2 month at the iCeIRA lab (Taiwan).

EXMO Project-Team

7. Partnerships and Cooperations

7.1. National Initiatives

7.1.1. ANR Datalift

Program: ANR-ContInt

Project acronym: Datalift

Project title: DATALIFT

Instrument: platform

Duration: September 2010 - March 2014

Coordinator: Inria EXMO/François Scharffe

Participants: Jérôme Euzenat, Zhengjie Fan, Jérôme David

See also: <http://www.datalift.org>

Abstract: EXMO coordinates with LIRMM the DATALIFT project whose goal is to produce a platform for publishing governmental data as linked data. EXMO is particularly involved in the generation of links between datasets (see §6.2).

7.1.2. ANR Lindicle

Program: ANR-Blanc international 2

Project acronym: LINDICLE

Project title: Linking data in cross-lingual environment

Duration: January 2013 - December 2016

Coordinator: Inria EXMO/Jérôme David

Participants: Jérôme Euzenat, Manuel Atencia Arcas, Jérôme David, Tatiana Lesnikova, Adam Sanchez Ayte

Other partners: Tsinghua university (CN)

See also: <http://lindicle.inrialpes.fr>

Abstract: The LINDICLE project investigates multilingual data interlinking between French, English and Chinese data sources (see §6.2).

7.2. European Initiatives

7.2.1. FP7 Projects

7.2.1.1. Ready4SmartCities

Type: CAPACITIES

Defi: ICT-2013.6.4 - Optimising Energy Systems in Smart Cities

Instrument: Coordination and Support Action

Project acronym: Ready4SmartCities

Project title: ICT Roadmap and Data Interoperability for Energy Systems in Smart Cities

Duration: October 2013 - September 2015

Coordinator: D'appolonia Spa (Italy)

Partner: D'appolonia (Italy) Universidad Politecnica de Madrid (Spain) CSTB (France), CERTH (Grèce), VTT (Finland), Inria (France), AIT (Austria), AEC3 (UK), Politecnico di Torino (Italy), Empirica (Germany)

Inria contact: Jérôme Euzenat

Participants: Jérôme Euzenat, Luz Maria Priego-Roche, Jérôme David

See also: <http://www.ready4smartcities.eu>

Abstract: The READY4SmartCities project intends to increase awareness and interoperability for the adoption of ICT and semantic technologies in energy system to obtain a reduction of energy consumption and CO2 emission at smart cities community level through innovative relying on RTD and innovation outcomes and ICT-based solutions.

7.3. International Research Visitors

7.3.1. Visits of International Scientists

- **Esther Lozano (Universidad Politecnica de Madrid)** visited EXMO from January 8th to May 8th, 2013 working on the combination of context-based matching with semantic modelling systems;
- **Jorge Gracia (Universidad Politecnica de Madrid)** visited EXMO from May 1st to July 27th, 2013, working on multilingual ontology/instance matching and expressive ontology matching;
- **Daniel Vila (Universidad Politecnica de Madrid)** visited EXMO from June 2nd to July 23rd, 2013 working on data interlinking and ontology inference;
- **Angela Locoro (Universita degli Studi di Genova)** visited EXMO from June 1st to 29th, 2013 working on context-based ontology matching and generalised the notion of context;
- **Lihua Zhao (NII, Tokyo)** visited EXMO from August 17th to September 21st, 2013 on combining data interlinking from ontology matching with ontology matching from links.

7.3.2. Visits to International Teams

- Jérôme David Visited Tsinghua University (Juanzi Li group), Beijing, China. 5/11 – 21/11/2013. He worked in the framework of the LINDICLE project on the refinement of ontologies extracted from online encyclopedia.

FLOWERS Project-Team

8. Partnerships and Cooperations

8.1. Scientific Collaborations (outside consortium projects)

8.1.1. *Collaboration and technological transfer with Laboratoire de Physiologie de la Perception et de l'Action (LPPA)*

A collaboration is in progress with Jacques Droulez and Steve Nguyen from Laboratoire de Physiologie de la Perception et de l'Action (LPPA), Paris. Poppy represents for them a humanoid platform very interesting because it is relatively flexible and versatile, with more similar proportions to that of humans, which facilitate comparison with the experimental results obtained in humans. The laboratory will evaluate this platform probabilistic methods of control of balance and locomotion.

In the short term the first experimental project with Poppy will test methods of management support, in the case of restoration of balance, in the case of walking to correct or prepare a change of direction. This project will be initiated in the framework of a long internship of master 2 that starts in January. In the future, we would also like to evaluate motor controllers compliant, and learning algorithms. This collaboration involves Matthieu Lapeyre and Pierre-Yves Oudeyer.

8.1.2. *Collaborations with Gipsa-Lab, Laboratoire de Psychologie et de Neurocognition (LPNC) and Laboratoire de Physiologie de la Perception et de l'Action (LPPA)*

Clément Moulin-Frier is continuing his collaborative work with people he worked with during his PhD thesis at GIPSA-Lab, LPNC and LPPA. See the section entitled "COSMO (Communicating about Objects using Sensory-Motor Operations): a Bayesian modeling framework for studying speech communication and the emergence of phonological systems" for more information. He is also continuing his collaborative work with people he worked with during his post-doc in 2011 at LPPA. See the section entitled "Probabilistic optimal control: a quasimetric approach" for more information.

8.1.3. *Collaboration with the Computer Science Department of the University of Zaragoza*

A collaboration is in progress with Iñaki Iturrate and Luis Montesano at Zaragoza University, Spain. We aim a developing a calibration free Brain Computer Interaction system through the use and extension of learning algorithm developed in the team [43], [45], [44]. We focus our effort on error related potentials that occur in the brain while observing or performing a task. They supposedly play a role in human learning as implicit feedback signals that evaluate the correctness or unexpectedness of received stimuli. Our goal is to automatically and reliably detect and classify these signals to provide feedback to artificial systems (e.g. a robot) that learn how to interact and adapt themselves to the user intentions and preferences.

8.2. Regional Initiatives

8.2.1. *FUI ROBOT POPULI*

This project led by Awabot (<http://www.awabot.com>) funded from 2012 to 2014 aims to investigate, prototype, and test new applications and interactions between the robot and the user to move from niche markets to the general public. This project builds on the theories of Geoffrey Moore (Crossing the Chasm), putting the user at the center of the product design and following the vision of a playful robot and connected to the cloud, where the robot is an interface for advanced interactive entertainment of the future. It brings together partners with complementary expertise to develop and / or adapt and integrate technological bricks missing to fulfill such a vision. Our goal in this project is to develop a robust and low cost navigation system based on RGB-D cameras.

Partners : ARTEFACTS STUDIO, LIRIS, ENSTA ParisTech, GAMAGORA (Université Lyon 2)

8.2.2. *PSPC ROMEO 2*

This project led by Aldebaran Robotics (<http://www.aldebaran-robotics.com/>) funded from 2012 to 2016 by OSEO aims at developing a humanoid robot for assisting people. The contribution of FLOWERS and ENSTA ParisTech are in the area of human-robot interaction, learning by demonstration, perception and semantic mapping.

Partners : ALL4TEC, Inria, CNRS, VOXLER, SPIROPS, ISIR, UVSQ, CEA LIST, ENSTA ParisTech, STRATE COLLEGE, TELECOM PARISTECH, ASSOCIATION APPROCHE

Web site: <http://www.aldebaran-robotics.com/fr/Projets/romeo.html>

8.3. National Initiatives

8.3.1. *ANR MACSi*

An ANR Project (MACSi, ANR Blanc 0216 02), coordinated by ISIR/Univesity Paris VI (Olivier Sigaud), on developmental robotics (motor learning, visual learning, and exploration algorithms on the iCub robot) continued. The MACSi project is a developmental robotics project based on the iCub humanoid robot and the Urbi open source software platform. It is funded an as ANR Blanc project from 2010 to 2013. The project addresses four fundamental challenges, led by four partners:

- How can a robot learn efficient perceptual representations of its body and of external objects given initially only low-level perceptual capabilities? Challenge leader : Inria-ENSTA-ParisTech FLOWERS (Paris).
- How can a robot learn motor representations and use them to build basic affordant reaching and manipulation skills? Challenge leader : ISIR-UPMC-Paris 6 (Paris). ISIR hosts the iCub humanoid robot on which the achievements will be evaluated.
- What guidance heuristics should be used to explore vast sensorimotor spaces in unknown changing bodies and environments? Challenge leader : Inria-ENSTA-ParisTech FLOWERS (Bordeaux).
- How can mechanisms for building efficient representations/abstractions, mechanisms for learning manipulation skills, and guidance mechanisms be integrated in the same experimental robotic architecture and reused for different robots? Challenge leader : GOSTAI company (Paris).

Web site: <http://macsi.isir.upmc.fr/>

8.4. European Initiatives

8.4.1. *FP7 Projects*

8.4.1.1. *3rd HAND*

Type: COOPERATION

Defi:ICT-2013.2.1 Robotics, Cognitive Systems & Smart Spaces, Symbiotic Interaction

Instrument: Collaborative project

Objectif: Target a) Intelligent robotics systems

Duration: October 2013 - September 2017

Coordinator: Inria, France

Partner: Universitaet Darmstadt, Germany

Partner: Stuttgart University, Germany

Partner: University of Innsbruck, Austria

Inria contact: Manuel Lopes

Abstract: Robots have been essential for keeping industrial manufacturing in Europe. Most factories have large numbers of robots in a fixed setup and few programs that produce the exact same product hundreds of thousands times. The only common interaction between the robot and the human worker has become the so-called "emergency stop button". As a result, re-programming robots for new or personalized products has become a key bottleneck for keeping manufacturing jobs in Europe. The core requirement to date has been the production in large numbers or at a high price. Robot-based small series production requires a major breakthrough in robotics: the development of a new class of semi-autonomous robots that can decrease this cost substantially. Such robots need to be aware of the human worker, alleviating him from the monotonous repetitive tasks while keeping him in the loop where his intelligence makes a substantial difference.

In this project, we pursue this breakthrough by developing a semi-autonomous robot assistant that acts as a third hand of a human worker. It will be straightforward to instruct even by an untrained layman worker, allow for efficient knowledge transfer between tasks and enable a effective collaboration between a human worker with a robot third hand. The main contributions of this project will be the scientific principles of semi-autonomous human-robot collaboration, a new semi-autonomous robotic system that is able to: i) learn cooperative tasks from demonstration; ii) learn from instruction; and iii) transfer knowledge between tasks and environments.

8.4.1.2. ERC EXPLORERS

Instrument: ERC Starting Grant

Duration: December 2009 - November 2014

Coordinator: Pierre-Yves Oudeyer, Inria.

Abstract: In spite of considerable and impressive work in artificial intelligence, machine learning, and pattern recognition in the past 50 years, we have no machine capable of adapting to the physical and social environment with the flexibility, robustness and versatility of a 6-months old human child. Instead of trying to simulate directly the adult's intelligence, EXPLORERS proposes to focus on the developmental processes that give rise to intelligence in infants by re-implementing them in machines. Framed in the developmental/epigenetic robotics research agenda, and grounded in research in human developmental psychology, its main target is to build robotic machines capable of autonomously learning and re-using a variety of skills and know-how that were not specified at design time, and with initially limited knowledge of the body and of the environment in which it will operate. This implies several fundamental issues: How can a robot discover its body and its relationships with the physical and social environment? How can it learn new skills without the intervention of an engineer? What internal motivations shall guide its exploration of vast spaces of skills? Can it learn through natural social interactions with humans? How to represent the learnt skills and how can they be re-used? EXPLORERS attacks directly those questions by proposing a series of scientific and technological advances: 1) we will formalize and implement sophisticated systems of intrinsic motivation, responsible of organized spontaneous exploration in humans, for the regulation of the growth of complexity of learning situations; 2) intrinsic motivation systems will be used to drive the learning of forward/anticipative sensorimotor models in high-dimensional multimodal spaces, as well as the building of reusable behavioural macros; 3) intrinsically motivated exploration will be coupled with social guidance from non-engineer humans; 4) an information-theoretic framework will complement intrinsically motivated exploration to allow for the inference of body maps; 5) we will show how learnt basic sensorimotor skills can be re-used to learn the meaning of early concrete words, pushing forward human-robot mutual understanding. Furthermore, we will setup large scale experiments, in order to show how these advances can allow a high-dimensional multimodal robot to learn collections of skills continuously in a weeks-to-months time scale. This project not only addresses fundamental scientific questions, but also relates to important societal issues: personal home robots are bound to become part of everyday life in the 21st century, in particular as helpful social companions in an aging society. EXPLORERS' objectives converge to the challenges implied by this vision: robots will have to be able to adapt and learn new skills in the unknown homes of users who are not engineers.

8.5. International Initiatives

8.5.1. Inria Associate Teams

8.5.1.1. NEUROCURIOSITY

Title: NeuroCuriosity

Inria principal investigator: Manuel Lopes

International Partner (Institution - Laboratory - Researcher):

Columbia Neuroscience (United States) - Jacqueline Goetlieb

Duration: 2013 - 2015

One of the most striking aspects of human behavior is our enormous curiosity, drive for exploration. From a child feverishly examining a new toy with its hands and its eyes, to a tourist exploring a new city, to a scientist studying the brain, humans incessantly want to know. This exuberant curiosity shapes our private and social lives, and is arguably a key cognitive feature that allows our species to understand, control and alter our world. We aim to develop a novel unified biological and computational theory, which explains curiosity in the domain of visual exploration and attention as a deliberate decision motivated by learning progress. This theory will build and improve upon pioneer computational models of intrinsic motivation elaborated in developmental robotics, and be empirically evaluated in the context of visual exploration in monkeys through behavioral and brain imaging techniques. This will be the first attempt at a biological-computational framework of intrinsic motivation and perceptual exploration and their underlying cognitive mechanisms. This collaboration involves Pierre-Yves Oudeyer and Manuel Lopes on the Inria side, and Jacqueline Gottlieb and Adrien Baranes on Univ. Columbia side.

8.6. International Research Visitors

8.6.1. Visits of International Scientists

- Jan Peters, Technische Universitaet Darmstadt
- Marc Toussaint, Stuttgart University
- Justus Piater, University of Innsbruck
- Luis Montesano, University of Zaragoza
- Michael Mistry, Lecturer in Robotics, Intelligent Robotics Lab, University of Birmingham
- Andrej Gams, Post-doc, Biorobotics Laboratory, EPFL
- Adrien Baranes, Columbia University, NY, US
- Katharina Rohlfing, Bielefeld University, Germany
- Yannis Demiris, Imperial College, UK
- Andrew Barto, Univ. Massachussets at Amherst, US

8.6.1.1. Internships

- Jules Brochard, Emergent Proximo-Distal Maturation through Adaptive Exploration
- Axel Davy, Safe exploration in MDPs
- Julie Golliot, Experimental Platform for User Study of Curiosity-driven Exploration
- Brice Miard, Experimental Platform for User Study of Curiosity-driven Exploration
- Chloé Rozenbaum, Learning Simultaneously New Tasks and Feedback Models in Socially Guided Robot Learning
- Caio Tomazelli Da Silva Oliveira, Multimodal learning of speech-action-video primitives

8.6.2. Visits to International Teams

PY Oudeyer visited Gottlieb's Cognitive Neuroscience lab at Columbia University, NY, US; CITEC at Bielefeld University, Germany.

F. Stulp visited the Max Planck Institute for Intelligent Systems (Stefan Schaal) in Tuebingen, Germany.

In May 2013, Matthieu Lapeyre visited the Bristol Robotic Lab to present the Poppy robot. A close collaboration will begin in 2014, in particular they will hire an engineer to design grasping hand for Poppy.

In May 2013, Jonathan Grizou visited Iñaki Iturrate and Luis Montesano at Zaragoza University, Spain.

In July 2013, Manuel Lopes visit the lab of Andrea Thomaz at Georgia Tech.

In August 2013, Clément Moulin-Frier visited the Honda Research Center in Tokyo as well as Pr. Sawada at Kagawa University, Japan. He gave talks in both labs. He also visited the Intelligent Robotics Laboratory directed by Prof. Hiroshi Ishiguro and Asada Laboratory directed by Prof. Minoru Asada, in Osaka. In October 2013 he visited the Developmental Neuromechanics & Communication Lab at Princeton University, USA.

In August 2013, Fabien Benureau, Olivier Mangin, Mai Nguyen and Jonathan Grizou, visited the Intelligent Robotics Laboratory directed by Prof. Hiroshi Ishiguro, Osaka; the Humanoid Robotics Institute directed by Prof. Atsuo Takanishi, Tokyo; Intelligent Systems and Informatics Laboratory directed by Prof. Yasuo Kuniyoshi, Tokyo; and Asada Laboratory directed by Prof. Minoru Asada, Osaka.

In October 2013, Manuel Lopes, Clément Moulin-Frier and Mai Nguyen visited the Cognitive Neuroscience lab of Jacqueline Gottlieb in New York.

GRAPHIK Project-Team

8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. ANR

8.1.1.1. ASPIQ

Participants: Jean-François Baget, Jérôme Fortin, Marie-Laure Mugnier, Michel Leclère.

ASPIQ (ASP technologies for Querying large scale multisource heterogeneous web information), is an ANR white program (duration: 4 years) that started in Oct. 2012. The project coordinator is Odile Papini (LSIS). It involves partners from CRIL and LERIA.

The main objective of this project is to propose:

- extensions of standard ASP for representing OWL2 tractable sublanguages;
- new operations for merging conflicting information in this extended ASP;
- the identification of subclasses of this extended ASP allowing for efficient query answering mechanisms;
- an implementation of a prototype reasoning system.
- *See Section 6.1 for this year results (Extensions of the Framework).*

8.1.1.2. Pagoda

Participants: Jean-François Baget, Marie-Laure Mugnier, Mélanie König, Michaël Thomazo.

Pagoda (Practical Algorithms for Ontology-based Data Access) is an ANR JCJC (young researchers) project that started in Jan. 2013 (duration: 4 years). The project coordinator is Meghyn Bienvenu (LRI). It involves partners from the EPI LEO, the LIG, and the Anatomy Laboratory of Grenoble.

The primary aim of this project is to help address challenges brought by scalability and the handling of data inconsistencies by developing novel OBDA (Ontology Based Data Access) query answering algorithms and practical methods for handling inconsistent data.

- *See Section 6.1 for this year results.*

8.1.1.3. Qualinca

Participants: Michel Leclère, Michel Chein, Madalina Croitoru, Léa Guizol, Rallou Thomopoulos, Marie-Laure Mugnier, Alain Gutierrez.

Qualinca is an ANR Contint project that started in Apr. 2012 (duration: 4 years). The project coordinator is Michel Leclère (GraphIK). It involves partners from LRI, LIG, ABES and INA.

The main objective is to elaborate mechanisms allowing to:

- evaluate the quality of an existing document base;
- maintain a given level of quality by controlling updating operations;
- increase the quality of a given base;
- develop generic methods that take into account the quality of a given base (for instance for searching documents or interconnecting bases).
- *See Section 6.3 for this year results.*

8.1.2. Competitivity Clusters

We are taking part in the Laboratory of Excellence (“labex”) *NUMEV* (Digital and Hardware Solutions, Modelling for the Environment and Life Sciences), led by University of Montpellier 2 in partnership with CNRS, University of Montpellier 1 and Inria. This project aims at developing information and communication technologies for environmental and life sciences. We are participating to one of the four axis, namely “Scientific Data: processing, integration and security”.

8.2. European Initiatives

8.2.1. FP7 Projects

8.2.1.1. EcoBioCap

Participants: Patrice Buche, Madalina Croitoru, Jérôme Fortin, Patricio Mosse.

EcoBiocap is a FP7-KBEE project that started in March 2011 (duration: 4 years). It is led by INRA (and scientifically managed by Montpellier IATE laboratory). It involves sixteen partners among which Cork University (Ireland), CSIC (Spain), Roma University La Sapienza (Italy), SIK (Sweden). The objective of EcoBioCAP is to “provide the EU food industry with customizable, ecoefficient, biodegradable packaging solutions with direct benefits both for the environment and EU consumers in terms of food quality and safety”. GraphIK is involved in this project via its common members with IATE team. The budget is managed by IATE team.

- See Section 6.2 for this year results.

8.2.2. Collaborations with Major European Organizations

Richard Booth: University of Luxembourg, Interdisciplinary Centre for Security, Reliability and Trust (Luxembourg)

Souhila Kaci collaborates with Richard Booth on abstract argumentation. Madalina Croitoru and Michaël Thomazo collaborate with Richard Booth on argumentation labelling distances.

Leon van der Torre: University of Luxembourg, Computer Science and Communications Research Unit (Luxembourg)

Souhila Kaci collaborates with Leon van der Torre on argumentation aspects. They co-supervise a PhD student (Tjitze Rienstra).

Sebastian Rudolph: TU Dresden (Germany)

Jean-François Baget, Marie-Laure Mugnier and Michaël Thomazo collaborate with Sebastian Rudolph on existential rules. Michaël Thomazo started a postdoc in Sebastian Rudolph’s team. Madalina Croitoru collaborates with Sebastian Rudolph (also with Sarah Gaggl) on approximation algorithms for argumentation semantics, as well as on multi agent knowledge allocation.

Srdjan Vesic: University of Luxembourg, Individual and Collective Reasoning research group (Luxembourg)

Madalina Croitoru collaborates with Srdjan Vesic on logical argumentation in the positive existential fragment of first-order logic with and without preferences.

Nir Oren: University of Aberdeen, Department of Computing Science (United Kingdom)

Madalina Croitoru collaborates with Nir Oren on graphical norm representation and reasoning, as well as on arguing about preferences using a structured argumentation framework.

Ioannis A. Vetsikas: University of Athens, IIT (Greece)

Madalina Croitoru collaborates with Ioannis A. Vetsikas on information selling mechanism design.

Talal Rahwan: University of Southampton, School of Electronics and Computer Science (United Kingdom)

Tomasz Michalak: University of Oxford, Department of Computer Science (United Kingdom)

Madalina Croitoru collaborates with Talal Rahwan and Tomasz Michalak on coalition formation using graphs structures.

8.3. International Research Visitors

8.3.1. Visits of International Scientists

- March 2013: Richard Booth (Univ. of Luxembourg). LIRMM AI seminar on *Quantifying disagreement in argument-based reasoning*.
- March 2013: Wojtek Jamroga (Univ. of Luxembourg). LIRMM AI seminar on *Some Funny Complexity Results for Judgment Aggregation*.
- April 2013: Pierre Bourhis (Univ. of Oxford). GraphIK seminar on *The Impact of Disjunction on Query Answering Under Guarded-based Existential Rules*.
- May 2013: Georg Gottlob (Univ. of Oxford). GraphIK seminar on *The Hypergraph Transversal Problem: Applications, Complexity, and Tractable Cases*.
- October 2013: Carsten Lutz (Univ. of Bremen). GraphIK seminar on *Ontology-Based Data Access: A Study Through Disjunctive Datalog, CSP, and MMSNP*, in the context of Michaël Thomazo's PhD's defense.
- October 2013: Georg Gottlob (Univ. of Oxford). GraphIK seminar on *Robust Constraint Satisfaction and Local Hidden Variables in Quantum Mechanics*, in the context of Michaël Thomazo's PhD's defense.
- November 2013: Roman Kontchakov and Michael Zakharyashev (Birkbeck College, Londres). GraphIK seminar on *Theory and practice of ontology-based data access with OWL 2 QL*.

8.3.2. Visits to International Teams

Patrice Buche visited Wageningen UR Food and Biobased Research (Netherlands) two days in May 2013 (scientific exchanges on quantity and units ontologies).

HYBRID Project-Team

8. Partnerships and Cooperations

8.1. Regional Initiatives

8.1.1. BRAINVOX Project

Participants: Anatole Lécuyer [contact], Jozef Legény.

BRAINVOX is a project funded by Brittany region in the frame of the CREATE call. It is a 4-year project (2009-2013) on the topic of Brain-Computer Interfaces. The objective is to reach a "mental vocabulary", more elaborated, and richer, for BCI applications, enabling to exploit various mental activities within novel hybrid schemes.

8.1.2. W3D Project

Participants: Ferran Argelaguet Sanz, Anatole Lécuyer [contact], Maud Marchal.

W3D is a project funded by Brittany region and "Images et Réseaux" competitiveness cluster. It is a 3-year project (2011-2013) dedicated to the improvement of perception and navigation on 3D Web content. It involves Inria/Hybrid and LOUSTIC lab, and two SMEs in the field of multimedia and web applications : MBA Multimédia and Polymorph Studio.

8.1.3. CNPAO Project

Participant: Valérie Gouranton [contact].

CNPAO ("Conservatoire Numérique du Patrimoine Archéologique de l'Ouest") is a research project partially funded by the Université Européenne de Bretagne (UEB). It involves IRISA/Hybrid and CReAAH. The main objectives are: (i) a sustainable and centralized archiving of 2D/3D data produced by the archaeological community, (ii) a free access to metadata, (iii) a secure access to data for the different actors involved in scientific projects, and (iv) the support and advice for these actors in the 3D data production and exploration through the latest digital technologies, modeling tools and virtual reality systems.

8.1.4. Labex S3PM

Participants: Bruno Arnaldi [contact], Valérie Gouranton [contact], Guillaume Claude.

S3PM is a 3-year project (2013-2016) funded by Labex CominLabs. It involves 3 academic research teams: Medicis (LTSI/Inserm), S4 and Hybrid (IRISA/Inria). S3PM aims at providing specific models, tools and software to create a collaborative virtual environment dedicated to neurosurgery processes using observations of real processes.

8.1.5. Labex HEMISFER

Participant: Anatole Lécuyer [contact].

HEMISFER is a 3-year project (2013-2016) funded by Labex CominLabs. It involves 4 Inria/IRISA teams (Hybrid, Visages (lead), Panama, Athena) and 2 medical centers: the Rennes Psychiatric Hospital (CHGR) and the Reeducation Department of Rennes Hospital (CHU Pontchaillou). The goal of HEMISFER is to make full use of neurofeedback paradigm in the context of rehabilitation and psychiatric disorders. The major breakthrough will come from the use of a coupling model associating functional and metabolic information from Magnetic Resonance Imaging (fMRI) to Electro-encephalography (EEG) to "enhance" the neurofeedback protocol. Clinical applications concern motor, neurological and psychiatric disorders (stroke, attention-deficit disorder, treatment-resistant mood disorders, etc).

8.2. National Initiatives

8.2.1. ANR CORVETTE

Participants: Bruno Arnaldi [contact], Valérie Gouranton [contact], Florian Nouviale, Thomas Lopez, Rozenn Bouville Berthelot, Thomas Boggini, Quentin Petit.

CORVETTE (COLlaboRative Virtual Environment Technical Training and Experiment) is a 4-year ANR project (2011-2014) led by Bruno Arnaldi. It involves 3 Academic partners (INSA Rennes, ENIB, CEA-List) and 4 Industrial partners (AFPA, Nexter Training, Virtualys, Golaem). CORVETTE aims at designing novel approaches for industrial training (maintenance, complex procedures, security, diagnosis, etc) exploiting virtual reality technologies. The project has three main research axes: collaborative work, virtual human, communication and evaluation. The project seeks to put in synergy: 1) Virtual Human for its ability to embody the user as an avatar and acting as a collaborator during training; 2) Natural communication between users and virtual humans for task-oriented dialogues; and 3) Methodologies in cognitive psychology for the assessment of the effectiveness of the collaboration of users and virtual humans to perform complex cooperative tasks in VR. All these components have been integrated into a unified environment based on an industrial scenario. Several evaluations regarding the different technologies developed in the project have also been achieved.



Figure 10. Exhibition of the CORVETTE project at Laval Virtual 2013.

8.2.2. ANR MANDARIN

Participants: Merwan Achibet, Anatole Lécuyer, Maud Marchal [contact].

MANDARIN ("MANipulation Dextre hAptique pour opéRations INdustrielles en RV") is a 4-year ANR project (2012-2015). MANDARIN partners are CEA-List (coordinator), Inria/Hybrid, UTC, Haption and Renault. It aims at designing new hardware and software solutions to achieve natural and intuitive mono and bi-manual dextrous interactions, suitable for virtual environments. The objective of Hybrid in MANDARIN is to design novel multimodal 3D interaction techniques and metaphors allowing to deal with haptic gloves limitations (portability, under-actuation) and to assist the user in virtual reality applications requiring dextrous manipulation. The results will be evaluated with a representative industrial application which is not feasible with currently existing technologies: the bi-manual manipulation of complex rigid objects and cables bundles.

8.2.3. ANR HOMO-TEXTILUS

Participants: Anatole Lécuyer [contact], Maud Marchal, Jonathan Mercier-Ganady.

HOMO-TEXTILUS is a 4-year ANR project (2012-2015). Partners of the project are : Inria/Hybrid, CHART, LIP6, TOMORROW LAND, RCP and potential end-user is Hussein Chalayan fashion designer. The objective of HOMO TEXTILUS is to study what could be the next generation of smart and augmented clothes, and their influence and potential impact on behavior and habits of their users. The project is strongly oriented towards human science, with both user studies and sociological studies. The involvement of Hybrid team in the project consists in studying the design of next-gen prototypes of clothes embedding novel kinds of sensors and actuators. Envisionned sensors relate to physiological measurements such as with EEG (electroencephalography and Brain-Computer Interfaces), EMG (muscular activity), GSR (galvanic skin response) or Heart Rate (HR). Envisionned actuators relate to new sensory stimulations such as vibrotactile displays or novel visual (eg LED) displays. These prototypes will thus be used in the various experiments planned in the project.

8.2.4. ANR ACOUSTIC

Participant: Maud Marchal [contact].

ACOUSTIC is a 3-year ANR project (2011-2013). Partners of the project are : INSERM/University of Rennes 1, CRICM, University of Strasbourg, Inria (Hybrid and Shacra teams). The main objective of the project ACouStiC is to develop an innovative strategy based on models for helping decision-making process during surgical planning in Deep Brain Stimulation. Models rely on different levels involved in the decision-making process; namely multimodal images, information, and knowledge. The project aims at developing methods for 1) building generic and patient specific models and 2) automatically computing optimal electrodes trajectories from these models taking into account possible simulated deformations occurring during surgery. Hybrid is involved in the project with Inria team Shacra and aims at providing models of deformations of the cerebral structures and electrodes for the surgical planning. The objective is to propose a biomechanical approach to model the brain and electrode deformations and also their mutual interaction.

8.2.5. ANR OpenViBE2

Participants: Anatole Lécuyer [contact], Jozef Legény, Jonathan Mercier-Ganady.

OpenViBE2 is a 4-year ANR project (2009-2013) led by Anatole Lécuyer which ended in February 2013. Partners of the project were: Inria/Hybrid, INSERM, GIPSA-LAB, CEA, CHART, CLARTE, UBISOFT, BLACK SHEEP, and KYLOTONN GAMES. The objective of OpenViBE2 was to study the potential of Brain-Computer Interfaces (BCI) for videogames. OpenViBE2 has proposed a shift of perspective about the use of BCI. First, in OpenViBE2 we considered the possibility to merge a BCI with traditional peripherals such as joysticks, mice and other devices, all being possibly used simultaneously in a virtual environment. Therefore, BCI was not seen as a replacement but as a complement of classical HCI. Second, we aimed at monitoring brain cognitive functions and mental states of the user in order to adapt, in real-time and in an automated fashion, the interaction protocol as well as the content of the remote/virtual environment (VE).

8.2.6. FUI SIFORAS

Participants: Bruno Arnaldi [contact], Valérie Gouranton [contact], Thomas Lopez.

SIFORAS (Simulation for training and assistance) is a 3-year project (2011-2014) funded by the competitive cluster "Images et Réseaux". SIFORAS involves 4 academic partners (INSA Rennes, ENIB, CEA-List, ENISE) and 9 Industrial partners (Nexter Training, Delta CAD, Virtualys, DAF Conseils, Nexter Systems, DCNS, Renault, SNCF, Alstom). This project consists in developing a pedagogical system for technical training in industrial procedures. It aims at proposing Instructional Systems Design to answer the new objectives of training (Intelligent Tutorial System, mobility, augmented reality, high productivity). The Hybrid implication in the project shares some common means and goals with the Corvette project, in particular concerning its global architecture based on STORM and LORA models, and exploiting GVT software (section 5.2).

8.2.7. *FUI Previz*

Participants: Bruno Arnaldi [contact], Valérie Gouranton [contact].

Previz is a 3-year project (2013-2016) funded by the competitive cluster "Images et Réseaux". Previz involves 4 Academic partners (Hybrid/INSA Rennes, ENS Louis-Lumière, LIRIS, Gipsa-Lab) and 9 Industrial partners (Technicolor, Ubisoft, SolidAnim, Ioumasystem, Polymorph). Previz aims at proposing new previsualization tools for movie directors. The goal of Hybrid in Previz is to introduce new interactions between real and virtual actors so that the actor's actions, no matter his/her real or virtual nature, impact both the real and the virtual environment. The project will end up with a new production pipeline in order to automatically adapt and synchronize the visual effects (VFX), in space and time, to the real performance of an actor.

8.2.8. *ADT MAN-IP*

Participant: Valérie Gouranton [contact].

The ADT MAN-IP is a 2-year project (2013-2015) funded by Inria for software support and development. MAN-IP involves two Inria teams: Hybrid and MimeTIC. MAN-IP aims at proposing a common software pipeline for both teams to facilitate the production of populated virtual environments. The resulting software should include functionalities for motion capture, automatic acquisition and modification, and high-level authoring tools.

8.2.9. *ADT OpenViBE-NT*

Participants: Anatole Lécuyer [contact], Jussi Lindgren [contact], Jozef Legény.

The ADT OpenViBE-NT is a 2-year project (2012-2014) funded by Inria for support and development of the OpenViBE software (section 5.1). OpenViBE-NT involves four Inria teams: Hybrid, Potioc, Athena, Neurosys - all being extensive users of OpenViBE. OpenViBE-NT aims at improving the current functionalities of OpenViBE platform, and helping in supporting its active and ever growing community of users.

8.3. European Initiatives

8.3.1. *FP7 VISIONAIR*

Participants: Valérie Gouranton, Thierry Duval, Bruno Arnaldi.

- Program: FP7-INFRA
- Project acronym: VISIONAIR
- Project title: VISION Advanced Infrastructure for Research
- Duration: Feb 2011 - Feb 2015
- Coordinator: INPG
- Other partners: INPG France, University Patras Greece, Cranfield University United Kingdom, Universiteit Twente Netherlands, Universitaet Stuttgart Germany, ICBPP Poland, Univ. Méditerranée France, CNR Italy, Inria France, KTH Sweden, Technion Israel, RWTH Germany, PUT Poland, AMPT France, TUK Germany, University Salford United Kingdom, Fraunhofer Germany, I2CAT Spain, University Essex United Kingdom, MTASEAKI Hungary, ECN France, UCL United Kingdom, Polimi Italy, European Manufacturing and Innovation Research Association

- Abstract: Visionair calls for the creation of a European infrastructure for high level visualisation facilities that are open to research communities across Europe and around the world. By integrating existing facilities, Visionair aims to create a world-class research infrastructure for conducting state-of-the-art research in visualisation, thus significantly enhancing the attractiveness and visibility of the European Research Area. Hybrid team is mainly involved in Work Package 9 (Advanced methods for interaction and collaboration) led and supervised by Prof. Georges Dumont (MimeTIC Inria team).

8.4. International Initiatives

8.4.1. Associate Team SIMS

Participant: Maud Marchal [contact].

SIMS is an Inria Associate Team involving Mimetic and Hybrid Inria teams in Rennes and the GAMMA Research Group of the University of North Carolina in the United States. SIMS focuses on realistic and effective simulation of highly complex systems based on human movement and interaction. The Associate Team has three main axes of research: crowd simulation, movement planning for autonomous virtual humans and real-time physical simulation for interactive environments. The latter axis is supervised by Maud Marchal. In this context, one Master student spent 8 months in the GAMMA Research Group, starting in November 2013.

8.5. International Research Visitors

8.5.1. Visits of International Scientists

- Dr. Francesco Grani, Postdoc at the Aalborg University, Denmark, spent a half month stay in our group in Rennes in June 2013 to work on auditory feedback in virtual environments, in the frame of EU FP7 "VISIONAIR" project.

8.5.2. Internships

- Mr. Takuya Sato, Master Student at the University of Tohoku in Sendai, Japan, spent a two-month internship in our group in Rennes in November and December 2013 to work on haptic feedback in collaborative virtual environments (Supervisors : Thierry Duval and Anatole Lécuyer).

8.5.3. Visits to International Teams

- Mr. Anthony Talvas, PhD student in the team, spent a three-month stay at University Rey Juan Carlos in Madrid, Spain, under the supervision of Pr. Miguel Otaduy. His stay was funded by Rennes Metropole.

IMAGINE Project-Team

7. Partnerships and Cooperations

7.1. Regional Initiatives

7.1.1. *Scenoptique (12/2012 - 03/2014)*

Participant: Rémi Ronfard.

In October 2011, we started a collaboration with Theatre des Celestins in Lyon on the topic of interactive editing of rehearsals. This research program is funded by the Region Rhone Alpes as part of their CIBLE project, with a budget for a doctoral thesis (Vineet Gandhi) and three large sensor video cameras. Theatre des Celestins is interested in novel tools for capturing, editing and browsing video recordings of their rehearsals, with applications in reviewing and simulating staging decisions. We are interested in building such tools as a direct application and test of our computational model of film editing, and also for building the world's first publicly available video resource on the creative process of theatre rehearsal. Using state-of-the-art video analysis methods, this corpus is expected to be useful in our future work on procedural animation of virtual actors and narrative design. The corpus is also expected to be shared with the LEAR team as a test bed for video-based action recognition.

7.1.2. *Labex Persyval*

Participants: Rémi Ronfard, Olivier Palombi, Armelle Bauer.

We received a doctoral grant from LABEX PERSYVAL, as part of the research program on authoring augmented reality (AAR) for PhD student Adela Barbelescu. Her thesis is entitled *directing virtual actors by imitation and mutual interaction - technological and cognitive challenges*. Her advisors are Rémi Ronfard and Gérard Bailly (GIPSA-LAB).

Additionally, this project funds the PhD thesis of Armelle Bauer which has started in October, co-advised by François Faure, Olivier Palombi, and Jocelyne Troccaz from TIMC-GMCAO. The goal is to tackle the scientific challenges of visualizing one's self anatomy in motion using Augmented Reality techniques.

7.1.3. *TAPIOCA, Persyval Grant (11/2013 - 11/2015)*

Participants: Damien Rohmer, Jean-Claude Léon, Marie-Paule Cani.

Tapioca (Tangibilité Physiologique Instrumentée: Outil mixte redimensionnable pour la conception d'artefact) is a *projet exploratoire* of the Persyval Grant. This project aim to study the use of resizable interactive interface to ease the generation of virtual models. This project is in collaboration with LIG, Gipsa-lab and GSCOP.

7.2. National Initiatives

7.2.1. *ANR ROMMA (01/2010-12/2013)*

Participants: François Faure, Jean-Claude Léon, Stefanie Hahmann.

The ANR project ROMMA has been accepted in 2009 and started in January 2010. The partners of this project are academic and industry experts in mechanical engineering, numerical simulation, geometric modeling and computer graphics. There are three academic members in the consortium: the LMT in Cachan, G-SCOP and LJK (EVASION and MGMI teams) in Grenoble. There are four industrial members: EADS, which coordinates the project, SAMTECH, DISTENE and ANTECIM. The aim of the project is to efficiently and robustly model very complex mechanical assemblies. We are working on the interactive computation of contacts between mechanical parts using GPU techniques. We will also investigate the Visualization of data with uncertainty, applied in the context of the project.

7.2.2. ANR SOHUSIM (10/2010-09/2014)

Participants: Ali Hamadi Dicko, François Faure.

Sohusim (Soft Human Simulation) is a ANR Project which started on October 1st 2010. It is done in collaboration between: EVASION (Inria), Fatronik France (TECNALIA), DEMAR (Inria), HPC PROJECT and the CHU de Montpellier.

This project deals with the problem of modeling and simulation of soft interactions between humans and objects. At the moment, there is no software capable of modeling the physical behavior of human soft tissues (muscles, fat, skin) in mechanical interaction with the environment. The existing software such as LifeMod or OpenSim, models muscles as links of variable length and applying a force to an articulated stiff skeleton. The management of soft tissues is not taken into account and does not constitute the main objective of this software.

A first axis of this project aims at the simple modeling and simulation of a passive human manipulated by a mecatronics device with for objective the study and the systems design of patient's manipulation with very low mobility (clinic bed). The second axis concentrates on the detailed modeling and the simulation of the interaction of an active lower limb with objects like orthosis, exoskeleton, clothes or shoes. The objective being there also to obtain a tool for design of devices in permanent contact with the human who allows determining the adequate ergonomics in terms of forms, location, materials, according to the aimed use.

Dicko Ali Hamadi is a Ph.D. student within EVASION team. His works turns around the problems in SOHUSIM project. He is co-tutored Olivier Palombi in IMAGINE. A part of this work was presented at Siggraph Asia [5].

7.2.3. ANR CORPUS SPECTACLE EN LIGNES (01/2013-01/2015)

Participant: Rémi Ronfard.

Spectacle En Ligne(s) amplifies our collaboration with the Theatre des Celestins in Lyon, which was started with the Scenoptique project in 2011. Scenoptique investigates novel techniques for recording ultra-high definition video, reframing them and editing them into interactive movies. Spectacle En Ligne(s), is targeted on the creation and diffusion of an original data set of integral video recordings of theatre and opera rehearsals. The data set is naturally suited to researchers interested in the creation process and the genetic analysis of dramatic art and mise en scene. To support research in this area, we are extending the audio and visual analysis tools developed in the Scenoptique project.

7.2.4. FUI Dynam'it (01/2012 - 02/2014)

Participant: Francois Faure.

2-year contract with two industrial partners: TeamTo (production of animated series for television) and Artefacts Studio (video games). The goal is to adapt some technologies created in SOFA, and especially the frame-based deformable objects [34], [33] to practical animation tools. This contract provides us with the funding of two engineers and one graphical artist during two years.

7.2.5. FUI Collodi (October 2013 - October 2016)

Participants: Francois Faure, Romain Testylier.

This 3-year contract with two industrial partners: TeamTo and Mercenaries Engineering (software for production rendering), is a follow-up and a generalization of Dynamit. The goal is to propose an integrated software for the animation and final rendering of high-quality movies, as an alternative to the ever-ageing Maya. It will include dynamics similarly to Dynamit, as well as innovative sketch-based kinematic animation techniques invented a Imagine by Martin Guay and Rémi Ronfard. This contract, started in October, funds 2 engineers for 3 years.

7.2.6. ANR CHROME (01/2012 - 08/2015)

Participant: Rémi Ronfard.

Chrome is a national project funded by the French Research Agency (ANR). The project is coordinated by Julien Pettré, member of MimeTIC. Partners are: Inria-Grenoble IMAGINE team (Remi Ronfard), Golaem SAS (Stephane Donikian), and Archivideo (Francois Gruson). The project has been launched in september 2012. The Chrome project develops new and original techniques to massively populate huge environments. The key idea is to base our approach on the crowd patch paradigm that enables populating environments from sets of pre-computed portions of crowd animation. These portions undergo specific conditions to be assembled into large scenes. The question of visual exploration of these complex scenes is also raised in the project. We develop original camera control techniques to explore the most relevant part of the animations without suffering occlusions due to the constantly moving content. A long-term goal of the project is to enable populating a large digital mockup of the whole France (Territoire 3D, provided by Archivideo). Dedicated efficient human animation techniques are required (Golaem). A strong originality of the project is to address the problem of crowded scene visualisation through the scope of virtual camera control, as task which is coordinated by Imagine team-member Rémi Ronfard.

Three phd students are funded by the project. Kevin Jordao is working on interactive design and animation of digital populations and crowds for very large environments. His advisors are Julien Pettré and Marie-Paule Cani. Quentin Galvanne is working on automatic creation of virtual animation in crowded environments. His advisors are Rémi Ronfard and March Christie (Mimetic team, Inria Bretagne). Julien Pettre. Chen-Kin Lim is working on crowd simulation and rendering of the behaviours of various populations using crowd patches. Her advisors are Rémi Ronfard and March Christie (Mimetic team, Inria Bretagne). Julien Pettre.

7.2.7. Action3DS (Caisse des dépôts) (10/2011 - 09/2014)

Participant: Rémi Ronfard.

Action3DS is a national project funded by Caisse des Dépôts, as part of the *projet Investissements d'avenir ACTION3DS* research program entitled *Technologies de numérisation et de valorisation des contenus culturels, scientifiques et éducatifs*.

The project is coordinated by Thales Angénieux (Patrick Defay). Partners are Inria (Rémi Ronfard), Lutin Userlab (Chrles Tijus), LIP6 (Bernadette Bouchon-Meunier), GREYC (David Tschumperlé), École nationale supérieure Louis Lumière (Pascal Martin), Binocle (Yves Pupulin), E2V Semiconductors and Device-Alab.

The goal of the project is the developpement of a compact professional stereoscopic camera for 3D broadcast and associated software. Rémi Ronfard is leading a work-package on real-time stereoscopic previsualization, gaze-based camera control and stereoscopic image quality.

The project is funding our new postdoc researcher Christophe Lino who is working on learning-based camera control for stereoscopic 3D cinematography with Rémi Ronfard.

7.2.8. AEN MorphoGenetics (10/2012 - 09/2015)

Participant: François Faure.

3-year collaboration with Inria teams Virtual Plants and Demar, as well as INRA (Agricultural research) and the Physics department of ENS Lyon. The goal is to better understand the coupling of genes and mechanical constraints in the morphogenesis (creation of shape) of plants. Our contribution is to create mechanical models of vegetal cells based on microscopy images. This project funds the Ph.D. thesis of Richard Malgat, who started in October, co-advised by François Faure (IMAGINE) and Arezki Boudaoud (ENS Lyon).

7.2.9. PEPS SEMYO (10/2012 - 09/2014)

Participant: François Faure.

2-year collaboration with Inria team DEMAR (Montpellier) and Institut de Myologie (Paris) to simulate 3D models of pathological muscles, for which no standard model exist. The main idea is to use our mesh-less frame-based model to easily create mechanical models based on segmented MRI images.

7.2.10. MSTIC Adamo (03/2012 - 12/2013)

Participant: Olivier Palombi.

7.3. European & International Initiatives

7.3.1. ERC Grant Expressive (04/2012-03/2017)

Participants: Marie-Paule Cani, Stefanie Hahmann, Jean-Claude Léon.

To make expressive and creative design possible in virtual environments, the goal is to totally move away from conventional 3D techniques, where sophisticated interfaces are used to edit the degrees of freedom of pre-existing geometric or physical models: this paradigm has failed, since even trained digital artists still create on traditional media and only use the computer to reproduce already designed content. To allow creative design in virtual environments, from early draft to progressive refinement and finalization of an idea, both interaction tools and models for shape and motion need to be revisited from a user-centred perspective. The challenge is to develop reactive 3D shapes – a new paradigm for high-level, animated 3D content – that will take form, refine, move and deform based on user intent, expressed through intuitive interaction gestures inserted in a user-knowledge context. Anchored in Computer Graphics, this work reaches the frontier of other domains, from Geometry, Conceptual Design and Simulation to Human Computer Interaction.

7.3.2. PhD grant from USM (University Sains Malaysia) (08/2012 - 07/2015)

This grant from USM funds one PhD student: Chen Kim Lim who is supervised in IMAGINE by Marie-Paule Cani. The subject of the thesis is about crowd modeling and animation.

7.3.3. Piper

The main objective of this European FP7 project is to develop new tools to position and personalize advanced human body models for injury prediction in car crashes. Our partners are automobile constructors and biomechanics research labs. Our main task is to provide tools for the interactive positioning of the models in the cockpits prior to the crash simulation, using our real-time simulation software SOFA. This 42-month contract funds one engineer in Imagine, and we plan to hire post-doc students next year.

7.4. International Research Visitors

7.4.1. Visits of International Scientists

- Bedrich Benes: Inverse Procedural Modeling. University of Purdue (12/12/2013).
- Paul Kry: Preserving Topology and Elasticity for Embedded Deformable Models. University of Toronto (14/11/2013).
- James Gain: Better Interfaces to Procedural Modelling. University of Cape Town (31/11/2013).
- Joaquim Jorge: Adding More Than Two Dimensions to Tabletop Interfaces. Is Tony Stark home? Universidade de Lisboa (23/09/2013).
- Frédéric Cordier: Inferring 3D curves from sketches, Université de Haute Alsace (11/07/2013)
- Karan Singh: Pose centric animation: support for a primitive artform, Université de Toronto (04/07/2013)
- Julien Pettre: Velocity-based Models for Microscopic Crowd Simulation, Inria Rennes (20/06/2013)
- Ladislav Kavan: Elasticity-Inspired Deformers for Character Articulation University of Pennsylvania (06/06/2013)
- Yotam Gingold: Rescuing Computers from Hard Problems, George Mason University (30/05/2013)
- Eftychios Sifakis: Detailed Functional Simulation of Human Anatomy: Design Challenges, Performance Considerations and Emerging Applications, University of Wisconsin-Madison (23/05/2013)
- Marc Christie: Directors Lens: an intelligent assistant for virtual cinematography, IRISA/Inria Rennes (05/04/2013)
- Loic Barthe: Models for Intuitive Modeling, Université de Toulouse (IRIT) (07/03/2013).

IN-SITU Project-Team

8. Partnerships and Cooperations

8.1. Regional Initiatives

DigiPods - Remote Collaborative Interaction among Heterogeneous Visualization Platforms, Région Île-de-France (2012-2015), Coordinator: Stéphane Huot. Partners: Digiteo/FCS Campus Paris-Saclay, Univ. Paris-Sud, Inria, CNRS, CEA, Telecom ParisTech. The goal of DIGIPODS is to design new interactive equipments and devices for collaborative interaction in immersive and high-resolution visualization platforms, connected through a high-end telepresence infrastructure. Beyond the usual interactive devices of such platforms (motion capture, interactive surfaces, haptic devices, audio and video systems), all the platforms will be augmented with new devices to facilitate co-located or remote interaction and collaboration: telepresence robots and the Digidarts, a new kind of interaction devices specifically designed for these needs. These equipments will be used by researchers in Human-Computer Interaction to explore the visualization and manipulation of large datasets, interaction in virtual reality, remote collaboration among heterogeneous platforms; but also by researchers from other fields and by professionals in order to explore and manipulate their complex data.

DigiCarts - Post-doctoral fellow position funded by Digiteo, Coordinator: Stéphane Huot. Partners: Univ. Paris-Sud, Inria, CNRS, CEA, Telecom ParisTech. Complements the DigiPods project with funding for a 18 months post-doctoral position focused on the design, implementation and evaluation of the Digidart devices.

DigiZoom - Funding by DIGICOSME Labex, Coordinator: Olivier Chapuis. Partners: U. Paris-Sud, Inria, Institut Mines-Telecom. Design, modeling and empirical evaluation of multi-scale navigation techniques depending on the input channels and output characteristics of the devices, in particular the size, in single-user and collaborative contexts.

8.2. National Initiatives

Digiscope - Collaborative Interaction with Complex Data and Computation (2011-2020) <http://digiscope.fr>. “Equipment of Excellence” project funded by the “Investissements d’Avenir” program of the French government. 10 academic partners: FCS Paris-Saclay (coordinator), Université Paris-Sud, CNRS, CEA, Inria, Institut Telecom ParisTech, Ecole Centrale Paris, Université Versailles - Saint-Quentin, ENS Cachan, Maison de la Simulation. Overall budget: 22.5 Meuros, including 6.7 Meuros public funding from ANR. Michel Beaudouin-Lafon: coordinator and principal investigator for the whole project. The goal of the project is to create nine high-end interactive rooms interconnected by high-speed networks and audio-video facilities to study remote collaboration across interactive visualization environments. The equipment will be open to outside users and targets four main application areas: scientific discovery, product lifetime management, decision support for crisis management, and education and training. In Situ will contribute the existing WILD room, a second room called WILDER funded by the project, and its expertise in the design and evaluation of advanced interaction techniques and the development of distributed software architectures for interactive systems.

MDGest - Interacting with Multi-Dimensional Gestures (2011-2014). InSitu is the only academic partner. Funded by the French National Research Agency (ANR), Programme JCJC (Junior researchers): 88 Keuros. Caroline Appert (coordinator) and Theophanis Tsandilas. This project investigates new interactions for small devices equipped with a touchscreen. Complementing the standard point-and-click interaction paradigm, the MDGest project explores an alternative way of interacting with a user interface: tracing gestures with the finger. According to previous work, this form of interaction has several benefits, as it is faster and more natural for certain contexts of use. The originality of the approach lies in considering new gesture characteristics (dimensions) to avoid complex shapes that can be hard for users to memorize and activate. Dimensions of interest include drawing speed (local or global), movement direction, device orientation or inclination, and distinctive drawing patterns in a movement.

DRAO – Adrien Bousseau (Inria, Sophia Antipolis) submitted a successful ANR grant with members from InSitu Theophanis Tsandilas (Inria) and Wendy Mackay, and Prof. Maneesh Agrawala (Berkeley), called *DRAO*, to create interactive graphics tools to support sketching. The kickoff meeting was held in Nov. 2012 and included interviews with designers from Toyota.

8.3. European Initiatives

8.3.1. FP7 Projects

8.3.1.1. *CREATIV*

Type: IDEAS

Instrument: ERC Advanced Grant

Duration: June 2013 - May 2018

Coordinator: Wendy Mackay

Partner: Inria (France)

Inria contact: Wendy Mackay

Abstract: *CREATIV* explores how the concept of co-adaptation can revolutionize the design and use of interactive software. Co-adaptation is the parallel phenomenon in which users both adapt their behavior to the system's constraints, learning its power and idiosyncrasies, and appropriate the system for their own needs, often using it in ways unintended by the system designer. The initial goal of the *CREATIV* project is to fundamentally improve the learning and expressive capabilities of advanced users of creative software, offering significantly enhanced methods for expressing and exploring their ideas. The ultimate goal is to radically transform interactive systems for everyone by creating a powerful and flexible partnership between human users and interactive technology.

8.3.1.2. *Social Privacy*

Type: PEOPLE

Instrument: Marie Curie International Outgoing Fellowships for Career Development

Duration: September 2012 - August 2015

Coordinator: Wendy Mackay

Partner: Inria (France) and Massachusetts Institute of Technology (USA)

Inria contact: Ilaria Liccardi

Abstract: Although users' right to privacy has long been protected, the rapid adoption of social media has surpassed society's ability to effectively regulate it. Today's users lack informed consent: they must make all-or-nothing decisions about on-line privacy regardless of context. The *Social Privacy* project will first diagnose the problem, exploring privacy issues associated with social media at the level of the individual, the enterprise and society, and then generate effective solutions, from providing users with technical safeguards and informed consent, to establishing corporate guidelines for protecting privacy, to developing and testing recommendations for public policy.

8.3.2. Collaborations in European Programs, except FP7

EIT ICT Labs Master School, European Institute of Technology. Coordinator: M. Beaudouin-Lafon. Partners: KTH (Sweden), U. Paris-Sud (France), U. Aalto (Finland), Technical University Berlin (Germany), Technical University Delft (Netherlands), U. College London (UK), U. Trento (Italy). InSitu participates in the Human-Computer Interaction and Design (HCID) major of the *EIT ICT Labs European Master School*. Paris-Sud is of the two sites for the first year of this Master Program, and host one of the specialties for second-year students. Students in this program receive a double degree after studying in two countries. https://www.dep-informatique.u-psud.fr/en/formation/lmd/M1_HCID.

8.3.3. Collaborations with Major European Organizations

VCoRE - Next-Generation Visual Computing Platform (ADT Inria, 2011-2014), Coordinator for InSitu: Stéphane Huot. Partners: Inria (Grenoble, Lille, Rennes, Saclay, Sophia Antipolis), IGD Fraunhofer Institute. Collaboration between Inria and IGD Fraunhofer Institute for the specification and development of a software framework dedicated to mixed/augmented/virtual reality and advanced visualization platforms (distributed computer graphics, simulation and interaction).

8.4. International Initiatives

8.4.1. Inria Associate Teams

SIRIUS, Situated Interaction Research, Associate Team between Inria, Stanford Univ. and UC San Diego. Scott Klemmer, Stanford Univ. and Jim Hollan, UC San Diego

Inria Silicon Valley allowed us to expand the scope of our work with Stanford and U.C. San Diego to include U.C. Berkeley (see below). Daniel Strazzula, a Master's student, was accepted as a Ph.D. student (Cordi grant), and Lora Oehlberg, a Ph.D. student, was accepted as a Post-Doc (Cordi Inria Silicon Valley) at InSitu. Members of InSitu went to Stanford and Berkeley for several week-long visits during the year. Volunteers from Berkeley, Stanford and U.C. San Diego were actively involved in the creation technology to support the CHI'13 conference in Paris, including the Interactive Schedule ([29]), author-sourcing [35]; the Video Previews, and the use of HydraScope to create CHIWall, for collaborative scheduling of the CHI'13 conference.

8.4.2. Inria International Partners

8.4.2.1. Declared Inria International Partners

BayScope - Architectures and Interaction Paradigms for Multi-surface Environments, NSF CNIC (Catalyzing New International Organizations) grant (2012-2013), Coordinator: Wendy Mackay. Partners: InSitu, Berkeley Institute of Design (BiD).

In the context of the 22m€ Digiscope project in France and corresponding projects at UCSD and Berkeley, we continued to work on BayScope, a strategy for creating novel applications for wall-size display and multisurface environments, by aggregating existing or new web-based applications. Prof. Bjoern Hartmann obtained support for this collaboration (NSF grant) that he secured for our collaboration. We developed HydraScope ([24]), a framework for transforming existing web applications into meta-applications that execute and synchronize multiple copies of applications in parallel, with a multi-user input layer for interacting with it, which was validated with five meta-applications.

8.4.3. Inria International Labs

CIRIC Chili (Emmanuel Pietriga & Claude Puech) – Publications on wall displays [27], mobile devices [31], [30] and focus+context navigation [28]. Thesis of C. Pindat.

8.5. International Research Visitors

8.5.1. Visits of International Scientists

8.5.1.1. Internships

- Maria Jesus Lobo, Pontificia Universidad Católica de Chile. *Graphical interaction techniques for undo and redo*, January - March 2013, Caroline Appert & Olivier Chapuis.
- Iuliia Vlasenko, University of Alberta, Canada. *Interactive visualization of temporal data on wall-size display*, June - November 2013, Wendy Mackay.

LAGADIC Project-Team

8. Partnerships and Cooperations

8.1. Regional Initiatives

8.1.1. *i-Lab ExtAR*

Participants: Clément Samson, Eric Marchand.

duration: 24 months.

ExtAR is an Inria i-Lab with Artefacto that started in March 2011. Its goal was to develop an augmented reality library for smartphones.

8.1.2. *Oseo Apash project*

Participants: François Pasteau, Marie Babel.

no Insa Rennes 2012-230, duration: 24 months.

Started in September 2012, the Apash project is supported by the Images & Réseaux cluster. It involves three laboratories connected to INSA Rennes, namely Irisa/Inria, IETR and LGCGM. Two industrial partners take part into this project: AdvanSEE and Ergovie. It aims at designing a driving assistance for electrical wheelchair towards the autonomy and security of disabled people. The work realized within this project is described in Section 6.3.4 .

8.1.3. *ARED NavRob*

Participants: Suman Bista, Paolo Robuffo Giordano, François Chaumette.

no Inria Rennes 8033, duration: 36 months.

This project funded by the Brittany council started in October 2013. It supports in part Suman Bista's Ph.D. about visual navigation of a humanoid robot (see Section 8.2.4).

8.2. National Initiatives

8.2.1. *ANR P2N Nanorobust*

Participants: Le Cui, Eric Marchand.

no. URI 11FA310-06D, duration: 48 months.

This project started in November 2011. It is composed of a consortium managed by Femto-ST in Besançon with LPN and Isir in Paris, Thalès and Lagadic group through the "Université de Rennes 1". Nanorobust deals with the development of micro- and nano-manipulation within SEM (Scanning Electron Microscope). Our goal is to provide visual servoing techniques for positioning and manipulation tasks with a nanometer precision.

8.2.2. *ANR Contint Visioland*

Participants: Patrick Rives, François Chaumette.

duration: 48 months.

This project started in November 2013. It is composed of a consortium managed by Onera in Toulouse with Airbus, Spikenet Technology, Ircyn, and Lagadic. It aims is to develop vision-based localization and navigation techniques for an autonomous landing on a runway.

8.2.3. *PEA Decsa*

Participants: Aurélien Yol, Eric Marchand.

no Inria Rennes 6630, duration: 36 months.

This project started in November 2011. It is composed of a consortium managed by Astrium with the Novadem, Sirehna, Spot Image and Magellium companies, and with the Inria Lagadic and Steep groups. It is devoted to the development of navigation and perception algorithms for small drones in urban environment.

8.2.4. *Oseo Romeo 2*

Participants: Nicolas Cazy, Suman Bista, Fabien Spindler, Paolo Robuffo Giordano, François Chaumette.

no Inria Rennes 7114, duration: 48 months.

This project started in November 2012. It is composed of a large consortium managed by Aldebaran Robotics. It aims to develop advanced control and perception functionalities to a humanoid robot. It supports in part Suman Bista's Ph.D. about visual navigation of a humanoid robot (see Section 8.2.4), as well as Nicolas Cazy's Ph.D. about model-based predictive control for visual servoing.

8.2.5. *Equipex Robotex*

Participants: Fabien Spindler, François Chaumette.

no Inria Rennes 6388, duration: 10 years.

Lagadic is one of the 15 French partners involved in the Equipex Robotex network. It is devoted to get significative equipments in the main robotics labs in France. In a near future, we plan to buy a humanoid robot, Romeo, by Aldebaran Robotics.

8.2.6. *Inria large scale initiative action PAL*

Participants: François Pasteau, Vishnu Narayanan, Cyril Joly, Marie Babel, Patrick Rives, François Chaumette.

Lagadic participates in the large-scale initiative action PAL (Personally Assisted Living) to develop technologies and services to improve the autonomy and quality of life for elderly and fragile persons. The purpose of PAL is to provide an experimental infrastructure, in order to facilitate the development of models, tools, technologies and concept demonstrations. Using the skills and objectives of the involved teams, four research themes have been defined: a) assessing the degree of frailty of the elderly, b) mobility of people, c) rehabilitation, transfer and assistance in walking, and d) social interaction. Lagadic is currently involved in the themes "mobility of people" and "assistance in walking" through collaborations with the EPI e-Motion (Grenoble), EPI Coprin (Sophia-Antipolis), and Handibio (Toulon). See Sections 6.2.3 , 6.3.4 , 6.3.5 and 6.4.4 .

Furthermore, the annual three-day PAL workshop has been organized in Rennes by François Pasteau, Marie Babel and Céline Gharsalli in July 2013.

8.3. European Initiatives

8.3.1. *FP7 Projects*

8.3.1.1. *FP7 Space RemoveDEBRIS*

Participants: Eric Marchand, Fabien Spindler, François Chaumette.

Instrument: Specific Targeted Research Project

Duration: from October 2013 till September 2016

Coordinator: University of Surrey (United Kingdom)

Partner: Surrey Satellite Technology (United Kingdom), Astrium (Toulouse, France and Bremen, Germany), Isis (Delft, The Netherlands), CSEM (Neuchâtel, Switzerland), Stellenbosch University (South Africa).

Inria contact: François Chaumette

Abstract: The goal of this project is to validate the model-based tracking algorithms developed during Antoine Petit's Ph.D. (see Section 6.1.1) on images acquired during an actual space debris removal mission.

8.3.1.2. FP7 Regpot Across

Participant: François Chaumette.

Program: Regpot

Project acronym: Across

Project title: Center of Research Excellence for Advanced Cooperative Systems

Duration: from September 2011 till March 2015

Coordinator: Prof. Ivan Petrovic from University of Zagreb (Croatia)

Other partners: KTH (Sweden), ETHZ (Switzerland), TUM (Germany), University of Manchester (UK), Vienna University of Technology (Austria), Politecnico di Milano (Italy), University of Sevilla (Spain), Eindhoven University of Technology (The Netherlands), University of Athens (Greece), etc.

Abstract: the goal of this project is to enhance collaborations with the University of Zagreb.

8.4. International Initiatives

8.4.1. Participation In other International Programs

- As a follow up to the long term collaboration with the “Centro de Tecnologia da Informação Renato Archer” (CTI) in Campinas (Brazil), a new Ph.D. student, Renato José Martins, joined the team in Sophia Antipolis thanks to a grant from the CNPq (2013-2017). He is co-directed by Patrick Rives and Samuel Siqueira Bueno from “Divisão de Robótica e Visão Computacional” at CTI. In the context of the project MuNave, funded by the Inria/CNPq Collaboration framework (2010-2012), Geraldo Silveira, researcher at CTI, has spent a one-week visit in Sophia Antipolis in May 2013.
- Alexandre Krupa started a collaboration with Nassir Navab from the Technische Universität München by beginning since September 2013 the joint supervision of Pierre Chatelain’s Ph.D.

8.5. International Research Visitors

8.5.1. Visits of International Scientists

8.5.1.1. Internships

- Raul Orlando Alvarado Lara and Francisco-Javier Rangel Butanda from the University of Guanajuato in Mexico did a 4-month master internship in Rennes. It was granted by Conacyt and their work was about visual servoing and 3D localization respectively.
- Ivan Markovic, Ph.D. student at the University of Zagreb, spent a three-month visit in Rennes in the scope of the FP7 Regpot Across project (see Section 8.3.1.2 and 6.3.6).
- Eduardo Moral-Fernandez, Ph.D. student at the Universidad de Malaga, Spain, visited our group in Sophia Antipolis from March to December 2013. He worked on dense SLAM using omnidirectional RGB-D sensors.

8.5.2. Visits to International Teams

- Manikandan Bakthavatchalam spent a three-month visit at ISR in Coimbra, Portugal, for collaborating with Omar Tahri about visual servoing based on photometric moments (see Section 6.2.1).
- Rafiq Sekkal spent a two-month visit at UPC in Barcelona, Spain, to collaborate with Ferran Marques on contour-based spatio-temporal segmentation (see Section 6.1.6).
- Pierre Chatelain spent a four-month visit in Nassir Navab’s lab at TUM, Germany, in the scope of his Ph.D.

LEAR Project-Team

8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. *QUAERO Project*

Participants: Matthijs Douze, Dan Oneata, Danila Potapov, Jerome Revaud, Cordelia Schmid, Franck Thollard, Heng Wang.

Quaero is a French-German search engine project supported by OSEO. It runs from 2008 to 2013 and includes many academic and industrial partners, such as Inria, CNRS, the universities of Karlsruhe and Aachen as well as LTU, Exalead and INA. LEAR/Inria is involved in the tasks of automatic image annotation, image clustering as well as large-scale image and video search. See <http://www.quaero.org> for more details.

8.1.2. *ANR Project Qcompere*

Participants: Guillaume Fortier, Cordelia Schmid, Jakob Verbeek.

This three-and-a-half year project started in November 2010. It is aimed at identifying people in video using both audio (using speech and speaker recognition) and visual data in challenging footage such as news broadcasts, or movies. The partners of this project are the CNRS laboratories LIMSI and LIG, the university of Caen, Inria's LEAR team, as well as two industrial partners Yacast and Vecsys Research.

8.1.3. *ANR Project Physionomie*

Participants: Frédéric Jurie [University of Caen], Jakob Verbeek, Shreyas Saxena.

Face recognition is nowadays an important technology in many applications ranging from tagging people in photo albums, to surveillance, and law enforcement. In this 3-year project (2013–2016) the goal is to broaden the scope of usefulness of face recognition to situations where high quality images are available in a dataset of known individuals, which have to be identified in relatively poor quality surveillance footage. To this end we will develop methods that can compare faces despite an asymmetry in the imaging conditions, as well as methods that can help searching for people based on facial attributes (old/young, male/female, etc.). The tools will be evaluated by law-enforcement professionals. The participants of this project are: Morpho, SensorIT, Université de Caen, Université de Strasbourg, Fondation pour la Recherche Stratégique, Préfecture de Police, Service des Technologies et des Systèmes d'Information de la Sécurité Intérieure, and LEAR.

8.1.4. *PEPS CNRS BMI (Biology - Mathematics - Computer Science), Project FlipFlop*

Participants: Elsa Bernard [Institut Curie, Ecoles des Mines-ParisTech], Laurent Jacob [CNRS, LBBE Laboratory], Julien Mairal, Jean-Philippe Vert [Institut Curie, Ecoles des Mines-ParisTech], Anne-Hélène Monsoro-Burq [Institut Curie].

Several inverse problems in genomics involve retrieving meaningful DNA sequences from observed data. This is for example the case of the isoform deconvolution problem of RNA-Seq data, which is currently of utmost importance in genomics. The problem can be cast as a sparse feature selection problem, where the features are mapped to the paths of a graph called “splicing graph”. Even though the number of paths is exponential in the graph size, we investigate network flow optimization techniques to efficiently solve the inverse problem in polynomial time [36]. The project involves researchers in machine learning, optimization, bio-informatics, and biology, from Inria Rhone-Alpes, Institut Curie in Paris, and the LBBE laboratory in Lyon.

8.1.5. *MASTODONS Program CNRS - Project Gargantua*

Participants: Zaid Harchaoui, Julien Mairal.

The project is concerned with machine learning and mathematical optimization for big data. The partners are from LJK (Grenoble), LIG (Grenoble), LIENS (ENS, Paris), Lab. P. Painleve (Lille). Principal investigator/leader: Zaid Harchaoui. Dates: May 2013-Dec. 2013

8.1.6. *Equipe-action ADM du Labex Persyval (Grenoble) “Khronos”*

Participant: Zaid Harchaoui.

The partners of this project are from the laboratories LJK, LIG, GIPSA, TIMC, CEA. The principal investigators/leaders are Zaid Harchaoui (Inria and LJK), Massih-Reza Amini (LIG). The project will start in Jan. 2014 and end in Dec. 2016.

8.1.7. *Project Math-STIC “Gauge”*

Participant: Zaid Harchaoui.

The project is concerned with statistical learning with gauge regularization penalty, a project funded by the Math-STIC “pôle” of the Université Joseph Fourier (Grenoble University). The partners are Inria Rhone-Alpes, CREST-ENSAE, Université Paris-Est. Principal investigator/leader: Zaid Harchaoui
Dates: Jan 2012-Dec 2013.

8.2. European Initiatives

8.2.1. *FP7 European Project AXES*

Participants: Ramazan Cinbis, Matthijs Douze, Zaid Harchaoui, Dan Oneata, Danila Potapov, Cordelia Schmid, Jakob Verbeek, Clement Leray.

This 4-year project started in January 2011. Its goal is to develop and evaluate tools to analyze and navigate large video archives, eg. from broadcasting services. The partners of the project are ERCIM, Univ. of Leuven, Univ. of Oxford, LEAR, Dublin City Univ., Fraunhofer Institute, Univ. of Twente, BBC, Netherlands Institute of Sound and Vision, Deutsche Welle, Technicolor, EADS, Univ. of Rotterdam. See <http://www.axes-project.eu/> for more information.

8.2.2. *FP7 European Network of Excellence PASCAL 2*

Participants: Zeynep Akata, Adrien Gaidon, Zaid Harchaoui, Cordelia Schmid, Jakob Verbeek.

PASCAL (Pattern Analysis, Statistical Modeling and Computational Learning) is a 7th framework EU Network of Excellence that started in March 2008 for five years. It has established a distributed institute that brings together researchers and students across Europe, and is now reaching out to countries all over the world. PASCAL is developing the expertise and scientific results that will help create new technologies such as intelligent interfaces and adaptive cognitive systems. To achieve this, it supports and encourages collaboration between experts in machine learning, statistics and optimization. It also promotes the use of machine learning in many relevant application domains such as machine vision. The project ended in February 2013.

8.2.3. *ERC Advanced grant Allegro*

Participants: Cordelia Schmid, Karteek Alahari, Jerome Revaud.

The ERC advanced grant ALLEGRO started in April 2013 for a duration of five years. The aim of ALLEGRO is to automatically learn from large quantities of data with weak labels. A massive and ever growing amount of digital image and video content is available today. It often comes with additional information, such as text, audio or other meta-data, that forms a rather sparse and noisy, yet rich and diverse source of annotation, ideally suited to emerging weakly supervised and active machine learning technology. The ALLEGRO project will take visual recognition to the next level by using this largely untapped source of data to automatically learn visual models. We will develop approaches capable of autonomously exploring evolving data collections, selecting the relevant information, and determining the visual models most appropriate for different object, scene, and activity categories. An emphasis will be put on learning visual models from video, a particularly rich source of information, and on the representation of human activities, one of today’s most challenging problems in computer vision.

8.3. International Initiatives

8.3.1. Inria Associate Teams

- **HYPERION: Large-scale statistical learning for visual recognition.** Inria principal investigator: Zaid Harchaoui. International Partner (Institution - Laboratory - Researcher): University of California Berkeley (United States) - Electrical Engineering and Computer Science Department. Duration: 2012 - 2014. The goal of the associated team “Hyperion” is to take up the challenges of large-scale statistical learning for image interpretation and video understanding. Despite the ever-increasing number of large annotated image and video datasets, designing principled and scalable statistical learning approaches from such big computer vision datasets remains a major scientific challenge.

The associated team consists of researchers from the LEAR project team of Inria and two teams of University of California Berkeley (resp. the Pr. Jitendra Malik and the Pr. Nourredine El Karoui teams). It allows the three teams to effectively combine their respective strengths in areas such as large-scale learning theory and algorithms, high-level feature design for computer vision, and high-dimensional statistical learning theory. It will result in significant progress in domains such as large-scale image classification, weakly-supervised learning for classification into attributes, and transfer learning.

8.3.2. Inria International Partners

- **UC Berkeley:** This collaboration between Bin Yu, Jack Gallant, Yuval Benjamini, Adam Bloniarz (UC Berkeley), Ben Willmore (Oxford University) and Julien Mairal (Inria LEAR) aims to discover the functionalities of areas of the visual cortex. We have introduced an image representation for area V4, adapting tools from computer vision to neuroscience data. The collaboration started when Julien Mairal was a post-doctoral researcher at UC Berkeley and is still ongoing. Adam Bloniarz, who is pursuing his PhD under the supervision of Prof. Bin Yu, visited LEAR during the summer 2013.
- **University of Edinburgh:** C. Schmid collaborates with V. Ferrari, associate professor at university of Edinburgh. Our initial collaboration (co-supervision of A. Prest 2009-2012) was renewed this year. Vicky Kalogeiton started a co-supervised PhD in September 2013; she is bi-localized between Uni. Edinburgh and Inria. Her subject is the automatic learning of object representations in videos.
- **MPI Tübingen:** C. Schmid collaborates with M. Black, a research director at MPI. In 2013, she spent one month at MPI and worked with a PhD student, S. Zuffi, and a postdoctoral researcher, H. Jhuang. This resulted in two ICCV’13 publications: one on modeling pose with flexible human puppets [32] and one on measuring the impact of low, intermediate and high-level descriptions on action recognition [22]. C. Schmid plans to continue this collaboration in 2014.

8.3.3. Participation In other International Programs

- **France-Berkeley fund:** The LEAR team was awarded in 2012 a grant from the France-Berkeley fund for the project with Pr. Jitendra Malik (EECS, UC Berkeley) on "Large-scale learning for image and video interpretation". The award amounts to 10,000 USD for a period of one year, from September 2012 to September 2013. The funds are meant to support scientific and scholarly exchanges and collaboration between the two teams.

8.4. International Research Visitors

8.4.1. Visits of International Scientists

- Jitendra Malik, Professor in UC Berkeley, visited LEAR during the summer 2013 as part of the associated team "Hyperion" and a project from the France-Berkeley fund. The goal of his visit was to develop new approaches for human action classification and localization in videos.

8.4.2. Internships

- Georgia Gkioxari, a PhD student from UC Berkeley, visited LEAR during the summer 2013 as part of the associated team "Hyperion" and a project from the France-Berkeley fund. The goal of her visit was to develop new approaches for human action localization in videos.
- Hyun Oh Song, a PhD student from UC Berkeley, visited LEAR during the fall 2013 as part of the associated team "Hyperion". The goal of his visit was to develop efficient approaches for part-based models in computer vision.
- Miles Lopes, a PhD student from UC Berkeley, visited LEAR during the spring 2013 as part of the associated team "Hyperion". The goal of his visit was to develop efficient approaches for estimating statistical functionals using convex optimization.
- Adam Bloniarz, a PhD student from UC Berkeley, visited LEAR during the summer 2013 as part of the associated team "Hyperion". The goal of his visit was to develop video representations adapted to neuroscience, based upon computer vision principles.

LINKS Team

7. Partnerships and Cooperations

7.1. Regional Initiatives

7.1.1. FUI Région AAP 14 Hermes (2013-2015)

Participants: Angela Bonifati [correspondent], Joachim Niehren, Iovka Boneva, Denis Debarbieux.

The Hermes project on “Relation Client Personnalisée et Contextualisée” is coordinated by Bonifati from Links. Our partners are the Université Lille 1, Logos Keyneosoftware, Cylande, Norsys, NumSight, Leroy Merlin, Kiabi and Auchan.

The project addresses the problem of enriching the client communication within the marketing process. Starting from heterogeneous data sources (connected devices, social networks and traditional marketing channels), one has to extract the necessary information at hand. The data sources can be seen in a streaming fashion as they produce continuous data.

7.2. National Initiatives

7.2.1. Competitiveness Clusters

We participate to the following <http://www.picom.fr/> (Pôle de compétitivité PICOM - regional research cluster on commerce industries). In particular, the Hermes project has been conceived within the cluster.

7.3. International Initiatives

7.3.1. Inria International Partners

7.3.1.1. Declared Inria International Partners

We have submitted a proposal for an Inria North-European Lab Lille-Oxford, which has been accepted. The main people involved are Joachim Niehren (leader), Pierre Bourhis and Angela Bonifati, but the cooperation is equally relevant for Iovka Boneva, Aurélien Lemay, Slawek Staworko, Sophie Tison, Radu Ciucanu (PhD student). The Oxford database group (<http://www.cs.ox.ac.uk/isg/db>) is one of the top database groups world wide. The main persons involved will be Michael Benedikt (leader), Dan Olteanu, Andreas Pieris (postdoc). Further promising cooperation opportunities are to be explored with members of Georg Gottlob's ERC project DiaDem (<http://www.cs.ox.ac.uk/projects/DIADEM/index.html>) on semantics-based information extraction.

7.4. International Research Visitors

7.4.1. Visits of International Scientists

Tova Milo (Tel-Aviv University, Israel) visited the team in February 2013 for one day.

Amr El Abbadi (UCSB, Usa) visited the team in March 2013 for one day.

Jan van den Bussche (Hasselt University, Belgium) visited the team in November 2013 for two days.

7.4.2. Visits to International Teams

Pierre Bourhis visited the Oxford database group (<http://www.cs.ox.ac.uk/isg/db>) for three weeks in October, November and December 2013.

MAGNET Team

8. Partnerships and Cooperations

8.1. Regional Initiatives

8.1.1. *Thèse Inria-Région NPdC (2012-2015)*

Participants: Marc Tommasi [correspondent], Pascal Denis, David Chatel.

PASCAL DENIS and MARC TOMMASI supervise the PhD thesis of DAVID CHATEL on semi-supervised clustering. The PhD is funded by Inria and the “Région Nord - Pas de Calais”.

8.2. National Initiatives

8.2.1. ANR

8.2.1.1. *ANR Lampada (2009-2014)*

Participants: Marc Tommasi [correspondent], Rémi Gilleron, Fabien Torre, Gemma Casas Garriga.

The Lampada project on “Learning Algorithms, Models and sPArse representations for structured DAta” is coordinated by Tommasi from Mostrare. Our partners are the SEQUEL project of Inria Lille Nord Europe, the LIF (Marseille), the HUBERT CURIEN laboratory (Saint-Etienne), and LIP6 (Paris). More information on the project can be found on <http://lampada.gforge.inria.fr/>.

8.2.2. *Competitivity Clusters*

We are part of FUI HERMES (2012-2015), a joint project in collaboration with many companies (Auchan, KeyneSoft, Cylande, ...). The main objective is to develop a platform for contextual customer relation management. The project started in November 2012.

8.3. European Initiatives

8.3.1. *Collaborations in European Programs, except FP7*

Program: ERC Advanced Grant

Project acronym: STAC

Project title: Strategic conversation

Duration: Sept. 2011 - Aug. 2016

Coordinator: Nicholas Asher, CNRS, Université Paul Sabatier, IRIT (France)

Other partners: School of Informatics, Edinburgh University; Heriot Watt University, Edinburgh

Abstract: STAC is a five year interdisciplinary project that aims to develop a new, formal and robust model of conversation, drawing from ideas in linguistics, philosophy, computer science and economics. The project brings a state of the art, linguistic theory of discourse interpretation together with a sophisticated view of agent interaction and strategic decision making, taking advantage of work on game theory.

In addition, MAGNET, in collaboration with SEQUEL, is part of the INRIA Lille - Nord Europe site for the European Network of Excellence in Pattern Analysis, Statistical Modelling and Computational Learning (PASCAL2).

MAGRIT Project-Team

8. Partnerships and Cooperations

8.1. Regional Initiatives

P. F Villard received fundings from the regional council to develop research about realistic simulation of organ dissection. The internship of Nicolas Koenig dealt with this subject and the results will be published in a communication at MMVR 2014.

8.2. National Initiatives

8.2.1. ANR

- ANR ARTIS (2009-2013)
Participants: M.-O. Berger, M. Loosvelt, P.-F. Villard.
The main objective of this fundamental research project is to develop inversion tools and to design and implement methods that allow for the production of augmented speech from the speech sound signal alone or with video images of the speaker's face. The Magrit team is especially concerned with the development of procedures allowing for the automatic construction of a speaker's model from various imaging modalities.
- ANR Visac (2009-2013)
Participants: M.-O. Berger, B. Wrobel-Dautcourt.
The ANR Visac is about acoustic-visual speech synthesis by bimodal concatenation. The major challenge of this project is to perform speech synthesis with its acoustic and visible components simultaneously. Within this project, the role of the Magrit team is to build a stereovision system able to record synchronized audio-visual sequences at a high frame rate [12].
- ANR IDeaS (2012-2016)
Participants: R. Anxionnat, M.-O. Berger, E. Kerrien.
The IDeaS Young Researcher ANR grant explores the potential of Image Driven Simulation (IDS) applied to interventional neuroradiology. IDS recognizes the current, and maybe essential, incapacity of interactive simulations to exactly superimpose onto actual data. Reasons are various: physical models are often inherently approximations of reality, simplifications must be made to reach interactive rates of computation, (bio-)mechanical parameters of the organs and surgical devices cannot but be known with uncertainty, data are noisy. This project investigates filtering techniques to fuse simulated and real data. Magrit team is in particular responsible for image processing and filtering techniques development, as well as validation.

8.2.2. Collaboration with the Shacra team and AEN SOFA

Participants: R. Anxionnat, M.-O. Berger, E. Kerrien, A. Yureidini.
The SOFA-InterMedS large-scale Inria initiative is a research-oriented collaboration across several Inria project-teams, international research groups and clinical partners. Its main objective is to leverage specific competences available in each team to further develop the multidisciplinary field of Medical Simulation research. Our action within the initiative takes place in close collaboration with both Shacra Inria project-team in Lille and the Department of diagnostic and therapeutic interventional neuroradiology of Nancy University Hospital. We aim at providing in-vivo models of the patient's organs, and in particular a precise geometric model of the arterial wall. Such a model is used by Shacra team to simulate the coil deployment within an intracranial aneurysm. The associated medical team in Nancy, and in particular our external collaborator René Anxionnat, is in charge of validating our results. For two years, we have also been collaborating with the Shacra team about real time augmentation of deformable organs

8.2.3. Institut Pascal, Université de Clermont-Ferrand

Participants: F. Sur.

Since June 2012, we have been engaged in a collaboration with Pr. Michel Grédiac. The aim is to give a mathematical analysis and to help improving the image processing tools used in experimental mechanics at Institut Pascal.

8.3. International Initiatives

8.3.1. Inria International Partners

8.3.1.1. Informal International Partners

Pierre-Frédéric Villard has a Honorary Research Fellow contract with Imperial College. The collaboration has involved 1 research visit in London in summer to mainly discuss about the writing of a common article [14]. He also participated as an activity leader in two one-week summer schools on Haptic Technology (to give the basics of computer haptics, including visual and haptics rendering, force feedback, haptic interfaces, collision detection, collision response and deformation modeling).

8.4. International Research Visitors

8.4.1. Visits to International Teams

Pierre-Frédéric Villard spent one month at Bangor University as a visiting researcher. This visiting fellowship was supported by the Wales Research Institute for Visual Computing (RIVIC). The aim was to improve existing solutions of respiration models based on optimization-driven models. Four parts have been studied: the meshing method, the deformation method, the boundary condition choice and the optimization method. A M.Sc. student was working on this subject and he has been remotely supervised by Pierre-Frédéric Villard until end of August.

MAIA Project-Team

8. Partnerships and Cooperations

8.1. Regional Initiatives

8.1.1. AME Satelor SATELOR

Participants: François Charpillat, Maxime Rio, Nicolas Beaufort, Xuan Nguyen, Amandine Dubois.

Economic mobilisation agency in Lorraine has launched a new project SATELOR providing it with 2.5 million Euros of funding over 3 years, out of an estimated total of 4.7 million. The leader of the project is Pharmagest-Diatelic. PHARMAGEST is the French leader in computer systems for pharmacies, with a 43.5 % share of the market, 9,800 clients and more than 700 employees. Pharmagest is in Nancy. Recently, PHARMAGEST Group expanded its activities into e-health and the development of telemedicine applications. The SATELOR project will accompany the partners of the project in developing new services for maintaining safely elderly people with loss of autonomy at home or people with a chronic illness. Maia team will play an important role for bringing some research results such as those presented in section 6.2.2.1 at an industrial level.

8.2. National Initiatives

8.2.1. Inria IPL PAL Personally Assisted Living

Participants: François Charpillat, Olivier Simonin, Mihai Andries.

The PAL project is a national Inria Large Scale Initiative involving several teams of the institute (Arobas, Coprin, E-motion, Lagadic, Demar, Maia, Prima, Pulsar and Trio). It is coordinated by David Daney (Inria Sophia-Antipolis, EPI Coprin). The project focuses on the study and experiment of models for health and well-being. Maia is particularly involved in the People Surveillance work package, by studying and developing intelligent environments and distributed tracking devices for people walking analysis and robotic assistance (smart tiles, 3D camera network, assistant robots), cf. Sec. 6.2.2.1 , 6.2.2.2 and 6.2.1.4 .

The PhD of Mihai Andries is funded by the PAL project.

8.2.2. PIA LAR Living Assistant Robot

Participants: François Charpillat, Abdallah Dib.

Partners : Crédit Agricole, Diatelic, Robosoft

LAR project has the objective to designing an assistant robot to improve the autonomy and quality of life for elderly and fragile persons. The project started at the beginning of the year. The role of the Maia Team is to develop a simultaneous localisation and mapping algorithm using a RGB-D camera. The main issue is to develop an algorithm able to deal with dynamic environment. An other issue is for the robot to be able to behave with acceptable social skills.

8.2.3. Inria ADT Percee (2011-13)

Participants: Olivier Simonin, François Charpillat, Nicolas Beaufort.

Olivier Rochel, from SED, is an external collaborator. Moutie Chaider was hired as an IJD in 2012.

Percee, for “Perception Distribuée pour Environnements Intelligents”, is a project proposed by the Maia and Madynes teams and funded by Inria. This ADT (Action de Développement Technologique) supports our action in the PAL Inria National Scale Initiative (Personally Assisted Living, see 8.2.1).

The project deals with the development and the study of intelligent homes. Since two years we have developed an experimental platform, the smart apartment. It allows us to study models and technology for life assistance (walk analysis with iTiles and camera networks, robotic assistants, health diagnostic, domotic functions, wireless communication inside home).

In particular we develop a new tactile floor, which is the iTiles network. Two engineers are funded by the ADT: Moutie Chaider (IJD) and Olivier Rochel (Inria research engineer) for two years.

8.2.4. ANR

8.2.4.1. ANR PHEROTAXIS

Participants: François Charpillat, Olivier Simonin.

Dominique Martinez (Cortex team, Inria NGE) is an external collaborator and the coordinator of the project for Nancy members.

PHEROTAXIS is an “Investissements d’Avenir” ANR 2011-2014 (Coordination: J.-P. Rospars, UMR PISC, INRA Versailles).

The theme of the research is localisation of odour sources by insects and robots. By associating experimental data with models, the project aims at defining a behavioral model of olfactive processes. This work provides several applications, in particular the development of bio-inspired components highly sensitive and selective.

The project is organized in five work packages and involves the PISC research unit (Versailles), Pasteur Institute (Paris) and LORIA/Inria institute (Nancy).

8.3. European Initiatives

8.3.1. Collaborations in European Programs, except FP7

Program: InterReg IV B

Project acronym: InTraDE

Project title: Intelligent Transportation for Dynamic Environment

Duration: 2010 - 2014

Coordinator: University of Science and Technology of Lille (Lille 1-LAGIS) (France),

Other partners: South East England Development Agency (United Kingdom), Centre Régional d’Innovation et de Transfert de Technologie – Transport et Logistique (CRITT TL) (France), AG Port of Oostende (AGHO) (Belgium), National Institute for Transport and Logistics, Dublin Institute of Technology (Ireland), Liverpool John Moores University (LOOM) (United Kingdom)

Abstract:

The InTraDE project (Intelligent Transportation for Dynamic Environments, <http://www.intrade-nwe.eu/>) is funded by the European North West Region. The project is coordinated by Rochdi Merzouki from University of Science and Technology of Lille (LAGIS lab.). Other partners are the Maia team, Liverpool John Moores University (LOOM), the National Institute for Transport and Logistics in Dublin Institute of Technology, the South East England Development Agency, the AGHO Port of Oostende and the CRITT in Le Havre. In the context of seaports and maritime terminals, the InTraDE project aims to improve the traffic management and space optimization inside confined spaces by developing a clean and safe intelligent transportation system. This transportation system will operate in parallel with virtual simulation software of the automated site, allowing a robust and real-time supervision of the goods handling operation.

The Maia team partner focuses on decentralized approaches to deal with the control of automated vehicle platooning and the adaptation of the traffic. Maia is funded with two PhD fellowships and one engineer. Both PhD thesis started in the end of 2010. The PhD of Jano Yazbeck, supervised by F. Charpillat and A. Scheuer, aims at studying a “Secure and robust immaterial hanging for automated vehicles” (see Sec. 6.2.1.1). The PhD of Mohamed Tlig, supervised by O. Simonin and O. Buffet, addresses “Reactive coordination for traffic adaptation in large situated multi-agent systems” (see Sec. 6.2.1.3).

8.4. International Research Visitors

8.4.1. Visits of International Scientists

- Dr. Iadine Chadès, Research Scientist at CSIRO, Ecosystem Sciences division (Brisbane, Australia), visited MAIA for 1 week in July 2013.

MANAO Team

7. Partnerships and Cooperations

7.1. Regional Initiatives

7.1.1. CTP materials (2011-2015):

U. Zaragoza, U. Girona

Leader: P. Barla (MANAO)

This collaboration between regions on both French and Spanish sides of Pyrénées aims at studying material properties through their connections between physical and image space. Although the purpose of such a study is general in scope, we also target a particular application: the acquisition of material properties from a single image of an object of unknown shape, under unknown illumination.

7.2. National Initiatives

7.2.1. ANR

7.2.1.1. ALTA (2011-2015):

MAVERICK, REVES

Leader: N. Holzschuch (MAVERICK)

The project ALTA aims at analyzing the light transport equations and at using the resulting representations and algorithms for more efficient computation. We target lighting simulations, either offline, high-quality simulation or interactive simulations.

7.2.1.2. "Young Researcher" IM&M (2011-2015):

IRIT

Leader: L. Barthe (IRIT)

This project aims at the definition of simple and robust tools for the modeling of 3D objects. To this end, the proposed approach consists in combining the nice mathematical properties of implicit surfaces with classical meshes.

7.2.1.3. SeARCH (2009-2013):

PFT3D Archéovision (CNRS), CEALex (USR CNRS 3134), ESTIA

Leader: P. Reuter

Cultural Heritage (CH) artifacts often come as a set of broken fragments leading to difficult 3D puzzles and sometime impossible to solve in a real world. The project's goal is to propose solutions from on-site acquisition, 3D surface reconstruction and semi-automatic virtual reassembly, taking into account the expertise of CH scientists. This project ended officially in March 2013, and we organized a closing conference and meeting in Bordeaux. We presented the results at "ANR - Les rencontres du numérique de l'ANR" in Paris at April 17th and 18th, 2013.

7.2.2. Competitivity Clusters

7.2.2.1. LabEx CPU:

IMB (UPR 5251), LABRI (UMR 5800), Inria (CENTRE BORDEAUX SUD-OUEST), I2M (NEW UMR FROM 2011), IMS (UMR 5218), CEA/DAM

Some members of MANAO participate in the local initiative CPU. As it includes many thematics, from fluid mechanics computation to structure safety but also management of timetable, safety of networks and protocols, management of energy consumption, etc., numerical technology can impact a whole industrial sector. In order to address problems in the domain of certification or qualification, we want to develop numerical sciences at such a level that it can be used as a certification tool.

7.3. European Initiatives

7.3.1. FP7 Projects

7.3.1.1. FP7 NoE - V-MusT.net (2011-2015):

partners available at <http://www.v-must.net/participants>

Leader: S. Pescarin (CNR - Italy)

V-MusT.net is a new European Network of Excellence dedicated to Virtual Museums. A Virtual Museum is a personalized, immersive, interactive experience that aims to enhance our understanding of the past in museums or on the Internet. The V-Must.net network enables heritage professionals around the world to connect, collaborate and advance the development and use of virtual museums.

7.3.1.2. FP7 ITN - PRISM “Perceptual Representations for Illumination, Shape and Materials” (2013-2016):

Giessen University, Université Paris-Descartes, Bilkent University, Université de Leuven, Delft University, Birmingham University, Philips and NextLimit

Leader: Roland Fleming (Giessen University)

The goal of this project is to better understand how the human visual system understands images in terms of meaningful components: How is shape perceived consistently in varying illumination conditions and for different materials? To which extent are humans able to guess the main illumination directions in a scene? What visual properties do we make use of to estimate the material an object is made of without touching it? Answering these questions will require inter-disciplinary research and collaborations.

7.3.2. Deutsche Forschungsgemeinschaft

7.3.2.1. DFG Emmy-Noether grant “Plenoptic Acquisition and Projection - Theoretical Developments and Applications” (2012-2017):

Inria

Leader: Ivo Ihrke (Inria)

This project aims to develop a comprehensive theory of the imaging process in optical-computational devices as developed in the newly emerging field of Computational Optics. The theory will be validated by a number of practical applications. It will allow for the modeling of image formation processes in measurement systems employing novel computational imaging and projection devices. This makes it possible to optimize these systems with respect to particular imaging tasks, which is currently impossible due to limited models. A further interesting aspect of the project is that computational imaging devices will become comparable with respect to parameters such as their resolution and noise characteristics which is hardly possible at the moment.

MAVERICK Project-Team

7. Partnerships and Cooperations

7.1. National Initiatives

7.1.1. ANR BLANC: ALTA

Participants: Nicolas Holzschuch, Cyril Soler.

We are funded by the ANR research program "Blanc" for a joint research project with two other Inria research teams, REVES in Sophia-Antipolis and iPARLA in Bordeaux. The goal of this project is studying light transport operators for global illumination, both in terms of frequency analysis and dimensional analysis. The grant started in October 2011, for 48 months.

7.1.2. ANR CONTINT: Galaxy/veRTIGE

Participants: Eric Bruneton, Jean-Dominique Gascuel, Nicolas Holzschuch, Fabrice Neyret.

RTIGE stands for Real-Time and Interactive Galaxy for Edutainment. This is an ANR CONTINT (Contents and Interactions) research program, for a joint research project with the EVASION Inria project-team, the GEPI and LERMA research teams at Paris Observatory, and the RSA Cosmos company. The goal of this project is to simulate the quality multi-spectral real-time exploration of the Galaxy with Hubble-like images, based on simulation data, statistical data coming from observation, star catalogs, and procedural amplification for stars and dust clouds distributions. RSA-Cosmos aims at integrating the results in digital planetariums. The grant started in December 2010, for 48 months.

7.1.3. ANR COSINUS: ROMMA

Participants: Georges-Pierre Bonneau, François Jourdes.

The ANR project ROMMA has been accepted in 2009. It started in January 2010 for a duration of 4 years. The partners of this project are academic and industry experts in mechanical engineering, numerical simulation, geometric modeling and computer graphics. The aim of the project is to efficiently and robustly model very complex mechanical assemblies. We work on the interactive computation of contacts between mechanical parts using GPU techniques. We also investigate the Visualization of data with uncertainty, applied in the context of the project.

7.1.4. ANR CONTINT: MAPSTYLE

Participants: Joëlle Thollot, Hugo Loi.

The MAPSTYLE project aims at exploring the possibilities offered by cartography and expressive rendering to propose original and new cartographic representations. Through this project, we target two types of needs. On the one hand, mapping agencies produce series paper maps with some renderings that are still derived from drawings made by hand 50 years ago: for example, rocky areas in the series TOP25 (to 1/25000) of the French Institut Géographique National (IGN). The rendering of these rocky areas must be automated and its effectiveness retained to meet the requirements of hikers safety. On the other hand, Internet mapping tools allow any user to become a cartographer. However, they provide default styles that cannot be changed (GeoPortal, Google Maps) or they are editable but without any assistance or expertise (CloudMade). In such cases, as in the case of mobile applications, we identify the need to offer users means to design map styles more personalised and more attractive to meet their expectations (decision-making, recreation, etc.) and their tastes. The grant started on October 2012, for 48 months.

7.2. International Initiatives

7.2.1. Informal International Partners

We have a continuing collaboration with Professor Kavita Bala, from Cornell University, USA, on the subject of global illumination and simulation of light scattering in participating media. Our work has been accepted at ACM transaction on graphics in 2014.

We currently have a very fruitful collaboration with Derek Nowrouzhezari, from University of Montreal, Canada, dealing with isotropic filter decomposition in the spherical domain, based on zonal harmonic basis.

7.3. International Research Visitors

7.3.1. Visits to International Teams

Fabrice Neyret is visiting WETA Digital (New-Zeland) since November 23, 2013. Eric Heitz visited WETA Digital (New-Zeland) from November 23, 2013 to December 12, 2013..

MIMETIC Project-Team

8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. ANR Contint: *iSpace&Time*

Participants: Fabrice Lamarche [contact], Julien Pettré, Marc Christie, Carl-Johan Jorgensen.

The *iSpace&Time* project is funded by the ANR and gathers six partners: IGN, Lamea, University of Rennes 1, LICIT (IFSTTAR), Telecom ParisTech and the SENSE laboratory (Orange). The goal of this project is the establishment of a demonstrator of a 4D Geographic Information System of the city on the web. This portal will integrate technologies such as web2.0, sensor networks, immersive visualization, animation and simulation. It will provide solutions ranging from simple 4D city visualization to tools for urban development. Main aspects of this project are:

- Creation of an immersive visualization based on panoramic acquired by a scanning vehicle using hybrid scanning (laser and image).
- Fusion of heterogeneous data issued by a network of sensor enabling to measure flows of pedestrians, vehicles and other mobile objects.
- Use of video cameras to measure, in real time, flows of pedestrians and vehicles.
- Study of the impact of a urban development on mobility by simulating vehicles and pedestrians.
- Integration of temporal information into the information system for visualization, data mining and simulation purpose.
- The mimetic team is involved in the pedestrian simulation part of this project. This project started in 2011 and will end in 2014.

8.1.2. ANR Contint: *Chrome*

Participants: Julien Pettré [contact], Kevin Jordao, Orianne Siret.

The *Chrome* project is led by Julien Pettré, member of MimeTIC. Partners are: Inria-Grenoble IMAGINE team (Remi Ronfard), Golaem SAS (Stephane Donikian), and Archivideo (Francois Gruson). The project has been launched in september 2012.

The *Chrome* project develops new and original techniques to massively populate huge environments. The key idea is to base our approach on the crowd patch paradigm that enables populating environments from sets of pre-computed portions of crowd animation. These portions undergo specific conditions to be assembled into large scenes. The question of visual exploration of these complex scenes is also raised in the project. We develop original camera control techniques to explore the most relevant part of the animations without suffering occlusions due to the constantly moving content. A far term goal of the project is to enable populating a large digital mockup of the whole France (Territoire 3D, provided by Archivideo). Dedicated efficient Human animation techniques are required (Golaem). A strong originality of the project is to address the problem a crowded scene visualisation through the scope of virtual camera control (Inria Rennes and Grenoble)

8.1.3. ANR TecSan: *RePLiCA*

Participant: Armel Crétual [contact].

The goal of *RePLiCA* project is to build and test a new rehabilitation program for facial praxia in children with cerebral palsy using an interactive device. *RePLiCA* started in january 2012 and will end in July 2015.

In a classical rehabilitation program, the child tries to reproduce the motion of his/her therapist. The feedback he/she has lays on the comparison of different modalities: the gesture of the therapist he/she has seen few seconds ago (visual space) and his/her own motion (proprioceptive space). Unfortunately, besides motor troubles these children often have some cognitive troubles and among them a difficulty to convert the information from a mental space to another one.

The principle of our tool is that during a rehabilitation session the child will observe simultaneously on the same screen an avatar, the virtual therapist's one, performing the gesture to be done, and a second avatar animated from the motion he actually performs. To avoid the use of a too complex motion capture system, the child will be filmed by a simple video camera. One first challenge is thus to be able to capture the child's facial motion with enough accuracy. A second one is to be able to provide him/her an additional feedback upon the gesture quality comparing it to a database of healthy children of the same age.

8.1.4. ANR JCJC: *Cinecitta*

Participants: Marc Christie [contact], Cunka Sanokho.

Cinecitta is a 3-year young researcher project funded by the French Research Agency (ANR) lead by Marc Christie. The project started in October 2012 and will end in October 2015.

The main objective of Cinecitta is to propose and evaluate a novel workflow which mixes user interaction using motion-tracked cameras and automated computation aspects for interactive virtual cinematography that will better support user creativity. We propose a novel cinematographic workflow that features a dynamic collaboration of a creative human filmmaker with an automated virtual camera planner. We expect the process to enhance the filmmaker's creative potential by enabling very rapid exploration of a wide range of viewpoint suggestions. The process has the potential to enhance the quality and utility of the automated planner's suggestions by adapting and reacting to the creative choices made by the filmmaker. This requires three advances in the field. First, the ability to generate relevant viewpoint suggestions following classical cinematic conventions. The formalization of these conventions in a computationally efficient and expressive model is a challenging task in order to select and propose the user with a relevant subset of viewpoints among millions of possibilities. Second, the ability to analyze data from real movies in order to formalize some elements of cinematographic style and genre. Third, the integration of motion-tracked cameras in the workflow. Motion-tracked cameras represent a great potential for cinematographic content creation. However given that tracking spaces are of limited size, there is a need to provide novel interaction metaphors to ease the process of content creation with tracked cameras. Finally we will gather feedback on our prototype by involving professionals (during dedicated workshops) and will perform user evaluations with students from cinema schools.

8.1.5. ANR Contint: *ENTRACTE*

Participants: Charles Pontonnier [contact], Georges Dumont, Nicolas Bideau, Franck Multon, Julien Pettré, Richard Kulpa, Ana Lucia Cruz Ruiz, Steve Tonneau.

The ANR project ENTRACTE is a collaboration between the Gepetto team in LAAS, Toulouse (head of the project) and the Inria/MimeTIC team. The project started in November 2013 and will end in August 2017. The purpose of the ENTRACTE project is to address the action planning problem, crucial for robots as well as for virtual human avatars, in analyzing human motion at a biomechanical level and in defining from this analysis bio-inspired motor control laws and bio-inspired paradigms for action planning. The project is launched since november 2013 and Ana-Lucia Cruz-Ruiz has been recruited as a PhD student since this date to begin to work on musculoskeletal-based methods for avatar animation. Moreover, Steve Tonneau, a PhD student currently entering in its third year is also developing bio-inspired posture generators for avatar navigation in encumbered environments.

8.1.6. ADT: *Man-IP*

Participant: Franck Multon [contact].

The ADT-MAN-IP aims at proposing a common production pipeline for both MimeTIC and Hybrid teams. This pipeline intends to facilitate the production of populated virtual reality environments.

The pipeline starts with the motion capture of an actor, using motion capture devices such as a Vicon (product of Oxford Metrics) system. To do so, we need to design new methods to automatically adapt all motion captures data to an internal skeleton that can be reused to retarget the motion to various types of skeletons and characters. The purpose is then to play this motion capture data on any type of virtual characters used in the demos, regardless their individual skeletons and morphology. The key point here is to make this process be as automatic as possible.

The second step in the pipeline is to design a high level scenario framework to describe a virtual scene and the possible user's interactions with this scene so that he/she can interact with the story directly.

In this ADT we also will have to connect these two opposite parts into a unique framework that can be used by non-experts in computer animation to design new immersive experiments involving autonomous virtual humans. The resulting framework could consequently be used in the Immersia immersive room for various types of application.

8.2. European Initiatives

8.2.1. FP7 Projects

8.2.1.1. INFRA-FP7: VISIONAIR

Participants: Georges Dumont [contact], Charles Pontonnier.

Acronym: VISIONAIR

Title: VISION Advanced Infrastructure for Research

Duration: 2011-2015

See also:<http://www.infra-visionair.eu/>

The european project VISIONAIR began in February 2011 in the infrastructure call of FP7. The project's goal is to create a European infrastructure that should be a unique, visible and attractive entry towards high level visualization facilities. These facilities will be open to the access of a wide set of research communities. By integrating our existing facilities, we will create a world-class research infrastructure enabling to conduct frontier research. This integration will provide a significant attractiveness and visibility of the European Research Area. The partners of this project have proposed to build a common infrastructure that would grant access to high level visualization and interaction facilities and resources to researchers. Indeed, researchers from Europe and from around the world will be welcome to carry out research projects using the visualization facilities provided by the infrastructure. Visibility and attractiveness will be increased by the invitation of external projects.

This project is built with the participation of 26 European partners.

Our actual Virtual Reality systems allowed us to be a key partner within this European project. Our Immersia (<http://www.irisa.fr/immersia>) Virtual Reality room is, in Europe, a key place for virtual reality. We are leading the Work Package 9 on Advanced methods for interaction and collaboration of this project and are deeply involved in the directory board and in the scientific piloting committee.

Within the frame of this project, studies on VR and sports about basketball throwing (see 6.4) and VR and ergonomics about fidelity of virtual environments for ergonomic applications (see 6.2) have been leaded.

8.3. International Initiatives

8.3.1. Inria Associate Teams

8.3.1.1. FORMOSA

Title: Fostering Research on Models for Storytelling Applications

Inria principal investigator: Marc Christie

Partner contact: Pr. Tsai Yen li

International Partner (Institution - Laboratory - Researcher):

National Cheng Chi University (Taiwan) - Intelligent Media Lab - Marc Christie

Duration: 2013 - 2015

See also: <http://www.irisa.fr/mimetic/GENS/mchristi/EA-FORMOSA/>

The application context targeted by this proposal is Interactive Virtual Storytelling. The growing importance of this form of media reveals the necessity to re-think and re-assess the way narratives are traditionally structured and authored. In turn, this requires from the research community to address complex scientific and technical challenges at the intersection of literature, robotics, artificial intelligence, and computer graphics. This joint collaboration addresses three key issues in virtual storytelling: (i) delivering better authoring tools for designing interactive narratives based on literary-founded narrative structures, (ii) establishing a bridge between the semantic level of the narrative and the geometric level of the final environment to enable the simulation of complex and realistic interactive scenarios in 3D, and (iii) providing a full integration of the cinematographic dimension through the control of high-level elements of filmic style (pacing, preferred viewpoints, camera motion). The project is founded on a past solid collaboration and will rely on the team's complementarity to achieve the tasks through the development of a joint research prototype.

8.3.1.2. SIMS

Title: Toward realistic and efficient simulation of highly complex systems

Inria principal investigator: Julien Pettré

Partner contact: Pr. Ming Lin

International Partner (Institution - Laboratory - Researcher):

University of North Carolina at Chapel Hill (United States) - GAMMA Research Group -
Julien Pettré

Duration: 2012 - 2014

See also: <http://www.irisa.fr/mimetic/GENS/jpettre/>

The general goal of SIMS is to make significant progress toward realistic and efficient simulation of highly complex systems which raise combinatory explosive problems. This proposal is focused on human motion and interaction, and covers 3 active topics with wide application range: 1. Crowd simulation: virtual human interacting with other virtual humans, 2. Autonomous virtual humans: who interact with their environment, 3. Physical Simulation: real humans interacting with virtual environments. SIMS is orthogonally structured by transversal questions: the evaluation of the level of realism reached by a simulation (which is a problem by itself in the considered topics), considering complex systems at various scales (micro, meso and macroscopic ones), and facing combinatory explosion of simulation algorithms.

8.4. International Research Visitors

8.4.1. Internships

- Alexandra Covaci, PhD student from University Brasso (Romania) partially funded by the VISION-AIR project and Brasso University, from March to April 2013. Joint works about virtual training in sports applied to basketball free throw.

MINT Project-Team

7. Partnerships and Cooperations

7.1. National Initiatives

7.1.1. *InSTInCT (ANR ContInt, 2009-2013)*

Participants: Géry Casiez [correspondant], Frédéric Giraud, Laurent Grisoni, Nicolas Roussel.

This project focused on the design, development and evaluation of new simple and efficient touch-based interfaces, with the goal of bringing widespread visibility to new generations of interactive 3D applications.

Partners: Inria [Mint, Iparla], Immersion, Cap Sciences

Web site: <http://anr-instinct.cap-sciences.net/>

7.1.2. *TOUCHIT (13th FUI, 2012-2015)*

Participants: Michel Amberg, Géry Casiez, Frédéric Giraud, Thomas Pietrzak, Nicolas Roussel [correspondant], Betty Lemaire-Semail [correspondant].

The purpose of this project is twofold. It aims at designing and implementing hardware solutions for tactile feedback based on programmable friction. It also aims at developing the knowledge and software tools required to use these new technologies for human-computer interaction. Grant for MINT is balanced on 272 keuro handled at University for L2EP, and 220 Keuros for Inria.

Partners: STMicroelectronics, CEA/LETI, Univ. Lille 1, Inria, Orange Labs, CNRS, EASii IC, MENAPIC and ALPHAUI.

Competitive clusters involved: **Minalogic**, **Cap Digital** and **MAUD**.

7.1.3. *Smart-Store (12th FUI, 2011-2014, extended to 2015)*

Participants: Samuel Degrande [correspondant], Laurent Grisoni, Fabrice Aubert.

The aim of this project is to set up, in the context of retail, some middleware and hardware setup for retail interactive terminal, that allows customer to connect with their own smart-phone on a system that includes a large screen, and allows to browse some store offer, as well as pre-order and/or link to further reconsulting. SME Idées-3com leads this FUI, which also includes Immochan, Oxylane, and VisioNord. Grant for MINT is 301 Keuros. This project start on september 2012 (start of this project has been delayed due to administrative problems), for a duration of 36 months.

Associated competitiveness cluster: PICOM (retail)

7.2. International Research Visitors

7.2.1. *Visits of International Scientists*

Short visits:

- **Michael Terry** (University of Waterloo, Canada) in June
- **Andy Cockburn** (University of Canterbury, New Zealand) in July
- **Karan Singh** (University of Toronto, Canada) in December

7.2.2. *Visits to International Teams*

F. Giraud was invited researcher at the electrical and computer engineering department of the University of Toronto (Ontario, Canada). He was granted with the sabbatical program of the international relations (september 2012, july 2013).

MORPHEO Team

8. Partnerships and Cooperations

8.1. Regional Initiatives

8.1.1. ARC6 project PADME – Perceptual quality Assessment of Dynamic MESHes and its applications

In this project, we propose to use a new and experimental “bottom-up” approach to study an interdisciplinary problem, namely the objective perceptual quality assessment of 3D dynamic meshes (i.e., shapes in motion with temporal coherence). The objectives of the proposed project are threefold:

1. to understand the HVS (human visual system) features when observing 3D animated meshes, through a series of psychophysical experiments;
2. to develop an efficient and open-source objective quality metric for dynamic meshes based on the results of the above experiments;
3. to apply the learned HVS features and the derived metric to the application of compression and/or watermarking of animated meshes.

This work is funded by the Rhône-Alpes région through an ARC6 grant for the period 2013-2016. The three partners are LIRIS (University Lyon 1, Florent Dupont), GIPSA-Lab (CNRS, Kai Wang) and LJK (University of Grenoble, Franck Hétroy). The PhD thesis of Georges Nader is part of the project.

8.2. National Initiatives

8.2.1. Motion analysis of laboratory rodents

In order to evaluate the scalability of previous work on motion analysis of laboratory rodents, a collaboration has been initiated with the Institut Clinique de la Souris (ICS), in Institut de Génétique et de Biologie Moléculaire et Cellulaire (IGBMC). This institute is dedicated to phenotyping of mice and requires reliable motion analysis tools. A multicamera platform has been deployed at ICS and will be exploited next year for tests ranging from one to two hundreds mice.

8.2.2. ANR

8.2.2.1. ANR project Morpho – Analysis of Human Shapes and Motions

Morpho is aimed at designing new technologies for the measure and for the analysis of dynamic surface evolutions using visual data. Optical systems and digital cameras provide a simple and non invasive mean to observe shapes that evolve and deform and we propose to study the associated computing tools that allow for the combined analysis of shapes and motions. Typical examples include the estimation of mean shapes given a set of 3D models or the identification of abnormal deformations of a shape given its typical evolutions. Therefore this does not only include static shape models but also the way they deform with respect to typical motions. It brings a new research area on how motions relate to shapes where the relationships can be represented through various models that include traditional underlying structures, such as parametric shape models, but are not limited to them. The interest arises in several application domains where temporal surface deformations need to be captured and analyzed. It includes human body analyses but also extends to other deforming objects, sails for instance. Potential applications with human bodies are anyway numerous and important, from the identification of pathologies to the design of new prostheses. The project focus is therefore on human body shapes and their motions and on how to characterize them through new biometric models for analysis purposes. 3 academic partners will collaborate on this project: the Inria Rhône-Alpes with the Morpheo team, the GIPSA-lab Grenoble and the Inria Lorraine with the Alice team. Website: <http://morpho.inrialpes.fr/>.

8.2.3. Competitiveness Clusters

8.2.3.1. *FUI project Creamove*

Creamove is a collaboration between the Morpheo team of the Inria Grenoble Rhône-Alpes, the 4D View Solution company specialised in multi-camera acquisition systems, the SIP company specialised in multi-media and interactive applications and a choreographer. The objective is to develop new interactive and artistic applications where humans can interact in 3D with virtual characters built from real videos. Dancer performances will be pre-recorded in 3D and used on-line to design new movement sequences based on inputs coming from human bodies captured in real time.

8.3. European Initiatives

8.3.1. FP7 Projects

8.3.1.1. *Re@ct*

Type: COOPERATION

Challenge: IMMERSIVE PRODUCTION AND DELIVERY OF INTERACTIVE 3D CONTENT

Instrument: Specific Targeted Research Project

Objective: Networked Media and Search Systems

Duration: December 2011 - November 2014

Coordinator: BBC (UK)

Partner: BBC (UK), Fraunhofer HHI (Germany), University of Surrey (UK), Artefacto (France), OMG (UK).

Inria contact: Jean-Sébastien Franco, Edmond Boyer

Abstract: RE@CT will introduce a new production methodology to create film-quality interactive characters from 3D video capture of actor performance. Recent advances in graphics hardware have produced interactive video games with photo-realistic scenes. However, interactive characters still lack the visual appeal and subtle details of real actor performance as captured on film. In addition, existing production pipelines for authoring animated characters are highly labour intensive. RE@CT aims to revolutionise the production of realistic characters and significantly reduce costs by developing an automated process to extract and represent animated characters from actor performance capture in a multiple camera studio. The key innovation is the development of methods for analysis and representation of 3D video to allow reuse for real-time interactive animation. This will enable efficient authoring of interactive characters with video quality appearance and motion. The project builds on the latest advances in 3D and free-viewpoint video from the contributing project partners. For interactive applications, the technical challenges are to achieve another step change in visual quality and to transform captured 3D video data into a representation that can be used to synthesise new actions and is compatible with current gaming technology.

8.4. International Initiatives

8.4.1. *Inria Associate Teams*

The Morpheo team is associated with the Matsuyama lab. at the University of Kyoto (<http://morpheo.inrialpes.fr/Kyoto/>). Both entities are working on the capture of evolving shapes using multiple videos and the objective of the collaboration is to make progress on the modeling of dynamic events using visual cues with a particular emphasize on human gesture modeling for analysis purposes. To this aim, the collaboration fosters exchanges between researchers in this domain, in particular young researchers, through visits between the two teams. In the frame of this collaboration, a workshop was organized in November 2013 at the Inria Grenoble (<http://morpheo.inrialpes.fr/kyoto/inria-kyoto-workshop-on-4d-modeling/>).

8.4.2. Inria International Partners

8.4.2.1. Informal International Partners

8.4.2.1.1. Collaboration with Forest Research, UK

A common work with an ecophysiologicalist from Forest Research, Eric Casella, is currently carried out to recover useful geometric information from unorganized point clouds of plants and trees, obtained with a terrestrial laser scanning device. Preliminary results have been presented this year at the FSPM conference [4].

8.4.2.1.2. Collaboration with TU Munich

The long term collaboration with TU Munich and Slobodan Ilic on human motion capture is ongoing with the work of Paul Huang [7] that was published at 3DV this year and received a best paper award. The work contributes with an approach that recovers both the shape and the articulated pose of a human body, over time sequences, using multiple videos.

8.5. International Research Visitors

8.5.1. Visits of International Scientists

- Prof. Matsuyama, Kyoto University, Matsuyama Lab, Japan.
- Associate Prof. Shohei Nobuhara, Kyoto University, Matsuyama Lab, Japan
- Assistant prof. Tony Tung, Kyoto University, Matsuyama Lab, Japan.

OAK Project-Team

7. Partnerships and Cooperations

7.1. Regional Initiatives

Data Warehousing for RDF (DW4RDF) is a 3-year project sponsored by the Digiteo foundation, between Inria and UNIV. PARIS-SUD. The project aims at defining and deploying a full framework for RDF data analytics, supporting its inherent structural heterogeneity and semantics, while at the same time providing powerful analytic tools for summarizing and analyzing the data. The project supports the PhD of Alexandra Roatis.

7.2. National Initiatives

7.2.1. ANR

Apprentissage Adaptatif pour le Crowdsourcing Intelligent et l'Accès à l'Information (ALICIA) is a 3.5-year project, starting in February 2014, supported by the ANR CONTINT call. The project is coordinated by Bogdan Cautis, with Nicole Bidoit, Melanie Herschel, and Ioana Manolescu. Its goal is to study models, techniques, and the practical deployment of adaptive learning techniques in user-centric applications, such as social networks and crowdsourcing.

Cloud-Based Organizational Design (CBOD) is a 4-year project accepted by the ANR in 2013 and is currently under financial negotiation. The project is coordinated by prof. Ahmed Bounfour from UNIV. PARIS-SUD. Its goal is to study and model the ways in which cloud computing impacts the behavior and operation of companies and organizations, with a particular focus on the cloud-based management of data, a crucial asset in many companies.

Datalyse is funded for 3.5 years as part of the *Investissement d'Avenir - Cloud & Big Data* national program. The project is led by the Grenoble company Eolas, a subsidiary of Business & Decision. It is a collaboration with LIG Grenoble, U. Lille 1, U. Montpellier, and Inria Rhône-Alpes aiming at building scalable and expressive tools for Big Data analytics.

7.2.2. LabEx, IdEx

Structured, Social and Semantic Search is a 3-year project started in October 2013, financed by the *LabEx (Laboratoire d'Excellence) DIGICOSME*. The project aims at developing a data model for rich structured content enriched with semantic annotations and authored in a distributed setting, as well as efficient algorithms for top-k search on such content.

BizModel4Cloud is a one-year interdisciplinary research project funded under a *Projet Exploratoire Premier Soutien (PEPS)* call joint between the CNRS and the IdEx Paris Saclay. It reunites the same partners as the ANR CBOD project of which it is an initial, short version.

7.3. European Initiatives

7.3.1. Collaborations in European Programs, except FP7

Program: COST

Project acronym: Keystone

Project title: Semantic keyword-based search on structured data sources

Duration: Oct 2013 – Oct 2018

Coordinator: Francesco Guerra (U. Modena, Italy)

Other partners: The project involves 24 countries, see http://www.cost.eu/domains_actions/ict/Actions/IC1302?parties

Abstract: To build efficient and expressive keyword search tools, the action “semantic KEYword-based Search on sTructured data sOurcEs” (KEYSTONE) proposes to draw upon competencies from several disciplines, such as semantic data management, the semantic web, information retrieval, artificial intelligence, machine learning, user interaction, service science, service design, and natural language processing.

Program: KIC EIT ICT Labs “Computing in the Cloud” Action Line

Project acronym: Europa

Project title: Massively Parallel Data Management

Duration: Jan 2013 – Dec 2013

Coordinator: Volker Markl (TU Berlin, Germany)

Other partners: UNIV. PARIS-SUD (France), Aalto Univ (Finland), InternetMemory (France)

Abstract: Europa focuses on massively parallel algorithms and platforms for data management in the cloud. At TU Berlin, the Stratosphere open-source platform has been developed as part of this activity. At Inria and UNIV. PARIS-SUD, our work has focused on developing the AMADA platform for efficiently exploiting Web data in the Amazon cloud.

7.4. International Initiatives

7.4.1. Inria Associate Teams

7.4.1.1. OakSaD

Title: Languages and techniques for efficient large-scale Web data management

Inria principal investigator: Ioana Manolescu

International Partner (Institution - Laboratory - Researcher):

University of California San Diego (United States) - Computer Science and Engineering -
Ioana Manolescu

Duration: 2013 - 2015

See also <https://team.inria.fr/oak/oaksad/>

Data on the Web is increasingly large and complex. The ways to process and share it have also evolved, from the classical scenario where users connect to a database, to today’s complex processes whereas data is jointly produced on the Web, disseminated through streams, corroborated and enriched through annotations, and exploited through complex business processes, or workflows. The OAK and San Diego teams work together to devise expressive languages, efficient techniques and scalable platforms for such applications. The main areas on which our interest is shared are: semantic Web annotations; large-scale distributed data sharing; monitoring and verification of automated data processing workflows in the cloud.

7.4.2. Inria International Partners

7.4.2.1. Informal International Partners

We collaborate closely with TU Berlin within the Europa KIC EIT ICT Labs Europa project; A. Katsifodimos moved there for his post-doc after completing his PhD in OAK.

We have collaborated significantly with researchers from the University of Pisa and University of Basilicata [15], [16].

7.5. International Research Visitors

7.5.1. Visits of International Scientists

Participant: Stefano Ceri.

Date: September 2013

Institution: Politecnico di Milano, Italy.

Participant: Alin Deutsch.

Date: July-August 2013

Institution: UCSD, USA.

7.5.1.1. Internships

Damian Alexis Bursztyn

Subject: Take What You Need: Efficiently Querying Semantic Web Data

Date: from Mar 2013 until Aug 2013

Institution: University of Buenos Aires (Argentina).

Varun Malhotra

Subject: Task factorization for PACT programs on semistructured data

Date: from May 2013 until Aug 2013

Institution: IIT Delhi (India).

ORPAILLEUR Project-Team

8. Partnerships and Cooperations

8.1. International Initiatives

8.1.1. *Participation In International Programs*

8.1.1.1. *Facepe Inria Project: CM2ID*

Participants: Amedeo Napoli [contact person], Chedy Raïssi.

This research project called “Combining Numerical and Symbolical Methods for the Classification of Multi-valued and Interval Data (CM2ID)” involves the Orpailleur Team at Inria NGE, AxIS at Inria Rocquencourt (Yves Lechevallier) and the computer science laboratory of the University of Recife (Prof. Francisco de A.T. de Carvalho). The project aims at developing and comparing classification and clustering algorithms for interval and multi-valued data. Two families of algorithms are studied, namely “clustering algorithms” based on the use of a similarity or a distance for comparing the objects, and “classification algorithms in Formal Concept Analysis (FCA)” based on attribute sharing between objects. The objectives here are to combine the facilities of both families of algorithms for improving the potential of each family in dealing with more complex and voluminous datasets.

Finally, a workshop was organized in April 2013, namely the “French-Brazilian Workshop on Numerical and Symbolic Methods of Data Analysis -WFB2013” (<http://www.cin.ufpe.br/~wfb2013/>).

8.1.1.2. *Fapemig Inria Project: IKMSDM*

Participants: Amedeo Napoli [contact person], Chedy Raïssi.

This Fapemig – Inria research project, called “Incorporating knowledge models into scalable data mining algorithms” involves researchers at Universidade Federal de Minas Gerais in Belo Horizonte –a group led by Prof. Wagner Meira– and the Orpailleur team at Inria Nancy Grand Est. In this project we are interested in the mining of large amount of data and we target two relevant application scenarios where such issue may be observed. The first one is text mining, i.e. extracting knowledge from texts and document categorization. The second application scenario is graph mining, i.e. determining relationship-based patterns and use these relations to perform classification tasks. In both cases, the computational complexity is large either because the high dimensionality of the data or the complexity of the patterns to be mined. Loïc Cerf from UFMG visited the Orpailleur team in January 2013 while Chedy Raïssi visited UFMG in May 2013.

8.1.1.3. *Pronex Brasilia*

Participant: Bernard Maigret [contact person].

In this research project, the goal is to identify, using virtual screening techniques that we developed, new compounds against tropical diseases (e.g. trypanosome, dengue and mycosis) in collaboration with several Brazilian laboratories among which the Department of Biology at University of Brasilia, together with the Harmonic Pharma start-up. Through this collaboration, several PhD and postdocs came to the lab for one year training with our home-developed virtual screening engine (VSM-G). This project is in part supported by the Brazilian CNPq agency. Fruitful results were already obtained leading to several papers in preparation and patents. These patents concern the discovery of new putative treatment of strong mycosis due to fungi particularly virulent in South America. These patents were funded by the University of Brasilia, Embrapa and Harmonic Pharma.

8.1.1.4. *International collaborations in Mining complex data*

Participants: Mehwish Alam, Aleksey Buzmakov, Melisachew Chekol, Victor Codocedo, Adrien Coulet, Elias Egho, Ioanna Lykourantzou, Amedeo Napoli [contact person], Chedy Raïssi, Jean-Sébastien Sereni, Mario Valencia.

8.1.1.4.1. PICS CNRS CAdOE

A collaboration involves the Orpailleur team, “Université du Québec à Montréal” (UQAM) in Montréal with Prof. Petko Valtchev and Laboratoire LIRMM in Montpellier with Prof. Marianne Huchard. This collaboration is supported by a CNRS PICS project (2011-2014), which is called “Concept Analysis driving Ontology Engineering” and abbreviated in “CAdOE”. The research work within this project is aimed at defining and implementing a semi-automatic methodology supporting ontology engineering based on the joint use of Formal Concept Analysis (FCA) and Relational Concept Analysis (RCA). This year the work was mainly focused on RCA and some important papers were published [33], [57].

8.1.1.4.2. Miscellaneous

- An on-going collaboration involves the Orpailleur team and Sergei Kuznetsov at Higher School of Economics in Moscow (HSE). Amedeo Napoli visited HSE laboratory in March 2013 (with the support of HSE) and met Sergei Kuznetsov several times during the year. In addition, Alexey Neznanov from HSE Moscow visited the Orpailleur team in May 2013 while Dmitry Ignatov visited the Orpailleur team in September 2013.

These visits were the occasion of preparing a publications. Moreover, Sergei Kuznetsov and Amedeo Napoli, together with Claudio Carpineto organized a workshop related to the ECIR Conference in Moscow in March 2013 on “Formal Concept Analysis meets Information Retrieval” (<http://www.hse.ru/en/org/hse/fcair>).

- A so-called AGAUR Project funded by UPC Barcelona involves Amedeo Napoli and Jaume Baixeries who is an Associate Professor at UPC Barcelona (Universitat Politècnica de Catalunya). Both researchers have worked, jointly with Mehdi Kaytoue, on the characterization of functional dependencies in many-valued data with FCA and pattern structures [38].
- A PHC Zenon project (Cyprus) with Florent Domenach, associated professor at the University of Nicosia in Cyprus was finished at the end of last year. This project was entitled “Knowledge Discovery for Complex Data in Formal and Relational Concept Analysis” (KD4CD) and is aimed at studying and combining different types of classification process in the framework of FCA. As a result of this collaboration, some papers were published this year, among which one at the ICFA Conference in Dresden [49], [61].
- A PHC Proteus project (Slovenia) with Riste Škrekovski, professor at the University of Ljubljana ended at the end of 2013. This project was entitled “Graphs for combinatorial chemistry and complex networks”. Several manuscripts are under submission.
- LEA STRUCO is an “Associated International Laboratory” of CNRS between IÚUK, Prague, and LIAFA, Paris. It focuses on high-level study of fundamental combinatorial objects, with a particular emphasis on comprehending and disseminating the state-of-the-art theories and techniques developed. The obtained insights shall be applied to obtain new results on existing problems as well as to identify directions and questions for future work. Jean-Sébastien Sereni is the contact person for LEA STRUCO which was initiated when Jean-Sébastien was a member of LIAFA.
- At present, Mario Valencia is the international coordinator of the MathAmSud project 13MATH-07 “Structural an algebraic problems on graph theory” (2013–2015). This project is funded by the following research institutes: CNRS in France, MinCyT in Argentina, CAPES in Brazil and CMM in Chile.

8.2. National Initiatives

8.2.1. ANR

8.2.1.1. HEREDIA

Participant: Jean-Sébastien Sereni [contact person].

HEREDIA (<http://www.liafa.univ-paris-diderot.fr/~sereni/Heredia/>) is an ANR JCJC (“Jeunes Chercheurs”) focusing on hereditary properties of graphs, which provide a general perspective to study graph properties. Several important general theorems are known and the approach offers an elegant way of unifying notions and proof techniques. Further, hereditary classes of graphs play a central role in graph theory. Besides their theoretical appeal, they are also particularly relevant from an algorithmic point of view. With Jean-Sébastien Sereni, the HEREDIA project involves Pierre Charbit (LIAFA, Paris), Louis Esperet (G-SCOP, Grenoble) and Nicolas Trotignon (LIP, Lyon).

8.2.1.2. *Hybride*

Participants: Luis-Felipe Melo, Amedeo Napoli, Chedy Raïssi, My Thao Tang, Mohsen Sayed, Yannick Toussaint [contact person].

The Hybride research project (<http://hybride.loria.fr/>) aims at developing new methods and tools for supporting knowledge discovery from textual data by combining methods from Natural Language Processing (NLP) and Knowledge Discovery in Databases (KDD). A key idea is to design an interacting and convergent process where NLP methods are used for guiding text mining and KDD methods are used for analyzing textual documents. NLP methods are mainly based on text analysis, and extraction of general and temporal information. KDD methods are based on pattern mining, e.g. itemsets and sequences, formal concept analysis and variations, and graph mining. In this way, NLP methods applied to some texts locate “textual information” that can be used by KDD methods as constraints for focusing the mining of textual data. By contrast, KDD methods can extract itemsets or sequences that can be used for guiding information extraction from texts and text analysis. Experimental and validation parts associated with the Hybride project are provided by an application to the documentation of rare diseases in the context of Orphanet.

The partners of the Hybride consortium are the GREYC Caen laboratory (pattern mining, NLP, text mining), the MoDyCo Paris laboratory (NLP, linguistics), the INSERM Paris laboratory (Orphanet, ontology design), and the Orpailleur team at Inria NGE (FCA, knowledge representation, pattern mining, text mining).

8.2.1.3. *ISTEX*

Participants: Luis-Felipe Melo, Amedeo Napoli, Yannick Toussaint [contact person].

ISTEX is a so-called “Initiative d’excellence” managed by CNRS and DIST (“Direction de l’Information Scientifique et Technique”). ISTEX aims at giving to the research and teaching community an on-line access to scientific publications in all the domains. Thus ISTEX is in concern with a massive acquisition of documentation such as journals, proceedings, corpus, databases...ISTEX-R is one research project within ISTEX in which is involved the Orpailleur team, with two other partners, namely the ATILF laboratory and the INIST Institute (both in Nancy). ISTEX-R aims at developing a new generation of tools for querying full-text documentation, analyzing their content or extracting information and knowledge units. A platform is currently under development to provide robust NLP tools for text processing, as well as methods in text mining and domain conceptualization.

8.2.1.4. *Kolflow*

Participants: Jean Lieber [contact person], Alice Hermann, Amedeo Napoli, Emmanuel Nauer, My Thao Tang, Yannick Toussaint.

Kolflow (<http://kolflow.univ-nantes.fr/>) is a 3-year basic research project taking place from February 2011 to July 2014, funded by French National Agency for Research (ANR), program ANR CONTINT. The aim of the project is investigation on man-machine collaboration in continuous knowledge-construction flows.

Kolflow partners are GDD (LINA Nantes), Silex (LIRIS Lyon), Orpailleur (Inria NGE/LORIA), Score (Inria NGE/LORIA), and Wimmics (Inria Sophia Antipolis).

8.2.1.5. *PEPSI: Polynomial Expansions of Protein Structures and Interactions*

Participants: David Ritchie, Marie-Dominique Devignes, Malika Smaïl-Tabbone.

The PEPSI (“Polynomial Expansions of Protein Structures and Interactions”) project is a collaboration with Sergei Grudinin at Inria Grenoble (project Nano-D) and Valentin Gordeliy at the Institut de Biologie Structurale (IBS) in Grenoble. This four-year project funded by the ANR “Modèles Numériques” program involves developing computational protein modeling and docking techniques and using them to help solve the structures of large molecular systems experimentally (<http://pepsi.gforge.inria.fr>).

8.2.1.6. *Termith*

Participants: Luis-Felipe Melo, Yannick Toussaint [contact person].

Termith (<http://www.atilf.fr/ressources/termith/>) is an ANR Project which involves the following laboratories: ATILF, LIDILEM, LINA, INIST, Inria Saclay and Inria Nancy Grand Est. It aims at indexing documents belonging to different domain of Humanities. Thus, the project focuses on extracting term candidates (information extraction) and on disambiguation.

In the Orpailleur team, we are mainly concerned by information extraction using Formal Concept Analysis techniques, but also itemset or sequence extraction. The objective is to define “contexts introducing terms”, i.e. finding textual environments allowing a system to decide whether a textual element is actually a term and its corresponding domain.

8.2.1.7. *Trajcan: a study of patient care trajectories*

Participants: Elias Egho, Nicolas Jay [contact person], Amedeo Napoli, Chedy Raïssi.

Since 30 years, many patient classification systems (PCS) have been developed. These systems aim at classifying care episodes into groups according to different patient characteristics. In France, the so-called “Programme de Médicalisation des Systèmes d’Information” (PMSI) is a national wide PCS in use in every hospital. It systematically collects data about millions of hospitalizations. Though it is used for funding purposes, it includes useful information for public health domains such as epidemiology or health care planning.

The objective of the Trajcan project is to represent and analyze “patient care trajectories” (patient suffering from cancer limited to breast, colon, rectum, and lung cancers) and the associated healthcare. The data are related to patients receiving hospital cares in the “Bourgogne” region and using data from the PMSI. Such an analysis involves various data, e.g. type of cancer, number of visits, type of stays, hospitalization services and therapies used, and demographic factors, i.e. age, gender, place of residence.

One thesis is currently carried out on this subject whose objective is to design a knowledge discovery system working on multidimensional and sequential data for characterizing Patient Care Trajectories (PCT) [52], [62]. This thesis combines knowledge discovery and knowledge representation methods for improving the definition of patient care trajectories as temporal objects (sequential data mining). The overall objective is to improve decision support and healthcare in detecting for example typical or exceptional trajectories for planning with precision healthcare for a given population.

In parallel, Formal Concept Analysis techniques were used in conjunction with regression tree analysis to produce semi-automated classification of PCTs in the field of breast cancer in France [27].

8.2.2. *Other National Initiatives and Collaborations*

8.2.2.1. *PEPS Cryo-CA*

Participant: David Ritchie [Inria Nancy].

Cryo-CA is a two-year PEPS project (“Projets exploratoires pluridisciplinaires”) funded by CNRS, involving a collaboration with cryo-electron microscopy experimentalists at the IGBMC (“Institut de Génétique et de Biologie Moléculaire et Cellulaire”) in Strasbourg. People involved in the project with David Ritchie are Sergei Grudinin (Inria Grenoble), Annick Dejaegere (IGBMC, Strasbourg), and Patrick Schultz (IGBMC Strasbourg). The aim of the project is to encourage collaborations between experimentalists and computer scientists in order to advance the state of the art of computational algorithms in structural biology.

8.2.2.2. *Towards the discovery of new nonribosomal peptides and synthetases*

We have initiated a collaboration with researchers from the LIFL and Université Lille Nord de France. We collaborated on the NRPS toolbox [109]. Data was cleaned and integrated from various public and specific analysis programs. The resulting database should facilitate the process of knowledge discovery of new nonribosomal peptides and synthetases.

8.3. Regional Initiatives

8.3.1. *Le Bois Santé (LBS)*

Participants: Emmanuel Bresso, Marie-Dominique Devignes [contact person], Malika Smaïl-Tabbone.

The project "LBS – Le Bois Santé – #38017" is funded by the European Regional Development Fund (FEDER) and the French "Fonds Unique Interministériel (FUI)" in the framework of the BioProLor consortium. This project is coordinated by "Harmonic Pharma", a start-up specialized in the identification of active principles in natural products. The aim of LBS is to exploit wood products in the pharmaceutical and nutriment domains. Concerned people in the team are working on data management and knowledge discovery about new therapeutic applications.

The BioProLor consortium is composed of 5 enterprises and 7 academic research teams, which were funded for 3 years (2010–2013) by AME ("Agence pour la Mobilisation Economique") for the design of compounds with high added-value which originate from plants in Lorraine. Finally, it should be noticed that the PhD Thesis work of Emmanuel Bresso was taken in charge by Harmonic Pharma (CIFRE contract, 2009-2013).

8.3.2. *PEPS Mirabelle EXPLOD-Biomed*

Participants: Adrien Coulet, Marie-Dominique Devignes [contact person], Gabin Personeni, Malika Smaïl-Tabbone.

This project initiates a collaboration with geneticists from the Hospital of Nancy, namely Philippe Jonveaux and Céline Bonnet. The aim of the EXPLOD-Biomed project is to propose novel knowledge discovery methods applied to Linked Open Data for discovering gene that could be responsible for intellectual deficiencies. Linked Open Data are available on-line, interconnected and encoded in a format which can be straightforwardly mapped to ontologies. Thus they offer novel opportunities for knowledge discovery in biomedical data. Here, geneticists are playing the role of experts, guiding the different steps of the knowledge discovery process.

8.3.3. *Hydreos*

Participant: Jean-François Mari [contact person].

The research project Hydreos (<http://www.hydreos.fr/fr>) is aimed at evaluating the quality of water. Actually, water resources relies on many agronomic variables, including land use successions. Accordingly, one objective of this research project is to have a better understanding of the changes in the organization of a territory. The data to be analyzed are obtained by surveys or by satellite images and describe the land use at the level of the agricultural parcel. Then there is a search for detecting changes in land use and for correlating these changes to groundwater quality.

The systems ARPEntAge (see § 5.2.2) and CarottAge (see § 5.2.1) are used in this context, especially by agronomists of INRA (ASTER Mirecourt <http://www6.nancy.inra.fr/sad-aster> and UMR Costel Rennes <http://www.univ-rennes2.fr/costel>). In addition, we participated in various meetings of researchers involved in the study of quality of groundwater in Alsace-Lorraine.

This year, our research work focused on collecting and preprocessing satellite data sampled in a territory in Brittany where there is an important phytoplanktonic biomass and *Ulva* species mass proliferation risk.

8.3.4. *Contrat Plan État Région*” (CPER)

The links between the Regional Administration and LORIA are materialized through the so-called “Contrat Plan État Région” (CPER) which is running from 2007 to 2013. The associated scientific program is called “Modélisations, informations et systèmes numériques” (MISN) and includes two tracks in which the Orpailleur team is involved.

- “Modeling Bio-molecules and their Interactions” (MBI).

The general objective of this project is to study how domain knowledge can be taken into account for improving the modeling of biomolecules and their interactions, and the modeling of biological systems (<http://bioinfo.loria.fr>). Six scientific projects are currently under development and involve collaborations with computer scientists and people working either in biology or chemistry. This project is coordinated by Marie-Dominique Devignes.

- An Inria experimental research platform is currently developed in the framework of MBI (<http://bioinfo.loria.fr/Plateforme%20MBI>), which is aimed at sharing data and computing resources. The specific features of this platform are relative to biomolecules modeling, to classification and to data integration for data mining. The platform is a constituent of the North-East node of RENABI –“Réseau National des Plateformes Bioinformatiques”– together with the platforms in Strasbourg, Reims, Lille, and Nancy-INIST.
- “Traitement Automatique des Langues et des Connaissances” (TALC).

TALC stands for “Automatic Processing of Languages and Knowledge”. The general objective of TALC is to study the relations existing between knowledge discovery, knowledge representation, reasoning, and natural language processing. In the framework of TALC, the Orpailleur team plays an important role as the research themes of the team are closely related to those of TALC. Actually, research projects are currently under development on knowledge management and decision support involving in particular the Kasimir and the Taaable systems.

PANAMA Project-Team

8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. OSEO: QUAERO CTC and Corpus Projects

Participants: Frédéric Bimbot, Laurence Catanese, Gabriel Sargent.

Main academic partners : IRCAM, IRIT, LIMSI, Telecom ParisTech

Duration: 2008 -december 2013

Research axis: 3.3

Description: Quaero is a European research and development program with the goal of developing multimedia and multilingual indexing and management tools for professional and general public applications (such as search engines).

Partners: Other companies involved in the consortium are: France Télécom, Exalead, Bertin Technologies, Jouve, Grass Valley GmbH, Vecsys, LTU Technologies, Siemens A.G. and Synapse Développement. Many public research institutes are also involved, including LIMSI-CNRS, Inria, IRCAM, RWTH Aachen, University of Karlsruhe, IRIT, Clips/Imag, Telecom ParisTech, INRA, as well as other public organisations such as INA, BNF, LIPN and DGA.

Funding: This program is supported by OSEO.

Coordinator: The consortium is led by Technicolor.

Contribution of PANAMA:

PANAMA is involved in two technological domains : audio processing and music information retrieval (WP6). The research activities (CTC project) are focused on improving audio and music analysis, segmentation and description algorithms in terms of efficiency, robustness and scalability. Some effort is also dedicated on corpus design, collection and annotation (Corpus Project).

PANAMA also takes part to research and corpus activities in multimodal processing (WP10), in close collaboration with the TEXMEX project-team.

8.1.2. OSEO-FUI: S-POD: “Assistance à personnes en danger potentiel”

Participants: Frédéric Bimbot, Romain Lebarbenchon.

Duration: August 2012-November 2016

Research axis: 3.2

Partners: ERYMA, CAPT/FOTON, CASSIDIAN, KAPTALIA, KERLINK, le LOUSTIC and Telecom Bretagne

Coordinator: ERYMA

Description: S-POD gathers research teams and industrial partners to that aim at setting up a framework to process and fuse audio, physiological and contextual data. The goal is to design an embedded autonomous system able to detect situations of potential danger arising in the immediate environment of a person (military, police, CIT, fire, etc.)

Contribution of PANAMA: PANAMA is in charge of R&I activities related to the qualitative and quantitative analysis of information from the acoustic environment (intensity, direction of arrival, nature of noise sounds, properties of voices, etc.) as well as to the exploitation of these analyses. The need for real-time embedded processing induces specific constraints.

8.1.3. Action de Développement Technologique: FASST

Participants: Nancy Bertin, Frédéric Bimbot, Jules Espiau de Lamaestre, Nathan Souviraà-Labastie.

Duration: 2 years (2012–2014).

Research axis: 3.2.2

Partners: Inria Teams Parole (Nancy) and Texmex (Rennes)

Description: This Inria ADT aims to develop a new version of our FASST audio source separation toolbox in order to facilitate its large-scale dissemination in the source separation community and in the various application communities. A specific effort will be made towards the speech processing community by developing an interface with existing speech recognition software. A beta version was internally released and tested from July 2013. The first public release is planned for January 2014.

8.2. European Initiatives

8.2.1. ERC-StG: PLEASE (Projections, Learning, and Sparsity for Efficient Data Processing)

Participants: Rémi Gribonval, Srdan Kitic, Pierre Machart, Cagdas Bilen, Luc Le Magoarou, Nancy Bertin.

Duration: January 2012 - December 2016

Research axis: 3.1

Principal investigator: Rémi Gribonval

Program: ERC Starting Grant

Project acronym: PLEASE

Project title: Projections, Learning and Sparsity for Efficient data processing

Abstract: The Please ERC is focused on the extension of the sparse representation paradigm towards that of *sparse modeling*, with the challenge of establishing, strengthening and clarifying connections between sparse representations and machine learning

Web site: <https://team.inria.fr/panama/projects/please/>

8.2.2. Eureka-Eurostars: i3DMusic

Participant: Laurent Simon.

Duration: October 2010 - September 2013

Research axis: 3.2.2

Partners: Audionamix (FR), Sonic Emotion (CH), École Polytechnique Fédérale de Lausanne (CH), PANAMA (FR)

Program: Eureka - Eurostars

Project acronym: i3DMusic

Project title: Real-time Interactive 3D Rendering of Musical Recordings

Abstract: The i3DMusic project (Real-time Interactive 3D Rendering of Musical Recordings) has been setup with the SMEs Audionamix and Sonic Emotion and the academic partner EPFL to provide a system enabling real-time interactive respatialization of mono or stereo music content. This will be achieved through the combination of source separation and 3D audio rendering techniques. Metiss is responsible for the source separation work package, more precisely for designing scalable online source separation algorithms and estimating advanced spatial parameters from the available mixture.

8.3. International Research Visitors

8.3.1. Visits of International Scientists

- Mike Davies, from May until July, Professor of Signal and Image Processing, University of Edinburgh
- Anders Hansen, from April until April, Research Fellow Royal Society, Center for Mathematical Sciences, University of Cambridge
- Dan Stowell, from March until March, Postdoctoral research assistant, Center for Digital Music, Queen Mary University of London
- Bob Sturm, from March until March, Assistant Professor, Aalborg University Copenhagen
- Boris Mailhé, from March until March, Postdoctoral research assistant, Center for Digital Music, Queen Mary University of London
- Simon Foucart, from March until March, Assistant Professor, Drexel University

8.3.2. Internships

- Anwaya Aras, from July until December, Third year undergraduate, Department of Computer Science BITS-Pilani, India.
- Emmanuel Deruty, from April to September, PhD Preparatory year, Musicology Department, Catholic University Louvain, Belgium

PAROLE Project-Team

8. Partnerships and Cooperations

8.1. National initiatives

8.1.1. Equipex ORTOLANG

Project acronym: ORTOLANG ³

Project title: Open Resources and TOols for LANGuage

Duration: September 2012 - May 2016 (phase I, signed in January 2013)

Coordinator: ATILF (Nancy)

Other partners: LPL (Aix en Provence), LORIA (Nancy), Modyco (Paris), LLL (Orléans), INIST (Nancy)

Abstract: The aim of ORTOLANG (Open Resources and TOols for LANGuage) is to propose a network infrastructure offering a repository of language data (corpora, lexicons, dictionaries, etc) and tools and their treatment that are readily available and well-documented which will:

- enable a real mutualization of analysis research, of modeling and automatic treatment of our language bringing us up to the best international level;
- facilitate the use and transfer of resources and tools set up within public laboratories towards industrial partners, in particular towards SME which cannot often develop such resources and tools for language treatment due to the costs of their realization;
- promote the French language and local languages of France by sharing knowledge which has been acquired by public laboratories.

Several teams of the LORIA laboratory contribute to this Equipex, mainly with respect to providing tools for speech and language processing, such as text-speech alignment, speech visualization, syntactic parsing and annotation, ...

8.1.2. ANR ARTIS

Project acronym: ARTIS

Project title: Inversion articulatoire de la parole audiovisuelle pour la parole augmentée

Duration: January 2009 - June 2013

Coordinator: Yves Laprie (LORIA)

Other partners: Gipsa-Lab, LTCI, IRIT

Abstract: The main objective of ARTIS is to recover the temporal evolution of the vocal tract shape from the acoustic signal.

This contract started in January 2009 in collaboration with LTCI (Paris), Gipsa-Lab (Grenoble) and IRIT (Toulouse). Its main purpose is the acoustic-to-articulatory inversion of speech signals. Unlike the European project ASPI the approach followed in our group will focus on the use of standard spectra input data, i.e. cepstral vectors. The objective of the project is to develop a demonstrator enabling inversion of speech signals in the domain of second language learning.

³<http://www.ortolang.fr>

This year the work has focused on the development of the inversion from cepstral data as input. We particularly worked on the comparison of cepstral vectors calculated on natural speech and those obtained via the articulatory to acoustic mapping. Bilinear frequency warping was combined with affine adaptation of cepstral coefficients. These two adaptation strategies enable a very good recovery of vocal tract shapes from natural speech. The second topic studied is the access to the codebook. Two pruning strategies, a simple one using the spectral peak corresponding to F2 and a more elaborated one exploiting lax dynamic programming applied on spectral peaks enable a very efficient access to the articulatory codebook used for inversion.

This year, the project focused on the articulatory synthesis in order to generate better sequences of consonant/vowel/consonant by developing time patterns coordinating source and vocal tract dynamics.

8.1.3. ANR ViSAC

Project acronym: VISAC

Project title: Acoustic-Visual Speech Synthesis by Bimodal Unit Concatenation

Duration: January 2009 - June 2013

Coordinator: Slim Ouni

Other partners: Magrit EPI (Inria)

Abstract: The main VISAC objective is to realize the bimodal (audio plus visual) synthesis of speech.

This contract started in January 2009 in collaboration with Magrit Inria team. The purpose of this project is to develop synthesis techniques where speech is considered as a bimodal signal with its acoustic and visual components that are considered simultaneously. This is done by concatenating bimodal diphone units, that is, units that comprise both acoustic and visual information. The latter is acquired using a stereovision technique. The proposed method addresses the problems of asynchrony and incoherence inherent in classic approaches to audiovisual synthesis. Unit selection is based on classic target and join costs from acoustic-only synthesis, which are augmented with a visual join cost. This final year of the project, we have performed an extensive evaluation of the synthesis system using perceptual and subjective evaluations. The overall outcome of the evaluation indicates that the proposed bimodal acoustic-visual synthesis technique provides intelligible speech in both acoustic and visual channels [22].

8.1.4. ANR ORFEO

Project acronym: ORFEO ⁴

Project title: Outils et Ressources pour le Français Ecrit et Oral

Duration: February 2013 - February 2016

Coordinator: Jeanne-Marie DEBAISIEUX (Université Paris 3)

Other partners: ATILF, CLLE-ERSS, ICAR, LIF, LORIA, LATTICE, MoDyCo

Abstract: The main ORFEO objective is the constitution of a Corpus for the Study of Contemporary French.

In this project, we have provided an automatic alignment at the word and phoneme levels for audio files from the corpus TCOF (Traitement de Corpus Oraux en Français). This corpus contains mainly spontaneous speech, recorded under various conditions with a large SNR range and a lot of overlapping speech. We tested different acoustic models and different adaptation methods for the forced alignment.

⁴[http://www.agence-nationale-recherche.fr/en/anr-funded-project/?tx_lwmsuivibilan_pi2\[CODE\]=ANR-12-CORP-0005](http://www.agence-nationale-recherche.fr/en/anr-funded-project/?tx_lwmsuivibilan_pi2[CODE]=ANR-12-CORP-0005)

8.1.5. ANR-DFG IFCASL

Project acronym: IFCASL

Project title: Individualized feedback in computer-assisted spoken language learning

Duration: March 2013 - February 2016

Coordinator: Jürgen Trouvain (Saarland University)

Other partners: Saarland University (COLI department)

Abstract: The main objective of IFCASL is to investigate learning of oral French by German speakers, and oral German by French speakers at the phonetic level.

The work has mainly focused on the design of a corpus of French sentences and text that will be recorded by German speakers learning French, recoding a corpus of German sentences read by French speakers, and tools for annotating French and German corpora. Beforehand, two preliminary small corpora have been designed and recorded in order to bring to the fore the most interesting phonetic issues to be investigated in the project. In addition this preliminary work was used to test the recording devices so as to guarantee the same quality of recording in Saarbrücken and in Nancy, and to design and develop recording software.

In this project, we also provided an automatic alignment procedure at the word and phoneme levels for 4 corpora: French sentences uttered by French speakers, French sentences uttered by German speakers, German sentences uttered by French speakers, German sentences uttered by German speakers.

8.1.6. ANR ContNomina

Project acronym: ContNomina

Project title: Exploitation of context for proper names recognition in the diachronic audio documents

Duration: February 2013 - July 2016

Coordinator: Irina Illina (Loria)

Other partners: LIA, Synalp

Abstract: the project ContNomina focuses on the problem of proper names in automatic audio processing systems by exploiting in the most efficient way the context of the processed documents. To do this, the project will address:

- the statistical modeling of contexts and of relationships between contexts and proper names;
- the contextualization of the recognition module through the dynamic adjustment of the lexicon and of the language model in order to make them more accurate and certainly more relevant in terms of lexical coverage, particularly with respect to proper names;
- the detection of proper names, on the one hand, in text documents for building lists of proper names, and on the other hand, in the output of the recognition system to identify spoken proper names in the audio / video data.

8.1.7. FUI RAPSODIE

Project acronym: RAPSODIE ⁵

Project title: Automatic Speech Recognition for Hard of Hearing or Handicapped People

Duration: March 2012 - February 2016 (signed in December 2012)

Coordinator: eRocca (Mieussy, Haute-Savoie)

Other partners: CEA (Grenoble), Inria (Nancy), CASTORAMA (France)

Abstract: The goal of the project is to realize a portable device that will help a hard of hearing person to communicate with other people. To achieve this goal the portable device will embed a speech recognition system, adapted to this task. Another application of the device will be environment vocal control for handicapped persons.

⁵<http://erocca.com/rapsodie>

In this project, the parole team is involved for optimizing the speech recognition models for the envisaged task, and contributes also to finding the best way of presenting the speech recognition results in order to maximize the communication efficiency between the hard of hearing person and the speaking person.

8.1.8. ADT FASST

The Action de Développement Technologique Inria (ADT) FASST (2012–2014) is conducted by PAROLE in collaboration with the teams PANAMA and TEXMEX of Inria Rennes. It aims to reimplemented into efficient C++ code the Flexible Audio Source Separation Toolbox (FASST) originally developed in Matlab by A. Ozerov, E. Vincent and F. Bimbot in the METISS team of Inria Rennes. This will enable the application of FASST on larger data sets, and its use by a larger audience. The new C++ version will be released early 2014. The second year of the project will be devoted to the integration of FASST with speech recognition software in order to perform noise robust speech recognition.

8.1.9. ADT VisArtico

The technological Development Action (ADT) Inria Visartico just started this November (11/2013 - 10/2015). The purpose of this project is to develop and improve VisArtico, an articulatory visualization software. In addition to improve the basic functionalities, several articulatory analysis and processing will be integrated. We will also work on the integration of multimodal data.

8.2. European initiatives

8.2.1. Collaborations in European Programs, except FP7

8.2.1.1. Interreg Allegro

Program: Interreg

Project acronym: Allegro

Project title: Adaptive Language LEarning technology for the Greater Region

Duration: 01/01/2009 to 31/12/2012

Coordinator: Saarland University

Other partners: Supélec Metz and DFK Kaiserslautern

Abstract: Allegro is an Interreg project (in cooperation with the Department of Computational Linguistics and Phonetics of the Saarland University and Supélec Metz) which started in April 2010. It is intended to develop software for foreign language learning. Our contribution consists of developing tools to help learners to master the prosody of a foreign language, i.e. the prosody of English by French learners, and then prosody of French by German learners. We started by recording (with the project Intonale) and segmenting of a corpus made up of English sentences uttered by French speakers and we analyzed specific problems encountered by French speakers when speaking English. The corrections were implemented in Jsnoori. The final review was held on May 15 in Saarbrücken.

8.2.1.2. Eureka - Eurostars i3DMusic

Besides the above contracts of which PAROLE is officially part, E. Vincent is responsible for his former team (PANAMA) of the following project.

Program: Eureka - Eurostars

Project acronym: i3DMusic

Project title: Real-time Interactive 3D Rendering of Musical Recordings

Duration: 01/10/2010 to 31/03/2014

Coordinator: Audionamix (FR)

Other partners: EPFL (CH), Sonic Emotion (CH)

Abstract: The i3DMusic project aims to enable real-time interactive respatialization of mono or stereo music content. This will be achieved through the combination of source separation and 3D audio rendering techniques. PANAMA is responsible for the source separation work package, more precisely for designing scalable online source separation algorithms and estimating advanced spatial parameters from the available mixture.

8.3. International initiatives

8.3.1. Declared Inria international partners

E. Vincent is involved as an associate member in the national Japanese JSPS Grant-in-Aid for Scientific Research project on distributed microphone arrays led by Nobutaka Ono from the National Institute of Informatics together with other partners from the University of Tsukuba and Tokyo Institute of Technology.

8.4. International research visitors

8.4.1. Visits of international scientists

- Mouhcin, Chami, INPT, Maroco, June,
- Karima Meftouh, Annaba University, until October,
- Amar Djeradi, USTHB, July, Algeria

PERCEPTION Team

7. Partnerships and Cooperations

7.1. European Initiatives

7.1.1. FP7 Projects

7.1.1.1. HUMAVIPS

Title: Humanoids with audiovisual skills in populated spaces

Type: COOPERATION (ICT)

Defi: Cognitive Systems and Robotics

Instrument: Specific Targeted Research Project (STREP)

Duration: February 2010 - January 2013

Coordinator: Inria (France)

Others partners: CTU Prague (Czech Republic), University of Bielefeld (Germany), IDIAP (Switzerland), Aldebaran Robotics (France)

See also: <http://humavips.inrialpes.fr>

Abstract: Humanoids expected to collaborate with people should be able to interact with them in the most natural way. This involves significant perceptual and interactive skills, operating in a coordinated fashion. Consider a social gathering scenario where a humanoid is expected to possess certain social skills. It should be able to analyze a populated space, to localize people, and to determine whether they are looking at the robot and are speaking to it. Humans appear to solve these tasks routinely by integrating the often complementary information provided by multi-sensory data processing, from 3D object positioning and sound-source localization to gesture recognition. Understanding the world from unrestricted sensorial data, recognizing people's intentions and behaving like them are extremely challenging problems. The objective of HUMAVIPS has been to endow humanoid robots with audiovisual (AV) abilities: exploration, recognition, and interaction, such that they exhibit adequate behavior when dealing with a group of people. Developed research and technological developments have emphasized the role played by multimodal perception within principled models of human-robot interaction and of humanoid behavior. An adequate architecture has implemented auditory and visual skills onto a fully programmable humanoid robot (the consumer robot NAO). A free and open-source software platform has been developed to foster dissemination and to ensure exploitation of the outcomes of HUMAVIPS beyond its lifetime.

7.2. International Initiatives

7.2.1. Inria International Partners

7.2.1.1. Declared Inria International Partners

- Bielefeld University (Germany),
- The Czech Technical University of Prague (Czech Republic),
- IDIAP Institute (Switzerland),
- Aldebaran Robotics (France).
- University of Patras (Greece).

7.2.1.2. Informal International Partners

- The Technion (Israel Institute of Technology),

- Bar Ilan University.

7.3. International Research Visitors

7.3.1. Visits of International Scientists

- Professor Sharon Gannot (Bar Ilan University),
- Professor Yoav Schechner (The Technion),
- Professor Michael Bronstein (University of Lugano),
- Professor Vasek Hlavac (Czech Technical University),
- Professor Geoff McLachlan (University of Queensland, Australia),
- Professor Josep Ramon Casas, (Technical University of Catalonia).

7.3.1.1. Internships

- Dionyssos Kounades-Bastien, University of Patras (Master student),
- Israel Dejene-Gebru, University of Trento (Master student).

POTIOC Team

7. Partnerships and Cooperations

7.1. Regional Initiatives

Potioc has strong relationships with **Cap Sciences**.

7.2. National Initiatives

FUI SIMCA 2000:

- duration: 2011-2013
- partners: Oktal, ENAC (Ecole Nationale de l'Aviation Civile), Toulouse-Blagnac airport, Air France, CGx AERO in SYS
- website: <https://team.inria.fr/potioc/fr/collaborative-projects/simca/>

PIA ville numérique "Villes transparentes":

- duration: 2012-2014
- partners: Pages Jaunes/Mappy, Vectuel/Virtuelcity

Inria ADT OpenViBE-NT:

- duration: 2012-2014
- partners: Inria teams Hybrid, Neurosys and Athena
- website: <http://openvibe.inria.fr>

Inria Project Lab BCI-LIFT:

- partners: Inria team Athena (Inria Sophia-Antipolis), Inria team Hybrid (Inria Rennes), Inria team Neurosys (Inria Nancy), LITIS (Université de Rouen), Inria team DEMAR (Inria Sophia-Antipolis), Inria team MINT (Inria Lille), DyCOG (INSERM Lyon)
- Project around BCI in the evaluation process, with collaboration just starting (first meeting with all the partners in October 2013)

7.3. European Initiatives

7.3.1. Collaborations with Major European Organizations

Collaboration with the University of Bristol, BIG (UK):

- University of Bristol, Bristol Interaction and Graphics (BIG) group, UK (Head: Pr. Sriram Subramanian)
- We have strong relationships with Sriram Subramanian. This has led to joint paper publications, numerous visits and a co-supervision of a PhD thesis (Camille Jeunet)

Bordeaux Idex project "Conception de Système d'interfaces cerveau-ordinateur prenant en compte les facteurs humains afin d'optimiser l'apprentissage de l'utilisateur:

- Bordeaux Idex funding for international PhD project
- partners: Bordeaux Segalen University (Handicap & Système nerveux team), Bristol University (BIG team)
- duration: October 2013 - September 2016

LIRA Stress and Relaxation project:

- Program: Inria - Philips - Fraunhofer partnership
- Project title: Life-style Research Association, Lifestyle Management: Stress and Relaxation
- Coordinator: Frederic Alexandre
- Other partners: Philips (Netherlands), Fraunhofer (Germany), Inria teams Hybrid and Mimetic
- Abstract: The Stress and Relaxation project aims at offering services to a user, at home or at work, to help this user evaluate and control his level of stress

7.4. International Initiatives

7.4.1. Inria International Partners

7.4.1.1. Informal International Partners

- Pr. Gerwin Schalk (Schalk Lab, Wadsworth center, NY, USA), Pr. Jonathan Brumberg (Kansas University, USA), Dr. Cuntai Guan (I2R, Singapore).
- Collaboration in the context of a project around the analysis of ElectroCorticoGraphic (ECoG) brain signals in order to decode speech related information from them.
- Multidisciplinary project involving experts from ECoG signals (Gerwin Schalk), speech neuroscience (Jonathan Brumberg) and speech recognition (Cuntai Guan)

7.5. International Research Visitors

7.5.1. Internships

This year, the Potioc team has hosted three PhD students

- Nicoletta Caramia, University de Pavia, Italy (Avril-July 2013)
- Asier Marzo, Universidad Pública de Navarra, Spain (August-November 2013)
- Flavio Bertini, University of Bologna, Italy (December 2013-February 2014)

Prima Project-Team

7. Partnerships and Cooperations

7.1. National Initiatives

7.1.1. *EquipEx AmiQual4Home - Ambient Intelligence for Quality of Life*

Participants: Stan Borkowski, Sabine Coquillart, Joëlle Coutaz, James Crowley [correspondant], Alexandre Demeure, Thierry Fraichard, Amaury Nègre, Patrick Reignier, Dominique Vaufreydaz, Nicolas Bonnefond, Rémi Pincent, Mayeul de Werbier d Antigneul, Rémi Barraquand, David Lombard.

Ambient Intelligence, Equipment d'Excellence, Investissement d'Avenir

The AmiQual4Home Innovation Factory is an open research facility for innovation and experimentation with human-centered services based on the use of large-scale deployment of interconnected digital devices capable of perception, action, interaction and communication. The Innovation Factory is composed of a collection of workshops for rapid creation of prototypes, surrounded by a collection of living labs and supported by a industrial innovation and transfer service. Creation of the Innovation Factory has been made possible by a 2.140 Million Euro grant from French National programme "Investissement d'avenir", together with substantial contributions of resources by Grenoble INP, Univ Joseph Fourier, UPMF, CNRS, Schneider Electric and the Commune of Montbonnot. The objective is to provide the academic and industrial communities with an open platform to enable research on design, integration and evaluation of systems and services for smart habitats.

The AmiQual4Home Innovation Factory is a unique combination of three different innovation instruments: (1) Workshops for rapid prototyping of devices that embed perception, action, interaction and communication in ordinary objects based on the MIT FabLab model, (2) Facilities for real-world test and evaluation of devices and services organised as open Living Labs, (3) Resources for assisting students, researchers, entrepreneurs and industrial partners in creating new economic activities. The proposed research facility will enable scientific research on these problems while also enabling design and evaluation of new forms of products and services with local industry.

The core of the AmiQual4Home Innovation Factory is a Creativity Lab composed of a collection of five workshops for the rapid prototyping of devices that integrate perception, action, interaction and communications into ordinary objects. The Creativity Lab is surrounded by a collection of six Living Labs for experimentation and evaluation in real world conditions. The combination of fabrication facilities and living labs will enable students, researchers, engineers, and entrepreneurs to experiment in co-creation and evaluation. The AmiQual4Home Innovation Factory will also include an innovation and transfer service to enable students, researchers and local entrepreneurs to create and grow new commercial activities based on the confluence of digital technologies with ordinary objects. The AmiQual4Home Innovation Factory will also provide an infrastructure for participation in education, innovation and research activities of the European Institute of Technology (EIT) KIC ICTLabs.

The AmiQual4Home Innovation Factory will enable a unique new form of coordinated ICT-SHS research that is not currently possible in France, by bringing together expertise from ICT and SHS to better understand human and social behaviour and to develop and evaluate novel systems and services for societal challenges. The confrontation of solutions from these different disciplines in a set of application domains (energy, comfort, cost of living, mobility, well-being) is expected to lead to the emergence of a common, generic foundation for Ambient Intelligence that can then be applied to other domains and locations. The initial multidisciplinary consortium will progressively develop interdisciplinary expertise with new concepts, theories, tools and methods for Ambient Intelligence.

The potential impact of such a technology, commonly referred to as "Ambient Intelligence", has been documented by the working groups of the French Ministry of Research (MESR) [35] as well as the SNRI (Stratégie Nationale de la Recherche et de l'Innovation).

In 2013 our efforts were focused on specifying the requirements for major components of the project, and on finalising contractual issues with ANR. We defined the layout and arrangement of the Creativity Lab workshops, we started the specification of the instrumentation needed for the Living Labs, and developed a first version of a set of easy-deployable wireless sensors for infield data acquisition, that we call the Rapid Deployment Minikit. A set of CNC machines was purchased, including a Fused Filament Fabrication 3D printer, a CO2 Laser cutter and engraver, and a CNC mill.

Following the kickoff meeting of the project held in October 2013, we received positive feedback and interest from local industry and research institutions, and several national project proposals submitted in 2013 identified AmiQual4Home as an important resource.

7.1.2. FUI PRAMAD

Participants: Claudine Combe, Lucas Nacsá, Maxime Portaz, Amaury Nègre, Dominique Vaufreydaz [correspondant].

Pramad is a collaborative project about *Plateforme Robotique d'Assistance et de Maintien à Domicile*. There are seven partners:

- R&D/industry: Orange Labs (project leader) and Covéa Tech (insurance company),
- Small companies: Interaction games (game designer, note that Wizardbox, the original partner was bought by Interaction games) and Robosoft (robot).
- Academic labs: Inria/PRIMA, ISIR (Paris VI) and Hôpital Broca (Paris).

The objectives of this project are to design and evaluate robot companion technologies to maintain frail people at home. Working with its partners, PRIMA research topics are:

- social interaction,
- robotic assistance,
- serious game for frailty evaluation and cognitive stimulation.

7.1.3. Inria Project-Teams PAL

Participants: Rémi Barraquand, Thierry Fraichard, Patrick Reignier, Amaury Nègre, Dominique Vaufreydaz [correspondant].

The 12 Inria Project-Teams (IPT) participating in a Large-scale initiative action Personally Assisted Living (PAL <http://pal.inria.fr>) propose to work together to develop technologies and services to improve the autonomy and quality of life for elderly and fragile persons. The goal of this program is to unite these groups around an experimental infrastructure, designed to enable collaborative experimentations.

PAL is organized around 12 IPT:

Demar, E-Motion, Flowers, Hephaistos, Lagadic, Lagadic-Sophia, Maia, Madynes, Phoenix, Prima, Stars and Reves.

The role of PRIMA within this project is to develop new algorithms mainly along two research axes:

- assessing frailty degree of the elderly,
- social interaction.

7.2. European Initiatives

7.2.1. Collaborations in European Programs, except FP7

7.2.1.1. CATRENE AppsGate

Participants: Jean-René Courtois, Rémy Dautriche, Alexandre Demeure [correspondant], Cédric Gérard, Camille Lenoir, Kouzma Petoukhov, Patrick Reignier.

AppsGate is a project about End User Development in the context of SmartHomes. There are seven partners:

- R&D/industry:
 - ST Microelectronics, NXP, PACE, Technicolor, ARD, Ripple Motion, 4MOD, HIERIA, VSN+UAB, SoftKinetic, Optrima, Vsonix, Evalan, Vestel, Turkcell, Immotronics.
- Academic labs:
 - Inria/PRIMA, Institut télécom.

The objectives of this project are to design and evaluate a new generation of set-top box, PRIMA is involved in designing End User Development tools dedicated for the Smart Home.

7.3. International Initiatives

7.3.1. Inria International Partners

7.3.1.1. Declared Inria International Partners

The Prima team participates in the project “Visually impaired people assistance using multimodal technologies”. The project leader is the Mica laboratory of Hanoi University of Science and Technology (HUST), the project is financed for three years, starting in July 2012, by the Flemish Interuniversity Council (VLIR UOS <http://www.vliruos.be/en>). The other partners are Danang University, Ghent University, and Imep-Lahc (Grenoble Inp). The overall objective of the project is to provide visually impaired children (in the Nguyen Dinh Chieu School in Hanoi) with helpful devices. The contact person in the Prima team is Augustin Lux. Prima contributed to the design and testing of a system for Visual Object Recognition.

Since the PERSPOS project (BQR Grenoble INP 2008-2009), the MICA center (UMI 2954 CNRS) and PRIMA has a long time collaboration on the concept of "large-scale" perceptive space. This space is an intelligent environment which will be deployed on a large surface containing several buildings (as a university campus for example). The user is wearing one or many mobile intelligent wireless devices (smartphone or wearable computer). By combining the concepts of large-scale perceptive environments and mobile computing, we can create intelligent spaces to propose services adapted to individuals and their activities, manage energy of building, etc. Our collaboration is focusing on user identification and localization within such a smart space. Tracking people in smart environments remains a challenging fundamental problem when tackling multiple users localization. Whether it is at the scale of a campus, of a building or more simply of a room, we can dynamically combine several localization levels (and several technologies) to allow a more accurate and reliable users localization system. In September 2013, a new co-supervised Ph.D. Thesis started on multiple users localization in large-scale perceptive spaces.

7.4. International Research Visitors

7.4.1. Internships

Participant: Carlos Di Pietro.

Subject: Design of a Robot Companion

Date: from March 2013 until August 2013

Institution: University of Buenos Aires (Argentina)

Participant: Muhamamd Amine Bouguerra.

Subject: Viability and Guaranteed Motion Safety

Date: from Sep. 2013 until Oct. 2013

Institution: University of Annaba (DZ)

Participant: Marceau Thalgott.

Subject: Bibliographical study of Brain Like Artificial Intelligence, Mini-Kit prototype development for a smart home.

Date: from February 2013 until August 2013

Institution: ENSIMAG

Participant: Adrien Czerny.

Subject: Software environment for life long learning and debugging of a cortical learning algorithm.

Date: from February 2013 until August 2013

Institution: ENSIMAG

Participant: Luiza Cicone.

Subject: Tools to support creative and design processes of interactive systems

Date: from March 2013 until August 2013

Institution: ENSIMAG

Participant: Simon Chalumeau.

Subject: Pico-Projector based Interaction

Date: from February 2013 until August 2013

Institution: Grenoble INP, UJF Grenoble

Participant: Maxime Portaz.

Subject: Supervised and unsupervised learning for intention recognition

Date: from March 2013 until August 2013

Institution: Université de Grenoble (Grenoble, France)

Participant: Martin Poirrier.

Subject: Robotics and Multimodal Sensor Fusion for detecting Human Social interaction

Date: from January 2013 until June 2013

Institution: Supinfo (Grenoble, France)

7.4.2. Visits to International Teams

Dominique Vaufreydaz, June 2013, MICA research center of Hanoi University of Science and Technology (HUST), in Hanoi Vietnam.

REVES Project-Team

7. Partnerships and Cooperations

7.1. National Initiatives

7.1.1. ANR ALTA

Participants: Emmanuelle Chapoulie, Stefan Popov, George Drettakis.

The ANR ALTA project started in October 2011, and focuses on the development of novel algorithms for realistic and efficient global illumination. The project is coordinated by the Grenoble Inria group ARTIS (N.Holzschuch), and the Bordeaux Inria group MANAO (X. Granier) is also a partner. Our participation is the study of error bounds for these algorithms and the development of interactive global illumination, and the development of the new global illumination algorithm described in Sec. 5.1.3 .

7.1.2. ANR DRAO

Participants: Emmanuel Iarussi, Adrien Bousseau.

<https://www-sop.inria.fr/members/Adrien.Bousseau/drao/>

The ANR DRAO is a young researcher project coordinated by Adrien Bousseau, in collaboration with the InSitu project team at Inria Saclay - Ile de France (W. Mackay and T. Tsandilas) and the MANAO project team (P. Barla and G. Guennebaud) and POTIOC project team (M. Hachet) at Inria Bordeaux - Sud Ouest. The goal of this collaboration is to develop novel drawing tools for amateurs as well as for expert designers and illustrators, combining expertise in Computer Graphics (REVES and MANAO) and Human-Computer Interaction (InSitu, POTIOC). This ANR project funds the PhD of Emmanuel Iarussi.

The first part of the project will be to observe how people draw with existing tools. To do so we will conduct observational studies where we will interview designers and illustrators and collect data by videotaping drawing sessions and by recording drawings with digital pens. In the second part of the project we will deduce from our observations new user interfaces and rendering algorithms that automate part of the drawing process and enrich 2D drawings with realistic rendering capabilities. We will combine computer vision and computer graphics techniques to estimate geometric information from sketches. We will then use this information to guide rendering algorithms that generate plausible depictions of material and lighting over the drawing. In the third part of the project, we plan to develop computer-assisted drawing lessons to teach amateurs how to draw from photographs and 3D models. We will apply image analysis algorithms to estimate the structure of a photograph and use that structure as guidance for drawing. To summarize, the goal of the ANR DRAO project is to make amateurs more confident in their drawing skills and to allow expert designers to produce complex illustrations more effectively.

The ANR DRAO has resulted in two publications this year on assisting drawing from photographs [19] and vector drawing of stylized materials [14].

7.1.3. ANR SEMAPOLIS

Participant: George Drettakis.

This ANR project started in October 2013. The goal is to use semantic information to improve urban reconstruction and rendering. The consortium is led by ENPC (R. Marlet) and includes the Inria Willow team and the GREY-C laboratory on image processing. Our contribution will be in the rendering part.

7.2. European Initiatives

7.2.1. FP7 Projects

7.2.1.1. VERVE

Title: VERVE

Type: COOPERATION (ICT)

Defi: Services to promote E-inclusion using socially realistic virtual environments

Instrument: Integrated Project (IP)

Duration: October 2011 - September 2014

Coordinator: Trinity College - Dublin (Ireland)

Others partners: DFKI (Germany), CNRS-ParisTech (France), CNRS-IRCAM (France), U. of Zaragoza (Spain), Testaluna (IT), KAINOS (UK)

See also: <http://www.verveconsortium.eu/>

Abstract

Social exclusion has many causes, but major factors are the fear and apathy that often accompany a disability. The European e-Inclusion policy stresses the importance of ICT in improving the quality of life in potentially disadvantaged groups, including older people and persons with disabilities. In this project, we will develop ICT tools to support the treatment of people who are at risk of social exclusion due to fear and/or apathy associated with a disability. These tools will be in the form of personalised VR scenarios and serious games specifically designed for therapeutic targets and made broadly available via a novel integration of interactive 3D environments directly into Web browsers. We will perform cutting edge research into rendering and simulating personalised and populated VR environments, 3D web graphics, and serious games. These technical efforts will be underpinned by our clinical/laboratory and industry partners, who will be fully involved throughout in the requirements, design and evaluation of VERVE, and liaison with the stakeholders (i.e., participants, carers/family, and health professionals). They will implement the VERVE interventions in three use-cases, each targeting a different group of participants: fear of falling, apathy related to cognitive decline and behavioural disturbances, and other emotional disturbances linked to anxiety. While developing clinical assessment methods and interventions for the first two patient groups is our primary focus, our results will be applicable to a much wider range of potentially disadvantaged individuals.

For the second period (October 2012 - September 2013), the consortium continued the work on implementing and improving the different solutions for the three use-cases: fear, apathy and anxieties. Different technologies were developed:

- Kitchen, a serious game for apathy.
- Freezing of Gait, a serious game for fear.
- Fear of Falling, a serious game for fear.
- Crowd-Phobia, a virtual reality application for anxieties.
- Memory Motivation Virtual Experience (MeMoVE), virtual reality application for apathy.

In particular REVES was mainly involved in the second use-case with the MeMoVE scenario. During this second period, the IBR technique was ported to the Immersive Space on a single screen of the CAVE. Experiments with healthy adults were performed in collaboration with the hospital of Nice (CHUN). The results of these experiments will be published in IEEE VR2014.

7.2.1.2. CR-PLAY – Capture Reconstruct Play

Type: COOPERATION (ICT)

Instrument: Specific Targeted Research Project

Objectif: Creativity

Duration: November 2013 - October 2016

Coordinator: Testaluna SA (IT)

Partner: TU Darmstadt (DE), UC London (UK), U. Patras (GR), Miniclip UK, Cursor Oy (FI)

Inria contact: George Drettakis

Abstract: The goal of this project is to use image- and video-based rendering and relighting techniques in the context of games and in particular mobile or casual games. The computer graphics and vision partners (UCL, TUD) are leaders in their fields, and have developed algorithms allowing easy capture of scenes using images and video, and reconstruction using vision algorithms. UCL and Inria have developed image- and video-based rendering algorithms which can be useful for games. These tools need to be perfected, reducing artifacts and difficulty of use so that they can be useful and productive for games companies. For evaluation, the HCI lab of the University of Patras will provide cutting-edge methodologies to make the resulting systems useable. The consortium is led by the games company Testaluna, based in Genova Italy, with whom we have a solid working relationship from our previous VERVE project (see above). Other industrial partners include Cursor Oy (a regional group of games companies in Finland, which is a leader in Europe in Casual games) and Miniclip, which is one of the major players in the online game market.

7.3. International Initiatives

7.3.1. Inria Associate Teams

- EA CRISP <http://www-sop.inria.fr/reves/crisp/>

The goal of the CRISP associate team between REVES and University of California (UC) Berkeley is to investigate novel ways to create, render and interact with images based on the study of human perception. This novel and emerging area has been the focus of ongoing collaborations between researchers from the REVES research group at Inria (Adrien Bousseau, George Drettakis) and researchers in Computer Science and Vision Science at UC Berkeley (Maneesh Agrawala, Ravi Ramamoorthi, Martin S. Banks (Human Vision Science)). All of the researchers involved in CRISP share a common interest in creating and manipulating effective synthetic imagery. To achieve this goal we focus on understanding how people perceive complex material, lighting and shape, on developing new rendering algorithms based on this understanding, and on building interactive tools that enable users to efficiently specify the kind of image they wish to create. More specifically, we explore the following research directions :

Perception: Images are generated from the interaction of lighting, material, and geometry. We evaluate how people perceive material, lighting, and geometry in realistic images such as photographs, and non realistic images such as drawings and paintings. This knowledge of human perception is essential for developing efficient rendering algorithms and interaction tools that focus on the most important perceptual features of an image.

Rendering: We develop rendering algorithms that generate images that are plausible with respect to the user's intent and allocate resources on the visual effects that best contribute to perception.

Interaction: We facilitate the creation of material, lighting, and geometric effects in synthetic images by developing novel user interfaces for novice and professional users.

Our contributions have the potential to benefit different applications of image creation such as illustration (archeology, architecture, education); entertainment (video games, movies) and design

(sketching, photograph editing). This research naturally falls in Inria's strategic objective of interacting with real and virtual worlds.

The CRISP collaboration has resulted in three publications this year in ACM Transactions on Graphics, two being in the SIGGRAPH proceeding. These publications explore the perception of materials in stylized images [11], the perception of distortions in image-based rendering [18] and vector drawing tools for depicting stylized materials [14]. Ongoing projects include those described in Sec. 5.3.9 and Sec. 5.1.3 .

7.3.2. Informal International Partners

7.3.2.1. France-USA

Participants: Gaurav Chaurasia, Adrien Bousseau, George Drettakis.

Beyond CRISP, we have an ongoing collaboration with Yale University (Holly Rushmeier and Julie Dorsey), on weathering, and we are continuing this collaboration on stone aging.

We also have an ongoing collaboration with Adobe Research (Sylvain Paris) and MIT (Fredo Durand) on parallel image-processing languages and global illumination (Fredo Durand).

7.3.2.2. France-Germany

Participant: George Drettakis.

We collaborate with the Max-Planck-Institut, Germany, where P. Vangorp (previously at REVES) is now a PostDoc. We collaborate on perception techniques for rendering see publication [18].

7.3.2.3. France-Canada

Participant: Adrien Bousseau.

We collaborate with K. Singh (University of Toronto) and Alla Scheffer (U. British Columbia, Vancouver), on sketching techniques for designers (see Sec. 5.3.10).

7.3.2.4. France-Greece

Participant: George Drettakis.

As mentioned in Sec. 5.2.3 we are collaborating with the Technical University of Crete on visual attention, in the context. of the Ph.D. of George Koulieris, supervised by Prof. Katerina Mania and the Un. of Cottburg (D. Cunningham).

7.4. International Research Visitors

7.4.1. Visits of International Scientists

7.4.1.1. Visitors

We hosted several researchers this year:

- George Koulieris (Tech. Univ. of Crete), in February.
- Eugene Fiume (Univ. of Toronto), in June.
- Peter Vangorp (MPI Informatik), in June.
- Wendy McKay, Theophanis Tsandilas and Lora Oehlberg (Insitu) in July.
- Floraine Berthouzoz (Berkeley), in April.
- Marty Banks (Berkeley), in September.
- Belen Masia (Zaragoza), in October.
- Pierre-Yves Laffont (Brown), in November.
- Holly Rushmeier (Yale), in November.
- Erik Reinhard (Technicolor), in November.

7.4.1.2. Internships

Participant: Joan Sol Roo.

Subject: Geometry Upsampling for Real-Time Rendering of Refractive Objects

Date: from May 2013 until Aug 2013

Institution: National University of the Center of the Buenos Aires Province (Argentina)

Participant: Arunim Samat.

Subject: Approximate Reflection Computation

Date: from Jul 2013 until Aug 2013

Institution: IIT Delhi (India)

Participant: Kritarth Anand.

Subject: Free-Viewpoint Image Based Rendering from Images With Dynamic Objects

Date: from May 2013 until Jul 2013

Institution: IIT Delhi (India)

SÉMAGRAMME Project-Team

7. Partnerships and Cooperations

7.1. Regional Initiatives

7.1.1. SLAM: Schizophrenia and Language, Analysis and Modeling

Participants: Maxime Amblard [coordinator], Philippe de Groote, Sylvain Pogodalla, Karën Fort.

Schizophrenia is well-known among mental illnesses for the strength of the thought disorders it involves, and for their widespread and spectacular manifestations: from deviant social behavior to delusion, not to speak about affective and sensitive distortions. It aims at exploring a specific manifestation, namely disorders in conversational speech. This is an interdisciplinary research, both empirical and theoretical from several domains, namely psychology, philosophy, linguistic and computer science.

The SLAMproject started from 2013 January for three years at the Maison des Sciences de l'Homme de Lorraine (MSH-Lorraine, USR 3261). While this year work was dedicated to the test protocol definition, the coming years will be devoted to building an open-access corpus of pathological uses of language.

This year, the first transcriptions of pathological interviews are analyses. The management chain was implemented for anonymization. Moreover, we use Distagger (Matthieu Constant and Anne Dister) to tag disfluencies in the interviews wich give interesting results. We also use Jsafran (Christophe Cerisara) and FRMG (Eric de la Clergerie) in order to have dependencies.

Other participants are: Denis Apotheloz (ATILF, Université de Lorraine), Valérie Aucouturier (Centre Léo Apostel, Université Libre de Bruxelles), Katarina Bartkova (ATILF, Université de Lorraine), Fethi Bretel (CHS Le Rouvray, Rouen), Michel Musiol (InterPSY, Université de Lorraine), Manuel Rebuschi (Archives Poincaré, Université de Lorraine).

The SLAMproject was supported by the MSH-Lorraine, USR 3261, and won a one year PEPS project HuMaIn (mission pour l'interdisciplinarité du CNRS). The CNRS part of the budget help to organize a workshop which gather linguists, psychologists and computer scientists in december : <http://webloria.loria.fr/~amblard/SLAM/index.php?n=Main.In-coh%E9rence13>

7.2. National Initiatives

7.2.1. ANR

7.2.1.1. Polymnie: Parsing and synthesis with abstract categorial grammars. From lexicon to discourse

Participants: Maxime Amblard, Philippe de Groote, Aleksandre Maskharashvili, Sylvain Pogodalla [coordinator], Sai Qian.

POLYMNIE⁴ is a research project funded by the French national research agency (ANR). It relies on the grammatical framework of Abstract Categorial Grammars (ACG). A feature of this formalism is to provide the same mathematical perspective both on the surface forms and on the more abstract forms the latter correspond to. As a consequence:

- ACG allows for the encoding of a large variety of grammatical formalisms such as context-free grammars, Tree Adjoining grammars (TAG), etc.
- ACG define two languages: an abstract language for the abstract forms, and an object language for the surface forms.

⁴<http://semagramme.loria.fr/doku.php?id=projects:polymnie>

Importantly, the notions of object language and abstract language are relative to each other. If we can naturally see surface forms as strings for instance and abstract forms as the associated syntactic trees, we can also consider to associate this abstract form to a first order logical formula as surface (object) form. This property is central in our project as it offers a unified approach to text analysis and text generation, in particular considering the underlying algorithms and their complexity.

ACG definition uses type-theory and lambda-calculus. From this point of view, they smoothly integrate formal semantics models issuing from Montague's proposal. Theories that extend to the discourse level such as Discourse Representation Theory (DRT) and Dynamic Predicate Logic (DPL) were not initially formulated using lambda-calculus. But such formulations have been proposed. In particular, a formulation based on continuation semantics allows them to be expressed quite naturally in the ACG architecture. Dynamic effects of discourse, in particular those related to anaphora resolution or rhetorical relation inference, have then to be expressed by lexical semantics or computed from the syntactic rules as studied in the Inria Collaborative Research Project (ARC) CAuLD⁵.

It has been shown that the discourse structure of texts plays a key role in their understanding. This is the case for both human readers and automatic processing systems. For instance, it can enhance text transformation systems such as the ones performing automatic summarization.

POLYMNIE focuses on studying and implementing the modeling of sentences and discourses in a compositional paradigm that takes into account their dynamics and their structures, both in parsing and in generation. To that end, we rely on the ACG framework. The kind of processing we are interested in relates to the automatic construction of summaries or to text simplification. This has to be considered in the limits of the modelling of the linguistic processes (as opposed to inferential processes for instance) these tasks involve.

The complexity of the phenomena, of their formal description, and of their interactions, require to set up a testing and development environment for linguistic modelling. It will consist in extending and stabilizing a software implementing the functionalities of the ACG framework. It will provide a tool for experimentation and validation of the approach.

Partners:

- Sémagramme people,
- Alpage (Paris 7 university & Inria Paris-Rocquencourt): Laurence Danlos (local coordinator), C. Braud, C. Roze, Éric Villemonte de la Clergerie,
- MELODI (IRIT, CNRS): Stergos Afantenos, Nicholas Asher (local coordinator), Juliette Conrath, Philippe Muller,
- Signes (LaBRI, CNRS): Jérôme Kirman, Richard Moot, Christian Retoré (local coordinator), Sylvain Salvati, Noémie-Fleur Sandillon-Rezer.

7.3. International Research Visitors

7.3.1. Visits of International Scientists

7.3.1.1. Internships

- Ahmed Abbache (Université Hassiba Benbouali, Algeria) did a 5 month internship in the Sémagramme team. He has been working on a formalization of the neokhalilian theory using ACGs.

7.3.2. Visits to International Teams

- Philippe de Groote, Aleksandre Maskharashvili, and Sylvain Pogodalla visited Pr. Makoto Kanazawa at NII, Tokyo, Japan, Oct. 21-25 2013.
- Philippe de Groote gave an invited talk at the Center for Logic and Philosophy of Science of the Tilburg University, on the occasion of Reinhard Muskens' 60th birthday.

⁵<http://www.loria.fr/~pogodall/cauld/>

SIROCCO Project-Team

8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. ANR-PERSEE

Participants: Christine Guillemot, Laurent Guillo, Olivier Le Meur.

- Title : Perceptual coding for 2D and 3D images.
- Research axis : § 6.2.1 , 6.1.1 .
- Partners : IRCCYN-Polytech Nantes, INSA-Rennes, Telecom Paris Tech.
- Funding : ANR.
- Period : Oct.2009-Aug.2013

The objective of the project is to develop perceptually driven coding solutions for mono-view and multi-view video. The SIROCCO project-team contributes on different problems for mono-view and multi-view video coding: visual attention modeling (see Section 6.1.1), texture synthesis and inpainting for both 2D and 3D content. Several methods for 2D image inpainting and 2D/3D inpainting to handle disocclusions in virtual view synthesis have been developed (see Sections 6.2.1 . A computational model for 3D content has also been studied (see Section 6.1.1).

8.1.2. ANR-ARSSO

Participants: Mounira Ebdelli, Christine Guillemot, Ronan Le Boulch, Olivier Le Meur, Aline Roumy.

- Title : Adaptable, Robust, Streaming SOLUTIONS.
- Research axis: 6.2.1 , 6.4.1
- Partners : Inria/Planète, TESA-ISAE, CEA-LETI/LNCA, ALCATEL LUCENT BELL LABS, THALES Communications, EUTELSAT SA.
- Funding : ANR.
- Period : 06/2010-11/2013

The ARSSO project focuses on multimedia content communication systems, characterized by more or less strict real-time communication constraints, within highly heterogeneous networks, and toward terminals potentially heterogeneous too. It follows that the transmission quality can largely differ in time and space. The solutions considered by the ARSSO project must therefore integrate robustness and dynamic adaptation mechanisms to cope with these features. The overall goal is to provide new algorithms, develop new streaming solutions and study their performances. The SIROCCO project-team contributes on the development of loss concealment methods based on video inpainting. The solutions developed in 2012 have been studied in the context of a video compression and transmission chain using the emerging HEVC coding standard and have been integrated in the project demonstrator.

8.2. European Initiatives

8.2.1. FP7-PEOPLE-SHIVPRO

Participants: Olivier Le Meur, Zhi Liu.

- Title : Saliency-aware High-resolution Video Processing.
- Research axis : 6.1.1 .
- Partners : Visting professor from Shanghai University.
- Funding : EC-FP7 MC-IIF International Incoming Fellowships (IIF).
- Period : 08/2012-07/2014

The proposal SHIVPRO (Saliency-aware High-resolution Video Processing) submitted to the call FP7-PEOPLE-2011-IIF (funding scheme: MC-IIF International Incoming Fellowships (IIF)) has been accepted. Dr. Z. Liu, from Beijing University, has joined the team since August 2012 for two years. The objective of this project is to propose an efficient spatio-temporal saliency model to predict salient regions in High-Resolution (HR) videos, and fully exploit it to ease the design and improve the performance of HR video compression and retargeting applications. With the aim to overcome the drawbacks of existing saliency models, based on a multiscale region representation, the proposed model systematically realizes statistical model saliency measuring, intra-scale saliency modification, inter-scale saliency propagation and flexible incorporation of top-down information, to generate a novel saliency representation form with scalability, saliency tree, from which a multiscale saliency fusion scheme is used to derive high-quality saliency maps at various scales.

8.3. International Research Visitors

8.3.1. Visits of International Scientists

Dr. Zhi Liu, from Shanghai University, has been visiting the team since August 2012 for two years. His stay is funded by the FP7-PEOPLE-2011-IIF program. The funding scheme is the MC-IIF International Incoming Fellowships (IIF).

SMIS Project-Team

8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. ANR KISS (Dec. 2011 - Dec. 2015)

Partners: Inria-SMIS (coordinator), Inria-SECRET, LIRIS, Univ. of Versailles, CryptoExperts, Gemalto, Yvelines district.

SMIS funding: 230k€.

The idea promoted in KISS is to embed, in trusted devices, software components capable of acquiring, storing and managing securely various forms of personal data (e.g., salary forms, invoices, banking statements, geolocation data, depending on the applications). These software components form a Personal Data Server which can remain under the holder's control. The scientific challenges include: embedded data management issues tackling regular, streaming and spatio-temporal data (e.g., geolocation data), data provenance-based privacy models, crypto-protected distributed protocols to implement private communications and secure global computations.

8.1.2. ARC CAPPRIS (Dec. 2011 - Dec. 2015)

Inria Large Scale Initiative.

Inria Partners: PRIVATICS (coordinator), SMIS, PLANETE, CIDRE, COMETE.

External partners: Univ. of Namur, Eurecom, LAAS.

Funding: not associated to individual project-teams.

An ARC is a long-term multi-disciplinary project launched by Inria to sustain large scale risky research actions in line with its own strategic plan. CAPPRIS stands for "Collaborative Action on the Protection of Privacy Rights in the Information Society". The key issues that will be addressed are: (1) the identification of existing and future threats to privacy, (2) the definition of formally grounded measures to assess and quantify privacy, (3) the definition of the fundamental principles underlying privacy by design and methods to apply them in concrete situations and (4) The integration of the social and legal dimensions. To assess the relevance and significance of the research results, they will be confronted to three classes of case studies CAPPRIS partners are involved in: namely Online Social Networks, Location Based Services and Electronic Health Record Systems.

8.1.3. PEPS PAIP (Pour une Approche Interdisciplinaire de la Privacy) (Sept. 2013 - Sept. 2014)

Partners: ADIS and SMIS (co-organizers), CERDI, DANTE, COMETE, GRACE, TPT, LIMSI.

Funding: 30K€ from CNRS, not associated to individual project-teams.

The Digital Society Institute (DSI) will be the UPSa IDEX catalyst for multidisciplinary research on societal challenges inherent to eLife/life digitization. DSI plans to be one of the European leading institutes fostering multidisciplinary research across ICTS and SHES. In 2013 DSI already hosts two kick-off major research projects : (1) Human and Machine Coevolution and (2) Privacy/digital identities. ADIS and SMIS are co-organizing project (2) on data privacy. The PEPS PAIP is part of project (2) and aims at fostering the cooperation between lawyers, economists and computer scientists on privacy issues, through the organization of brainstorming days and workshops and a study of possible joint experiments of privacy preserving applications.

8.1.4. Digiteo LETEVONE chair (2010-2013)

Partners: LIX (Ecole Polytechnique), PRISM (UVSQ), DBWeb (Telecom ParisTech), Exalead S.A..

Funding: Grant covers the expenses of Pr. Vazirgiannis' visits to France (hosted by LIX) and of 2 PHD students.

Participant in the DIGITEO Learning Techniques for Evolving Networks chair, held by Pr. Michalis Vazirgiannis (Athens University of Economics and Business) from 2010 to 2013. The overall objective of the proposed project is mining and learning from the large scale and dynamically evolving data and graphs generated in the Web 2.0 context. Our particular collaboration has dealt with privacy protection of users' data in this context.

8.2. European Initiatives

8.2.1. FP7 Projects

8.2.1.1. PDS4NRJ (Aug. 2013 - Aug. 2014)

Instrument: Marie Curie Intra-European Fellowships for Career Development

Duration: 2013 Aug. - 2014 Aug.

Inria contact: Philippe Bonnet

This project, called PDS4NRJ, is based on the insights that (a) secure personal data management can be radically improved with the advent of secure hardware embedded on personal devices at the edges of the Internet, and (b) that a secure personal data management infrastructure should be applied in the context of smart buildings. Our overall objective is to define a new form of decentralized infrastructure for sharing smart meter data with access and usage control guarantees. The PDS4NRJ project is a unique opportunity for Philippe Bonnet, currently associate professor at ITU (Denmark), to become a leading expert in the field of secure personal data management thanks to a tight cooperation with SMIS members.

8.2.2. Collaborations in European Programs, except FP7

Program: Danish Council for Independent Research (FTP call)

Project acronym: CLyDE

Project title: Cross-LaYer optimized Database Engine

Duration: 10/2011 - 10/2014

Coordinator: Philippe Bonnet (ITU of Copenhagen)

Other partners: IT University of Copenhagen (Denmark), SMIS

Abstract: The goal is to explore how flash devices, operating system and database system can be designed together to improve overall performance. Such a co-design is particularly important for the next generation database appliances, or cloud-based relational database systems for which well-suited flash components must be specified. More generally, our goal is to influence the evolution of flash devices and commodity database systems for the benefit of data intensive applications. The project should result in two complementary open-source software systems: (i) a bimodal flash device software component based on the idea from [6], and (ii) a database system optimized for bimodal flash devices. The project funding is managed by the IT University of Copenhagen and covers the expenses for two co-supervised PhD students (including regular visits to and from Denmark).

8.2.3. Collaborations with Major European Organizations

The SMIS members have developed tight European cooperations with the following persons/teams:

Philippe Bonnet (Associate Professor at the University of Copenhagen, Denmark)

Collaboration on Flash-based data management for high-end servers. The study of flash devices started during a short sabbatical of Luc Bouganim (from April to August 2008) in Copenhagen. The uFLIP study has been conducted in close cooperation with Philippe Bonnet from IT University of Copenhagen and Björn Þór Jónsson from Reykjavík University. The cooperation with Copenhagen is very active and led to new studies on flash devices and on the Trusted Cell architecture. Two PhD students are currently co-supervised by Luc Bouganim and Philippe Bonnet. Philippe Bonnet got a Marie-Curie IEF grant and will visit SMIS for one year in 2013-2014.

Michalis Vazirgiannis (Athens University of Economics and Business)

Collaboration on Minimal Exposure in the context of Michalis' Digiteo Chair at LIX (Ecole Polytechnique).

8.3. International Research Visitors

See Section [8.2.1](#) .

STARS Project-Team

8. Partnerships and Cooperations

8.1. Regional Initiatives

8.1.1. Collaborations

- Stars has a strong collaboration with the CobTek team (CHU Nice).
- G. Charpiat works with Yuliya Tarabalka (AYIN team) and with Björn Menze (Computer Vision Laboratory at ETH Zurich, Medical Vision group of CSAIL at MIT, and collaborator of Asclepios team) on the topic of shape growth/shrinkage enforcement for the segmentation of time series.
- G. Charpiat worked with former members from the Ariana team: Ahmed Gamal Eldin (LEAR team), Xavier Descombes (MORPHEME team) and Josiane Zerubia (AYIN team) on the topic of multiple object detection.
- A. Ressouche has a strong collaboration with the Rainbow team (I3S, UNS).

8.2. National Initiatives

8.2.1. ANR

8.2.1.1. MOVEMENT

Program: ANR CSOSG

Project acronym: MOVEMENT

Project title: AutoMatic BiOmetric Verification and PersonnEl Tracking for SeaMless Airport ArEas Security MaNagement

Duration: January 2014-June 2017

Coordinator: MORPHO (FR)

Other partners: SAGEM (FR), Inria Sophia-Antipolis (FR), EGIDIUM (FR), EVITECH (FR) and CERAPS (FR)

Abstract: MOVEMENT is focusing on the management of security zones in the non public airport areas. These areas, with a restricted access, are dedicated to service activities such as maintenance, aircraft ground handling, airfreight activities, etc. In these areas, personnel movements tracking and traceability have to be improved in order to facilitate their passage through the different areas, while insuring a high level of security to prevent any unauthorized access. Movement aims at proposing a new concept for the airport's non public security zones (e.g.customs control rooms or luggage loading/unloading areas) management along with the development of an innovative supervision system prototype.

8.2.1.2. SafEE

Program: ANR TESCOAN

Project acronym: SafEE

Project title: Safe & Easy Environment for Alzheimer Disease and related disorders

Duration: December 2013-May 2017

Coordinator: CHU Nice

Other partners: Nice Hospital(FR), Nice University (CobTeck FR), Inria Sophia-Antipolis (FR), Aromatherapeutics (FR), SolarGames(FR), Taichung Veterans General Hospital TVGH (TW), NCKU Hospital(TW), SMILE Lab at National Cheng Kung University NCKU (TW), BDE (TW)

Abstract: SafEE project aims at investigating technologies for stimulation and intervention for Alzheimer patients. More precisely, the main goals are: (1) to focus on specific clinical targets in three domains behavior, motricity and cognition (2) to merge assessment and non pharmacological help/intervention and (3) to propose easy ICT device solutions for the end users. In this project, experimental studies will be conducted both in France (at Hospital and Nursery Home) and in Taiwan.

8.2.2. Investment of future

8.2.2.1. Az@GAME

Program: DGCIS

Project acronym: Az@GAME

Project title: un outil d'aide au diagnostic médical sur l'évolution de la maladie d'Alzheimer et les pathologies assimilées.

Duration: January 2012- December 2015

Coordinator: Groupe Genius

Other partners: IDATE (FR), Inria(Stars), CMRR (CHU Nice) and CobTek(Nice University).

See also: <http://www.azagame.fr/>

Abstract: This French project aims at providing evidence concerning the interest of serious games to design non pharmacological approaches to prevent dementia patients from behavioural disturbances, most particularly for the stimulation of apathy.

8.2.3. Large Scale Inria Initiative

8.2.3.1. PAL

Program: Inria

Project acronym: PAL

Project title: Personally Assisted Living

Duration: 2010 -2014

Coordinator: COPRIN team

Other partners: AROBAS, DEMAR, E-MOTION, STARS, PRIMA, MAIA, TRIO, and LAGADIC Inria teams

See also: <http://www-sop.inria.fr/coprin/aen/>

Abstract: The objective of this project is to create a research infrastructure that will enable experiments with technologies for improving the quality of life for persons who have suffered a loss of autonomy through age, illness or accident. In particular, the project seeks to enable development of technologies that can provide services for elderly and fragile persons, as well as their immediate family, caregivers and social groups.

8.2.4. Other collaborations

- G. Charpiat works with Yann Ollivier and Jamal Atif (TAO team) as well as Rémi Peyre (École des Mines de Nancy / Institut Élie Cartan) on the topic of image compression.
- G. Charpiat works with Giacomo Nardi, Gabriel Peyré and François-Xavier Vialard (Ceremade, Paris-Dauphine University) on the generalization of gradient flows to non-standard metrics.

8.3. European Initiatives

8.3.1. FP7 Projects

8.3.1.1. CENTAUR

Title: Crowded ENvironments moniToring for Activity Understanding and Recognition

Type: POEPLÉ

Defi: Computer Vision

Instrument: Industry-Academia Partnerships and Pathway

Duration: January 2013 - December 2016

Coordinator: Honeywell (CZE)

Other partners: Neovison (CZE), Inria Sophia-Antipolis (CZE), Queen Mary University of London (UK) and EPFL in Lausanne (CH).

Inria contact: François Brémond

Abstract: CENTAUR aims at developing a network of scientific excellence addressing research topics in computer vision and advancing the state of the art in video surveillance. The cross fertilization of ideas and technology between academia, research institutions and industry will lay the foundations to new methodologies and commercial solutions for monitoring crowded scenes. Three thrusts identified will enable the monitoring of crowded scenes: a) multi camera, multicoverage tracking of objects of interest, b) Anomaly detection and fusion of multimodal sensors, c) activity recognition and behavior analysis in crowded environments.

8.3.1.2. SUPPORT

Title: Security UPgrade for PORTs

Type: SECURITE

Defi: Port Security

Instrument: Industry-Academia Partnerships and Pathway

Duration: July 2010 - June 2014

Coordinator: BMT Group (UK)

Other partners: Inria Sophia-Antipolis (FR); Swedish Defence Research Agency (SE); Securitas (SE); Technical Research Centre of Finland (FI); MARLO (NO); INLECOM Systems (UK).

Inria contact: François Brémond

Abstract: SUPPORT is addressing potential threats on passenger life and the potential for crippling economic damage arising from intentional unlawful attacks on port facilities, by engaging representative stakeholders to guide the development of next generation solutions for upgraded preventive and remedial security capabilities in European ports. The overall benefit will be the secure and efficient operation of European ports enabling uninterrupted flows of cargos and passengers while suppressing attacks on high value port facilities, illegal immigration and trafficking of drugs, weapons and illicit substances all in line with the efforts of FRONTEX and EU member states.

8.3.1.3. Dem@Care

Title: Dementia Ambient Care: Multi-Sensing Monitoring for Intelligent Remote Management and Decision Support

Type: ICT

Defi: Cognitive Systems and Robotics

Instrument: Industry-Academia Partnerships and Pathway

Duration: November 2011-November 2015

Coordinator: Centre for Research and Technology Hellas (G)

Other partners: Inria Sophia-Antipolis (FR); University of Bordeaux 1 (FR); Cassidian (FR), Nice Hospital (FR), LinkCareServices (FR), Lulea Tekniska Universitet (SE); Dublin City University (IE); IBM Israel (IL); Philips (NL); Vistek ISRA Vision (TR).

Inria contact: François Brémond

Abstract: The objective of Dem@Care is the development of a complete system providing personal health services to persons with dementia, as well as medical professionals, by using a multitude of sensors, for context-aware, multiparametric monitoring of lifestyle, ambient environment, and health parameters. Multisensor data analysis, combined with intelligent decision making mechanisms, will allow an accurate representation of the person's current status and will provide the appropriate feedback, both to the person and the associated medical professionals. Multi-parametric monitoring of daily activities, lifestyle, behaviour, in combination with medical data, can provide clinicians with a comprehensive image of the person's condition and its progression, without their being physically present, allowing remote care of their condition.

8.3.1.4. VANAHEIM

Title: Autonomous Monitoring of Underground Transportation Environment

Type: ICT

Defi: Cognitive Systems and Robotics

Instrument: Industry-Academia Partnerships and Pathway

Duration: February 2010 - November 2013

Coordinator: Multitel (Belgium)

Other partners: Inria Sophia-Antipolis (FR); Thales Communications (FR); IDIAP (CH); Torino GTT (Italy); Régie Autonome des Transports Parisiens RATP (France); Ludwig Boltzmann Institute for Urban Ethology (Austria); Thales Communications (Italy).

Inria contact: François Brémond

See also: <http://www.vanaheim-project.eu/>

Abstract: The aim of this project is to study innovative surveillance components for the autonomous monitoring of multi-Sensory and networked Infrastructure such as underground transportation environment.

8.3.2. Collaborations in European Programs, except FP7

8.3.2.1. PANORAMA

Program: ENIAC

Project acronym: PANORAMA

Project title: Ultra Wide Context Aware Imaging

Duration: April 2012 - March 2015

Coordinator: Philips Healthcare (NL)

Other partners :Medisys (FR), Grass Valley (NL), Bosch Security Systems (NL), STMicroelectronics (FR), Thales Angenieux (FR), CapnaDST (UK), CMOSIS (BE), CycloMedia (Netherlands), Q-Free (Netherlands), TU Eindhoven (NL) , University of Leeds (UK), University of Catania (IT), Inria(France), ARMINES (France), IBBT (Belgium).

See also: <http://www.panorama-project.eu/>

Inria contact: François Brémond

Abstract: PANORAMA aims to research, develop and demonstrate generic breakthrough technologies and hardware architectures for a broad range of imaging applications. For example, object segmentation is a basic building block of many intermediate and low level image analysis methods. In broadcast applications, segmentation can find people's faces and optimize exposure, noise reduction and color processing for those faces; even more importantly, in a multi-camera set-up these imaging parameters can then be optimized to provide a consistent display of faces (e.g., matching colors) or other regions of interest. PANORAMA will deliver solutions for applications in medical imaging, broadcasting systems and security & surveillance, all of which face similar challenging issues in the real time handling and processing of large volumes of image data. These solutions require the

development of imaging sensors with higher resolutions and new pixel architectures. Furthermore, integrated high performance computing hardware will be needed to allow for the real time image processing and system control. The related ENIAC work program domains and Grand Challenges are Health and Ageing Society - Hospital Healthcare, Communication & Digital Lifestyles - Evolution to a digital lifestyle and Safety & Security - GC Consumers and Citizens security.

8.4. International Initiatives

8.4.1. Inria International Partners

8.4.1.1. Collaborations with Asia

Stars has been cooperating with the Multimedia Research Center in Hanoi MICA on semantics extraction from multimedia data. Stars also collaborates with the National Cheng Kung University in Taiwan and I2R in Singapore.

8.4.1.2. Collaboration with U.S.

Stars collaborates with the University of Southern California.

8.4.1.3. Collaboration with Europe

Stars collaborates with Multitel in Belgium, the University of Kingston upon Thames UK, and the University of Bergen in Norway.

8.4.2. Participation In other International Programs

- EIT ICT Labs is one of the first three Knowledge and Innovation Communities (KICs) selected by the European Institute of Innovation & Technology (EIT) to accelerate innovation in Europe. EIT is a new independent community body set up to address Europe's innovation gap. It aims to rapidly emerge as a key driver of EU's sustainable growth and competitiveness through the stimulation of world-leading innovation. Among the partners, there are strong technical universities (U Berlin, 3TU / NIRICT, Aalto University, UPMC - Université Pierre et Marie Curie, Université Paris-Sud 11, Institut Telecom, The Royal Institute of Technology); excellent research centres (DFKI, Inria, Novay , VTT, SICS) and leading companies (Deutsche Telekom Laboratories, SAP, Siemens, Philips, Nokia, Alcatel-Lucent, France Telecom, Ericsson). This project is largely described at <http://eit.ictlabs.eu>.

Stars is involved in the EIT ICT Labs - Health and Wellbeing .

8.5. International Research Visitors

8.5.1. Visits of International Scientists

8.5.1.1. Internships

Narjes Ghrairi

Subject: Primitive Event Generation in an Activity Recognition Platform

Date: from Apr 2013 until Sep 2013

Institution: Ecole Nationale d'Ingénieurs de Tunis (Tunisia)

Mohammed Cherif Bergheul

Subject: Adaptive composition and formal verification of software in ubiquitous computing. Application to ambient health care systems.

Date: from Apr 2013 until Sep 2013

Institution: Ecole Polytech'Nice Cairo (Egypt)

Kartick Subramanian

Subject: People Tracking

Date: from Mar 2013 until Aug 2013

Institution: Nanyang Technological University, Singapore

Augustin Caverzasi

Subject: Trajectory fusion of multi-camera RGB-Depth tracking in partial overlapped scenes.

Date: from Aug 2013 until Dec 2013

Institution: Universidad Nacional de Córdoba, Facultad de Ciencias Exactas Físicas y Naturales, Argentina

Stefanus Candra

Subject: Evaluation of activity recognition system using RGB-Depth camera (e.g. Kinect)

Date: from Aug 2013 until Dec 2013

Institution: University of California, Berkeley CA, Usa

Sahil Dhawan

Subject: Assment of people detection using RGB-Depth sensors (e.g. Kinect), for apathetic patients to improve activity recognition systems.

Date: from Jan 2013 until Jul 2013

Institution: Birla institute of technology and Science, Pilani , India

Marco San Biagio

Subject: People detection using the Brownian descriptor.

Date: from Apr 2013 until Sep 2013

Institution: Italian Inst. of Tech. of Genova

Michal Koperski

Subject: 3D Trajectories for Action Recognition Using Depth Sensors

Date: from Apr 2013 until Dec 2013

Institution: Wroclaw University of Technology

TEXMEX Project-Team

8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. ANR FIRE-ID

Participants: Sébastien Champion, Philippe-Henri Gosselin, Patrick Gros, Hervé Jégou.

Duration: 3 years, started in May 2012.

Partner: Xerox Research Center Europe

The FIRE-ID project considers the semantic annotation of visual content, such as photos or videos shared on social networks, or images captured by video surveillance devices or scanned documents. More specifically, the project considers the fine-grained recognition problem, where the number of classes is large and where classes are visually similar, for instance animals, products, vehicles or document forms. We also assumed that the amount of annotated data available per class for the learning stage is limited.

8.1.2. ANR Secular

Participants: Laurent Amsaleg, Teddy Furon, Benjamin Mathon, Hervé Jégou, Ewa Kijak.

Duration: 3 years, started in September 2012.

Partners: Morpho, Univ. Caen GREYC, Telecom ParisTech, Inria Rennes

Content-based retrieval systems (CBRS) need security and privacy. CBRS become the main multimedia security technology to enforce copyright laws (content monetization) or to spot illegal contents (detection of copies, paedophile images, ...) over the Internet. However, they were not designed with privacy, confidentiality and security in mind. This comes in serious conflict with their use in these new security-oriented applications. Privacy is endangered due to information leaks when correlating users, queries and the contents stored-in-the-clear in the database. It is especially the case of images containing faces which are so popular in social networks. Biometrics systems have long relied on protection techniques and anonymization processes that have never been used in the context of CBRS. The project seeks to a better understanding of how biometrics related techniques can help increasing the security levels of CBRS while not degrading their performance.

8.2. European Initiatives

8.2.1. Collaborations in European Programs, except FP7

Program: Eurostars

Project title: Forensic Image Identifier and Analyzer

Duration: 03/2011 - 07/2014

Coordinator: Videntifier Technologies

Other partners: Videntifier Technologies (Iceland), Forensic Pathways (UK)

Abstract: FIIA is an innovative software service for the Forensic market that automatically identifies and analyzes the content of images on web sites and seized computers. The service saves time and money, gathers better evidence, and builds stronger court cases. We are in charge of helping with the technology needed to identify the logos from terrorist organizations that are inserted in images or videos. Challenges are related to the poor resolution and small size of logos as well as to the very strict efficiency constraints that the logo detector must match.

8.2.2. Quaero

Participants: Laurent Amsaleg, Sébastien Champion, Vincent Claveau, Julien Fayolle, Guillaume Gravier, Patrick Gros, Gylfi Gudmundsson, Carryn Hayward, Hervé Jégou, Ewa Kijak, Fabienne Moreau, Christian Raymond, Pascale Sébillot.

Duration: 5 years, starting in May 2008.

Prime: Technicolor.

Quaero is a large research and applicative program in the field of multimedia description (ranging from text to speech and video) and search engines. It groups 5 application projects, a joint Core Technology Cluster developing and providing advanced technologies to the application projects, and a Corpus project in charge of providing the necessary data to develop and evaluate the technologies. The large scope of QUAERO's ambitious objectives allows it to take full advantage of Texmex's many areas of research, through its tasks on: Indexing Multimedia Objects, Term Acquisition and Recognition, Semantic Annotation, Video Segmentation, Multi-modal Video Structuring, Image and video fingerprinting.

In 2013, a key fact is the best paper award obtained by Cédric Penet at CBMI 2013.

8.3. International Initiatives

8.3.1. Inria International Partners

8.3.1.1. Informal International Partners

- Intelligent Systems Lab Amsterdam (ISLA), University van Amsterdam
- Pontifical Catholic Univeristy of Minas Gerais, Brazil
- National Institute for Informatics, Japan
- Prague Technical University, Czech Republic
- National Technical University of Athens, Greece

8.4. International Research Visitors

8.4.1. Visits of International Scientists

- Michael Rabbat
Dates: November 2013 (1 month)
Subject: Continuous Associative Memories
Institution: Mc Gill University, Canada

8.4.2. Internships

- Giorgos Tolias
Dates: October 2012–January 2013 (5 months)
Subject: Large scale visual search
Institution: National Technical University of Athens (Greece)

8.4.3. Visits to International Teams

- Mihir Jain
Dates: June 2013–September 2013
Subject: Action Recognition and Event Retrieval
Institution: Intelligent Systems Lab Amsterdam (ISLA), University van Amsterdam

TITANE Team

8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. *Grand emprunt*

Culture 3D Clouds (started in October 2012) is a national project aimed at devising a cloud computing platform for 3D scanning, documentation, preservation and dissemination of cultural heritage.

8.2. European Initiatives

8.2.1. *FP7 Projects*

8.2.1.1. *IRON - Robust Geometry Processing*

Type: IDEAS

Instrument: ERC Starting Grant

Duration: January 2011 - December 2015

Coordinator: Pierre Alliez

Inria contact: Pierre Alliez

Abstract: The purpose of this project is to bring forth the full scientific and technological potential of Digital Geometry Processing by consolidating its most foundational aspects. Our methodology will draw from and bridge the two main communities (computer graphics and computational geometry) involved in discrete geometry to derive algorithmic and theoretical contributions that provide both robustness to noisy, unprocessed inputs, and strong guarantees on the outputs. The intended impact is to make the digital geometry pipeline as generic and ironclad as its Digital Signal Processing counterpart.

8.3. International Research Visitors

8.3.1. *Visits of International Scientists*

Dmitry Anisimov, from University of Lugano, visited us in September-October. We also had short visits of Marcel Campen and Henrik Zimmer from RWTH Aachen.

8.3.1.1. *Internships*

Anmol Garg from IIT Bombay: Anisotropic metrics for shape approximation.

8.3.2. *Visits to International Teams*

David Bommes visited the Applied Geometry Lab at California Institute of Technology (Caltech) from May to June.

TYREX Team

7. Partnerships and Cooperations

7.1. National Initiatives

7.1.1. Investissements d'avenir

CLAIRE

Title: Community Learning through Adaptive and Interactive multichannel Resources for Education

Call: Technologies for e-education

Duration: March 2012 - February 2014

Coordinator: **OpenClassrooms, ex-SimpleIT**

Others partners: LIRIS

See also: <http://www.projet-claire.fr/>

Abstract: Project CLAIRE aims at developing an open-source tool for collaborative authoring in an e-learning environment (Learning Content Management System), targeting teachers and students in high-school and universities. Its innovative features include:

- a platform for collaborative structured editing of rich media and "semantic" content, e.g.: tools for chaptering video, and for generating interactive evaluation tests
- processes for continuous enhancement of content, e.g.: social annotation, behaviour analysis, accessible multi-support publishing, e.g.: web, PDF, ODT, LaTeX, smartphones, tablets.

Datalyse

Title: Entrepôt Intelligent pour Big Data hétérogènes. Investissements d'Avenir Développement de l'Economie Numérique.

Call: Cloud Computing, num 3 – Big Data.

Duration: May 2013 - November 2016

Coordinator: **Business & Decision Eolas**

Others partners: Groupement des Mousquetaires, Inria Saclay (OAK EPC), LIG (Hadas and Eroads teams), LIRMM (Montpellier), LIFL (Lille).

See also: <http://www.datalyse.fr/>

Abstract: Project Datalyse aims at designing and deploying an infrastructure for big data storage, collection, certification, integration, categorization, enrichment and sharing over very large heterogeneous data sets. It relies on an industrial platform, to be made available on the cloud, and focuses on three flagship applications, showcasing three uses of big data over different data sets:

- **Data Center Monitoring:** The goal of this application is to provide features such as traceability, reporting, optimization and analysis of abnormal behaviour regarding energy efficiency and security issues. The application will be built with an existing application called ScopeBR (Eolas) and will be deployed in two different green data centers, those of Eolas and GDF SUEZ.
- **“Territoire de données ouvertes et liées”:** This application aims at extracting and provisioning public open data collected from the city of Grenoble and its suburbs. The goal is to make public data available to third-party application developers and to federate local actors around a single platform.
- **Real-time Business Intelligence for the management and processing of points of sale:** this application will focus on real-time data analytics and will be deployed within “Groupement des Mousquetaires” in support of their business intelligence platforms.

7.1.2. ANR

Typex

Title: Typeful certified XML: integrating language, logic, and data-oriented best practices

Call: Programme Blanc

Duration: January 2012 - December 2014

Coordinator: PPS (CNRS - Paris 7 Diderot)

Others partners: LRI (Orsay)

See also: <http://typex.lri.fr>

Abstract: The highly ambitious and final goal of this project is to produce a new generation of XML programming languages stemming from the synergy of integrating three approaches into a unique framework:

- a logical approach based on solvers
- a programming language (PL) approach
- a data-oriented approach

These languages will feature precise and polymorphic type systems that merge PL typing techniques with logical-solver-based type inference. They will be implemented efficiently using the latest research on tree automata and formally certified using modern theorem prover technology. They will offer the capacity to specify and formally verify invariants, business rules, and data integrity, and will have a direct and immediate impact on standardization processes.

7.2. European Initiatives

7.2.1. FP7 Projects

7.2.1.1. VENTURI

Title: immersiVe ENhancemenT of User-worlD Interactions

Type: Cooperation (ICT)

Call: FP7-ICT-20111.5 Networked Media and Search Systems

Instrument: Specific Targeted Research Project (STREP)

Duration: October 2011 - September 2014

Coordinator: Fondazione Bruno Kessler (Italy)

Others partners: Fraunhofer Heinrich Hertz Institute (Germany), ST Microelectronics (Italy), ST-Ericsson (France), Metaio (Germany), e-Diam Interactive (Spain), Sony-Ericsson (Sweden)

See also: <https://venturi.fbk.eu/>

Abstract: Venturi aims to create a pervasive Augmented Reality paradigm, where available information will be presented in a user- rather than device-specific way. The goal is to create an experience that is always present whilst never obstructing. Venturi will exploit, optimize and extend current and next generation mobile platforms; verifying platform and QoE performance through life-enriching use cases and applications to ensure device-to-user continuity.

WILLOW Project-Team

8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. *Agence Nationale de la Recherche (ANR): SEMAPOLIS*

Participants: Mathieu Aubry, Josef Sivic.

The goal of the SEMAPOLIS project is to develop advanced large-scale image analysis and learning techniques to semantize city images and produce semantized 3D reconstructions of urban environments, including proper rendering. Geometric 3D models of existing cities have a wide range of applications, such as navigation in virtual environments and realistic sceneries for video games and movies. A number of players (Google, Microsoft, Apple) have started to produce such data. However, the models feature only plain surfaces, textured from available pictures. This limits their use in urban studies and in the construction industry, excluding in practice applications to diagnosis and simulation. Besides, geometry and texturing are often wrong when there are invisible or discontinuous parts, e.g., with occluding foreground objects such as trees, cars or lampposts, which are pervasive in urban scenes. This project will go beyond the plain geometric models by producing semantized 3D models, i.e., models which are not bare surfaces but which identify architectural elements such as windows, walls, roofs, doors, etc. Semantic information is useful in a larger number of scenarios, including diagnosis and simulation for building renovation projects, accurate shadow impact taking into account actual window location, and more general urban planning and studies such as solar cell deployment. Another line of applications concerns improved virtual cities for navigation, with object-specific rendering, e.g., specular surfaces for windows. Models can also be made more compact, encoding object repetition (e.g., windows) rather than instances and replacing actual textures with more generic ones according to semantics; it allows cheap and fast transmission over low- bandwidth mobile phone networks, and efficient storage in GPS navigation devices.

This is a collaborative effort with LIGM / ENPC (R. Marlet), University of Caen (F. Jurie), Inria Sophia Antipolis (G. Drettakis) and Acute3D (R. Keriven).

8.2. European Initiatives

8.2.1. *QUAERO (Inria)*

Participant: Ivan Laptev.

QUAERO (AII) is a European collaborative research and development program with the goal of developing multimedia and multi-lingual indexing and management tools for professional and public applications. Quero consortium involves 24 academic and industrial partners led by Technicolor (previously Thomson). Willow participates in work package 9 "Video Processing" and leads work on motion recognition and event recognition tasks.

8.2.2. *EIT-ICT labs: Mobile visual content analysis (Inria)*

Participants: Ivan Laptev, Josef Sivic.

The goal of this project within the European EIT-ICT activity is to mature developed technology towards real-world applications as well as transfer technology to industrial partners. Particular focus of this project is on computer vision technology for novel applications with wearable devices. The next generation mobile phones may not be in the pocket but worn by users as glasses continuously capturing audio-video data, providing visual feedback to the user and storing data for future access. Automatic answers to "Where did I leave my keys yesterday?" or "How did this place look like 100 years ago?" enabled by such devices could change our daily life while creating numerous new business opportunities. The output of this activity is new computer vision technology to enable a range of innovative mobile wearable applications.

This is a collaborative effort with S. Carlsson (KTH Stockholm) and J. Laaksonen (Aalto University).

8.2.3. European Research Council (ERC) Advanced Grant: “VideoWorld” - Jean Ponce

Participants: Jean Ponce, Ivan Laptev, Josef Sivic.

WILLOW will be funded in part from 2011 to 2015 by the ERC Advanced Grant "VideoWorld" awarded to Jean Ponce by the European Research Council.

This project is concerned with the automated computer analysis of video streams: Digital video is everywhere, at home, at work, and on the Internet. Yet, effective technology for organizing, retrieving, improving, and editing its content is nowhere to be found. Models for video content, interpretation and manipulation inherited from still imagery are obsolete, and new ones must be invented. With a new convergence between computer vision, machine learning, and signal processing, the time is right for such an endeavor. Concretely, we will develop novel spatio-temporal models of video content learned from training data and capturing both the local appearance and nonrigid motion of the elements—persons and their surroundings—that make up a dynamic scene. We will also develop formal models of the video interpretation process that leave behind the architectures inherited from the world of still images to capture the complex interactions between these elements, yet can be learned effectively despite the sparse annotations typical of video understanding scenarios. Finally, we will propose a unified model for video restoration and editing that builds on recent advances in sparse coding and dictionary learning, and will allow for unprecedented control of the video stream. This project addresses fundamental research issues, but its results are expected to serve as a basis for groundbreaking technological advances for applications as varied as film post-production, video archival, and smart camera phones.

8.2.4. European Research Council (ERC) Starting Grant: “Activia” - Ivan Laptev

Participant: Ivan Laptev.

WILLOW will be funded in part from 2013 to 2017 by the ERC Starting Grant "Activia" awarded to Ivan Laptev by the European Research Council.

Computer vision is concerned with the automated interpretation of images and video streams. Today’s research is (mostly) aimed at answering queries such as “Is this a picture of a dog?”, “Is the person walking in this video?” (image and video categorisation) or sometimes “Find the dog in this photo” (object detection). While categorisation and detection are useful for many tasks, inferring correct class labels is not the final answer to visual recognition. The categories and locations of objects do not provide direct understanding of their function, i.e., how things work, what they can be used for, or how they can act and react. Neither do action categories provide direct understanding of subject’s intention, i.e., the purpose of his/her activity. Such an understanding, however, would be highly desirable to answer currently unsolvable queries such as “Am I in danger?” or “What can happen in this scene?”. Answering such queries is the aim of this project.

The main challenge is to uncover the functional properties of objects and the purpose of actions by addressing visual recognition from a different and yet unexplored perspective. The major novelty of this proposal is to leverage observations of people, i.e., their actions and interactions to automatically learn the use, the purpose and the function of objects and scenes from visual data. This approach is timely as it builds upon two key recent technological advances: (a) the immense progress in visual object, scene and human action recognition achieved in the last ten years, and (b) the emergence of massive amounts of image and video data readily available for training visual models. My leading expertise in human action recognition and video understanding puts me in a strong position to realise this project. ACTIVIA addresses fundamental research issues in automated interpretation of dynamic visual scenes, but its results are expected to serve as a basis for ground-breaking technological advances in practical applications. The recognition of functional properties and intentions as explored in this project will directly support high-impact applications such as prediction and alert of abnormal events and automated personal assistance, which are likely to revolutionise today’s approaches to crime protection, hazard prevention, elderly care, and many others.

8.2.5. European Research Council (ERC) Starting Grant: “Leap” - Josef Sivic

Participant: Josef Sivic.

The contract is to be signed and will begin during 2014. WILLOW will be funded in part from 2014 to 2018 by the ERC Starting Grant "Leap" awarded to Josef Sivic by the European Research Council.

People constantly draw on past visual experiences to anticipate future events and better understand, navigate, and interact with their environment, for example, when seeing an angry dog or a quickly approaching car. Currently there is no artificial system with a similar level of visual analysis and prediction capabilities. LEAP is a first step in that direction, leveraging the emerging collective visual memory formed by the unprecedented amount of visual data available in public archives, on the Internet and from surveillance or personal cameras - a complex evolving net of dynamic scenes, distributed across many different data sources, and equipped with plentiful but noisy and incomplete metadata. The goal of this project is to analyze dynamic patterns in this shared visual experience in order (i) to find and quantify their trends; and (ii) learn to predict future events in dynamic scenes. With ever expanding computational resources and this extraordinary data, the main scientific challenge is now to invent new and powerful models adapted to its scale and its spatio-temporal, distributed and dynamic nature. To address this challenge, we will first design new models that generalize across different data sources, where scenes are captured under vastly different imaging conditions such as camera viewpoint, temporal sampling, illumination or resolution. Next, we will develop a framework for finding, describing and quantifying trends that involve measuring long-term changes in many related scenes. Finally, we will develop a methodology and tools for synthesizing complex future predictions from aligned past visual experiences. Our models will be automatically learnt from large-scale, distributed, and asynchronous visual data, coming from different sources and with different forms of readily-available but noisy and incomplete metadata such as text, speech, geotags, scene depth (stereo sensors), or gaze and body motion (wearable sensors). Breakthrough progress on these problems would have profound implications on our everyday lives as well as science and commerce, with safer cars that anticipate the behavior of pedestrians on streets; tools that help doctors monitor, diagnose and predict patients' health; and smart glasses that help people react in unfamiliar situations enabled by the advances from this project.

8.3. International Initiatives

8.3.1. IARPA FINDER Visual geo-localization (Inria)

Participants: Josef Sivic, Petr Gronat, Nicolas Maisonneuve.

Finder is an IARPA funded project aiming to develop technology to geo-localize images and videos that do not have geolocation tag. It is common today for even consumer-grade cameras to tag the images that they capture with the location of the image on the earth's surface ("geolocation"). However, some imagery does not have a geolocation tag and it can be important to know the location of the camera, image, or objects in the scene. Finder aims to develop technology to automatically or semi-automatically geo-localize images and video that do not have the geolocation tag using reference data from many sources, including overhead and ground-based images, digital elevation data, existing well-understood image collections, surface geology, geography, and cultural information.

Partners: ObjectVideo, DigitalGlobe, UC Berkeley, CMU, Brown Univ., Cornell Univ., Univ. of Kentucky, GMU, Indiana Univ., and Washington Univ.

8.3.2. Inria Associate Team VIP

Participants: Ivan Laptev, Josef Sivic.

This project brings together three internationally recognized research groups with complementary expertise in human action recognition (Inria), qualitative and geometric scene interpretation (CMU) and large scale object recognition and human visual perception (MIT). The goal of VIP (Visual Interpretation of functional Properties) is to discover, model and learn functional properties of objects and scenes from image and video data.

Partners: Aude Oliva (MIT) and Alexei Efros (CMU). The project will be funded during 2012-2014.

8.3.3. Inria International Chair - Prof. John Canny (UC Berkeley)

Participants: John Canny [UC Berkeley], Jean Ponce, Ivan Laptev, Josef Sivic.

Prof. John Canny (UC Berkeley) has been awarded the Inria International chair in 2013. He has visited Willow in November 2013 for a week to begin a lasting collaboration.

8.3.4. Inria CityLab initiative

Participants: Josef Sivic, Jean Ponce, Ivan Laptev, Alyosha Efros [UC Berkeley].

Willow participates in the ongoing CityLab@Inria initiative (co-ordinated by V. Issarny), which aims to leverage Inria research results towards developing "smart cities" by enabling radically new ways of living in, regulating, operating and managing cities. The activity of Willow focuses on urban-scale quantitative visual analysis and is pursued in collaboration with A. Efros (UC Berkeley).

Currently, map-based street-level imagery, such as Google Street-view provides a comprehensive visual record of many cities worldwide. Additional visual sensors are likely to be wide-spread in near future: cameras will be built in most manufactured cars and (some) people will continuously capture their daily visual experience using wearable mobile devices such as Google Glass. All this data will provide large-scale, comprehensive and dynamically updated visual record of urban environments.

The goal of this project is to develop automatic data analytic tools for large-scale quantitative analysis of such dynamic visual data. The aim is to provide quantitative answers to questions like: What are the typical architectural elements (e.g., different types of windows or balconies) characterizing a visual style of a city district? What is their geo-spatial distribution (see figure 1)? How does the visual style of a geo-spatial area evolve over time? What are the boundaries between visually coherent areas in a city? Other types of interesting questions concern distribution of people and their activities: How do the number of people and their activities at particular places evolve during a day, over different seasons or years? Are there tourists sightseeing, urban dwellers shopping, elderly walking dogs, or children playing on the street? What are the major causes for bicycle accidents?

Break-through progress on these goals would open-up completely new ways smart cities are visualized, modeled, planned and simulated, taking into account large-scale dynamic visual input from a range of visual sensors (e.g., cameras on cars, visual data from citizens, or static surveillance cameras).

8.4. International Research Visitors

8.4.1. Visits of International Scientists

Prof. Alexei Efros (UC Berkeley) has visited Willow for six months in 2013. Aude Oliva (Principal investigator, Massachusetts Institute of Technology) visited Willow for three months in 2013. Prof. John Canny (UC Berkeley) has visited Willow for a week in fall 2013 to begin a long term collaboration.

8.4.2. Visits to International Teams

Vincent Delaitre has visited the Robotics Institute, Carnegie Mellon University during November 2012 — January 2013, within the scope of the Inria associate team VIP. Maxime Oquab has done a 3 months internship at Microsoft Research in New York City, U.S.A.

WIMMICS Project-Team

8. Partnerships and Cooperations

8.1. Regional Initiatives

8.1.1. ePSP

Participants: Alain Giboin, Nhan Le Than, Michel Buffa.

Nhan Le Than animates the ePSP interdisciplinary working group at Nice Sophia Antipolis University on the topics of personalized eHealth ¹⁵.

8.1.2. HCI Group of Pôle GLC at I3S UNS

Participant: Alain Giboin.

The HCI Group brings together researchers from Pôle GLC teams conducting or wishing to conduct research related to HCI. The group specifically addresses the issues of how to conduct user experiments to evaluate the UIs of the software developed in GLC. The group establishes collaborations between researchers in the design and implementation of experiments. Collaboration took place this year between the teams Rainbow and Wimmics on the assessment of (1) an application composition process driven by the composition of UIs, and (2) the prototype OntoCompo supporting this process. The prototype allows a composition mainly driven by the direct manipulation of UI elements, the other components (task model and software components) being hidden, but still being linked to the UI elements. A user testing of both the process and the prototype has been designed and implemented [70].

8.1.3. Collaboration Agorantic-Inria

Participant: Alain Giboin.

Agorantic is a Federative Structure for Research of the Université d'Avignon et des Pays du Vaucluse, conducting studies on "Culture, heritage and digital societies". Agorantic is interested in how worlds of culture and heritage interact with the Web and digital technology, leading, e.g., to: new forms of knowledge sharing and access to culture, heritage and territories; new forms of writing, mediation and use of cultural events and heritage; new forms of mobility and of territorial representation. Collaboration began this year between ITCS and HSS teams from Agorantic and Inria Sophia Antipolis, including Wimmics, conducting interdisciplinary ITCS-HSS research. This initial collaboration resulted in setting up a proposal of a project for analyzing, designing, and evaluating a system recommending visit tours to museum visitors (individuals and groups).

8.1.4. MSHS : Axe-2 "TIC, Usages et Communautés"

Participants: Alain Giboin, Aurore Defays, Fabien Gandon.

Axis-2 of the Maison des Sciences Humaines et Sociales (MSHS) du Sud-Est (Nice) is interested in the relationships between ICT, Practices and Communities. Axis-2 objective is to make explicit two aspects of the relationship between digital technology and community building: (1) networks and (2) artifacts. Two Axis-2 groups-projects address these aspects: (1) the group-project "Social networks and digital networks" and the group-project "Artifacts and coordination." The first group-project examines how the Internet allows reconstructing the dynamics of interaction networks by making explicit interaction phenomena that could not be observed and treated before the event of Big Data. The second group-project studies the impact of cognitive technologies on the social and cognitive coordination between individuals in organizational and community contexts. Wimmics was involved in the second group-project. In this group, we reported our work on the analysis and modeling of the representations shared by members of a group (also called common ground or common frame of reference).

¹⁵<http://eps.unice.fr/>

8.1.5. MSHS : SyCoViSo project, Systèmes Cognitifs et Formes de Vie Sociale

Participants: Alain Giboin, Elena Cabrio, Fabien Gandon.

SyCoViSo is a project of the MSHS Sud-Est that brings together researchers in HSS and ITCS. Several Inria teams are involved in this project, including Wimmics. SyCoViSo goal is to analyze and model internal and external cognitive processes involved in various forms of social life. SyCoViSo consisted originally of eight thematic groups; Wimmics was a member of the "Artifacts, interaction and social networks" group. Following the two SyCoViSo scientific days organized in June 2013, the project was given a second level of organization with three areas having a cross-disciplinary potential: (1) Computational modelling; (2) Classification of artefacts lying beyond the skin; (3) Unconscious factors impacting decision making: emotions, beliefs, morale, etc. Wimmics interest focused in particular on computational modeling of linguistic exchanges occurring in social networks and online communities.

8.2. National Initiatives

8.2.1. ANR Labcom SMILK

SMILK (Social Media Intelligence and Linked Knowledge) is a joint laboratory (Labcom, 2013-2016) between the Wimmics team and the Research and Innovation unit of VISEO (Grenoble). Natural Language Processing, Linked Open Data and Social Networks as well as the links between them are at the core of this LabCom. The purpose of SMILK is both to develop research and technologies in order to retrieve, analyze, and reason on textual data coming from Web sources, and to make use of LOD, social networks structures and interaction in order to improve the analysis and understanding of textual resources. Topics covered by SMILK include: use of data and vocabularies published on the Web in order to search, analyze, disambiguate and structure textual knowledge in a smart way, but also to feed internal information sources; reasoning on the combination of internal and public data and schemes, query and presentation of data and inferences in natural formats.

8.2.2. Ministry of Culture: DBpedia.fr

This project named "DBpedia.fr" proposes the creation of a French chapter of the base DBpedia used in many English applications, in particular for the publication of cultural collections. Because DBpedia is focused on the English version of Wikipedia it ignores some of the French topics and their data. This project aims at extracting a maximum of RDF data from the French version and providing a stable and scalable end-point for them. We now consider means to improve both the quantity and the quality of the data. The DBpedia.fr project was the first project of the Semanticpedia convention signed by the Ministry of Culture, the Wikimedia foundation and Inria.

Web site: <http://wimmics.inria.fr/projects/dbpedia>

8.2.3. ANR Datalift

DataLift is an ANR project (2010-2013). Its goal is to design a platform to publish and interlink datasets on the Web of data. Datalift will both publish datasets coming from a network of partners and data providers and propose a set of tools for easing the datasets publication process. DataLift brings raw structured data coming from various formats (relational databases, CSV, XML, ...) to semantic data interlinked on the Web of Data.

Partners: Inria Exmo & Wimmics, LIRMM, Eurecom, Mondeca, Atos, IGN, INSEE, FING

Web site: <http://www.datalift.org>

8.2.4. ANR Kolflow

Kolflow is an ANR project (2011-2014), it proposes to extend collective intelligence with smart agents relying on automated reasoning. Smart agents can significantly reduce the overhead of communities in the process of continuously building knowledge. Consequently, continuous knowledge building is much more efficient. Kolflow aims at building a social semantic space where humans collaborate with smart agents in order to produce knowledge understandable by humans and machines.

Partners: Inria Orpailleur & Wimmics, Silex U. Claude Bernard Lyon, GDD U. of Nantes

Web site: <http://kolflow.univ-nantes.fr>

8.2.5. *ANR OCKTOPUS*

OCKTOPUS is an ANR project (2012-2015). The objective of OCKTOPUS is to increase the potential social and economic benefit of the large and quickly growing amounts of user-generated content, by transforming it into useful knowledge. We believe that it is possible to considerably improve upon existing generic Information Retrieval techniques by exploiting the specific structure of this content and of the online communities which produce it. Specifically, we will focus on a multi-disciplinary approach in order to address the problem of finding relevant answers to questions within forums and question-answer sites. To create metrics and predictors of content quality and use them to improve the search experience of a user, we will take advantage of:

- the experience of the CRG (the management research institute of Ecole Polytechnique and CNRS) to understand better the incentives of, and interactions between individuals who produce online content within large communities;
- the experience of the Wimmics research team to analyze the structural and temporal aspects of the complex typed social graphs found within these communities;
- the ability of Alcméon (a start-up developing a search application dedicated to user-generated content) to integrate and test the results of OCKTOPUS within a common demonstration framework, in order to assess their practical usefulness when applied to concrete large-scale datasets.

Partners: Alcméon, CRG, Inria Wimmics.

Web site: <http://ocktopus.alcmeon.com>

8.2.6. *CNRS Mastodons CrEDIBLE*

Participants: Olivier Corby, Catherine Faron Zucker, Alban Gaignard.

We participate to the CrEDIBLE research project funded by the MASTODONS program of the interdisciplinary mission of CNRS which objective is to bring together scientists from all disciplines involved in the implementation of systems sharing of distributed and heterogeneous medical imaging, provide an overview of this area and to evaluate methods of state of the art and technology that affect this area. In this framework, we participated to the organization of a 3-days workshop and we worked with members of the I3S Modalis team on the distribution of algorithms in the Corese/KGRAM engine.

Catherine Faron Zucker was chairman of one of its session and worked with members of the I3S Modalis team on a survey of existing approaches for the translation of relational data to RDF data.

Web site: <https://credible.i3s.unice.fr>

8.2.7. *Inria Large Scale Initiative Action PAL*

Participants: Alain Giboin, Célia Ormea.

In collaboration with David Daney (Coprin), Rémy Ramadour (Coprin), Rémi Barraquand (Prima), Marie Babel (Lagadic).

For the second year, Wimmics participated in the large-scale initiative action PAL (Personally Assisted Living) to develop technologies and services to improve the autonomy and quality of life for elderly and frail persons. Wimmics was involved in two main actions: (1) a socio-ergonomic field study to inform the design of a device (such as a robotic shopping trolley) assisting elderly and frail persons to do their shopping autonomously; the results of this study are documented in Célia Ormea Master Thesis; (2) the development and the application of a procedure to collaboratively elaborate a shared scenario to structure the demonstration of the platform integrating the different PAL services.

Web site: <http://pal.inria.fr>

8.3. International Initiatives

8.3.1. Informal International Partners

Université de Montréal, Canada

HERON (Higher Educational Research ON tutoring systems) Laboratory (Head: Claude Frasson).

Topic of the collaboration: Social exchanges and emotions in mediated polemics – Analysis and data.

Polytechnique Montréal, Canada

Software Engineering Laboratory (Head: Pierre Robillard).

Topic of the collaboration: Modeling of software development processes and teams for quality assessment purposes.

Annaba University, Algeria

The funding of the scientific collaboration project with the LabGed laboratory of university of Annaba (Algeria) by CNRS and DPGRF (Algeria) ended last year but continued in 2013 through the co-supervising of two PhD students from the university of Annaba with our Algerian colleague Hassina Seridi. Samia Beldjoudi works on the personalization of resource recommendation and Khaled Halimi on the personalization and socialization of ubiquitous e-learning systems based on Semantic Web models and techniques.

In 2013 Khaled Halimi visited the team for three months and started writing his thesis during this period. Catherine Faron Zucker received his PhD advisor Hassina Seridi in december with the project of setting a collaboration within the PICS CNRS program in 2014.

8.3.2. Inria International Labs

We participate to the LIRIMA where we have a long term collaboration with University Gaston Berger at Saint-Louis, Senegal. We host two PhD students: Papa Fary Diallo and Oumy Seye.

Catherine Faron Zucker participated to the LIRIMA scientific days in September in Marocco ¹⁶.

8.3.3. Participation In other International Programs

Our team is strongly involved in W3C activities:

- Fabien Gandon in the Advisory Committee representative for Inria.
- Olivier Corby participates to SPARQL 1.1 standardization working group.
- Fabien Gandon and Olivier Corby participate to RDF 1.1 standardization working group.
- Serena Villata participates to the LDP (Linked Data Platform) standardization working group.

8.4. International Research Visitors

8.4.1. Visits of International Scientists

Oscar Rodriguez Rocha:

Exploiting the Semantic Web, UGC and Context-Awareness to enhance mobile services for end-users, January 25.

Claude Frasson: *The Emotional Brain*, March 3.

Alberto Barrón Cedeño: *"Uncovering" Good Feedback Instances from an On-line Machine Translation Systems*, April 26.

Luis Ibáñez: *Live Linked Data: making Linked Data writable with massive optimistic replication and Conflict-Free Replicated Data Types*, June 10.

¹⁶<http://www.lirima.uninet.cm/index.php/en>

Bernardo Magnini: *The KNOWLEDGE STORE: an Integrated Framework for Ontology Population*, September 6.

Alessio Palmero Aprosio: *Extending Linked Open Data resources exploiting Wikipedia as source of informations*, October 7.

Pierre Robillard, Professor, Department of Computer Engineering, Polytechnique Montréal, Canada.

Stefan Decker, *From Networked Knowledge to Insight(s)*, November 29.

8.4.1.1. Internships

Aurore Defays, PhD student in Ergonomics at the University of Liège, Belgium.

Gessica Puri, PhD student at the Architecture Faculty of Genoa, Italy.

ZENITH Project-Team

8. Partnerships and Cooperations

8.1. Regional Initiatives

8.1.1. Labex NUMEV, Montpellier

URL: <http://www.lirmm.fr/numev>

We are participating in the Laboratory of Excellence (labex) NUMEV (Digital and Hardware Solutions, Modelling for the Environment and Life Sciences) headed by University of Montpellier 2 in partnership with CNRS, University of Montpellier 1, and Inria. NUMEV seeks to harmonize the approaches of hard sciences and life and environmental sciences in order to pave the way for an emerging interdisciplinary group with an international profile. The NUMEV project is decomposed in four complementary research themes: Modeling, Algorithms and computation, Scientific data (processing, integration, security), Model-Systems and measurements. Patrick Valduriez heads the theme on scientific data.

8.1.2. Institut de Biologie Computationnelle (IBC), Montpellier

URL: <http://www.ibc-montpellier.fr>

IBC is a 5 year project with a funding of 2Meuros by the MENRT (“Investissements d’Avenir” program) to develop innovative methods and software to integrate and analyze biological data at large scale in health, agronomy and environment. Patrick Valduriez heads the workpackage on integration of biological data and knowledge.

8.2. National Initiatives

8.2.1. ANR

8.2.1.1. OTMedia (2011-2013), 150Keuros

Participants: Alexis Joly, Julien Champ, Pierre Letessier.

The Transmedia Observatory project, launched in November 2010, aims to develop processes, tools and methods to better understand the challenges and changes in the media sphere. Studying and tracking media events on all media (web, press, radio and television) are the two prioritized research areas. OTMedia brings together six partners: Inria (Zenith), AFP (French Press Agency), INA (French National Audiovisual Institute), Paris 3 Sorbonne Nouvelle (researchers in Information Science and Communication), Syllabs (a SME specialized in semantic analysis and automatic creation of text) and the Computer Science Laboratory of Avignon University. Zenith addresses more specifically the research challenges related to the trans-media tracking of visual contents (images and videos) and the clustering of heterogeneous information sources.

8.2.2. PIA

8.2.2.1. Datascale (2013-2015), 250Keuros

Participants: Reza Akbarinia, Florent Masseglia, Saber Salah, Patrick Valduriez.

The Datascale project is a “projet investissements d’avenir” on big data with Bull (leader), CEA, ActiveEon SAS, Armadillo, Twenga, IPGP, Xedix and Inria (Zenith) . The goal of the project is to develop the essential technologies for big data, including efficient data management, software architecture and database architecture, and demonstrate their scalability with representative applications. In this project, the Zenith team works on data mining with Hadoop MapReduce.

8.2.2.2. Xdata (2013-2015), 125Keuros

Participants: Emmanuel Castanier, Patrick Valduriez.

The X-data project is a “projet investissements d’avenir” on big data with Data Publica (leader), Orange, La Poste, EDF, Cinequant, Hurence and Inria (Indes, Planete and Zenith) . The goal of the project is to develop a big data platform with various tools and services to integrate open data and partners’s private data for analyzing the location, density and consuming of individuals and organizations in terms of energy and services. In this project, the Zenith team heads the workpackage on data integration.

8.2.3. Others

8.2.3.1. RTRA Pl@ntNet (2009-2013), 1M euros

Participants: Alexis Joly, Hervé Goëau, Julien Champ, Saloua Litayem, Mathias Chouet.

The Pl@ntNet project <http://www.plantnet-project.org/> was launched in 2009 by a large international consortium headed by three groups with complementary skills (UMR AMAP ⁶, IMEDIA project team at Inria, and the French botanical network TelaBotanica ⁷), with financial support from the Agropolis Foundation. Due to the departure of Nozha Boujemaa from the head of IMEDIA and the mobility of Alexis Joly in 2011, Zenith has been entrusted with the Inria’s management and scientific coordination of the project in spring 2012. The objectives of the project are (i) to develop cutting-edge transdisciplinary research at the frontier between integrative botany and computational sciences, based on the use of large datasets and expertise in plant morphology, anatomy, agronomy, taxonomy, ecology, biogeography and practical uses (ii) provide free, easy-access software tools and methods for plant identification and for the aggregation, management, sharing and utilization of plant-related data (iii) promote citizen science as a powerful means to enrich databases with new information on plants and to meet the need for capacity building in agronomy, botany and ecology.

8.2.3.2. CIFRE INA/Inria (2011-2013), 100Keuros

Participants: Alexis Joly, Pierre Letessier.

This CIFRE contract with INA allows funding a 3-years PhD (Pierre Letessier). This PhD addresses research challenges related to content-based mining of visual objects in large collections.

8.2.3.3. CIFRE INA/Inria (2013-2016), 100Keuros

Participants: Alexis Joly, Valentin Leveau, Patrick Valduriez.

This CIFRE contract with INA allows funding a 3-years PhD (Valentin Leveau). This PhD addresses research challenges related to large-scale supervised content-based retrieval notably in distributed environments.

8.2.3.4. CNRS INS2I Mastodons (2013), 30Keuros

Participants: Florent Masseglia, Esther Pacitti [leader], Patrick Valduriez.

This project deals with the problems of big data in the context of life science, where masses of data are being produced, e.g. by Next Generation Sequencing technologies or plant phenotyping platforms. In this project, Zenith addresses the specific problems of large-scale data analysis and data sharing.

8.3. European Initiatives

8.3.1. FP7 Projects

8.3.1.1. CoherentPaaS

Project title: A Coherent and Rich Platform as a Service with a Common Programming Model

Instrument: Integrated Project

Duration: 2013 - 2016

Total funding: 5 Meuros (Zenith: 500Keuros)

Coordinator: U. Madrid, Spain

⁶<http://amap.cirad.fr/en/>

⁷<http://www.tela-botanica.org/>

Partner: FORTH (Greece), ICCS (Greece), INESC (Portugal) and the companies MonetDB (Netherlands), QuartetFS (France), Sparsity (Spain), Neurocom (Greece), Portugal Telecom (Portugal).

Inria contact: Patrick Valduriez

Accessing and managing large amounts of data is becoming a major obstacle to developing new cloud applications and services with correct semantics, requiring tremendous programming effort and expertise. CoherentPaaS addresses this issue in the cloud PaaS landscape by developing a PaaS that incorporates a rich and diverse set of cloud data management technologies, including no SQL data stores, such as key-value data stores and graph databases, SQL data stores, such as in-memory and column-oriented databases, hybrid systems, such as SQL engines on top on key-value data stores, and complex event processing data management systems. It uses a common query language to unify the programming models of all systems under a single paradigm and provides holistic coherence across data stores using a scalable, transactional management system. CoherentPaaS will dramatically reduce the effort required to build and the quality of the resulting cloud applications using multiple cloud data management technologies via a single query language, a uniform programming model, and ACID-based global transactional semantics. CoherentPaaS will design and build a working prototype and will validate the proposed technology with real-life use cases. In this project, Zenith is in charge of designing an SQL-like query language to query multiple databases (SQL, NoSQL) in a cloud and implementing a compiler/optimizer and query engine for that language.

8.4. International Initiatives

8.4.1. Inria Associate Teams

8.4.1.1. BIGDATANET

Title: A hybrid P2P/cloud for big data

Inria principal investigator: Patrick Valduriez

International Partner (Institution - Laboratory - Researcher):

University of California at Santa Barbara (United States) - Distributed Systems Lab. - Amr El Abbadi and Divy Agrawal

Duration: 2013 -2015

See also: <https://team.inria.fr/zenith/projects/international-projects/bigdatanet/>

The main objective of this research and scientific collaboration is to develop a hybrid architecture of a computational platform that leverages the cloud computing and the P2P computing paradigms. The resulting architecture will enable scalable data management and data analysis infrastructures that can be used to host a variety of next-generation applications that benefit from computing, storage, and networking resources that exist not only at the network core (i.e., data-centers) but also at the network edge (i.e., machines at the user level as well as machines available in CDNs – content distribution networks hosted in ISPs).

8.4.2. International Benchmarks

8.4.2.1. ImageCLEF

Title: The CLEF Cross Language Image Retrieval Track

Inria principal investigator: Alexis Joly

International Partners (Institution - Laboratory - Researcher): HES-SO (Switzerland), Yahoo! Research (Spain), IBrandenburg Technical University (Germany), diap Research Institute (Switzerland), University of Alicante (Spain), Universidad Politécnic de Valencia (Spain), UMR AMAP (France)

Duration: 2011 -2013

See also: <http://www.imageclef.org>

Since its first edition in 2003, ImageCLEF has become one of the key initiatives promoting the benchmark evaluation of algorithms for the cross-language annotation and retrieval of images in various domains, such as public and personal images, to data acquired by mobile robot platforms and botanic collections. Over the years, by providing new data collections and challenging tasks to the community of interest, the ImageCLEF lab has achieved a unique position in the multi lingual image annotation and retrieval research landscape. As an illustration of its impact, the 2013 edition attracted more than 100 registered team world-wide and 42 of them did cross the finish line by submitting runs of their system [30]. Zenith, through the implication of Alexis Joly and Hervé Goëau, is one of the co-organizer of the lab and the initiator of the plant retrieval task since 2011

8.4.3. Inria International Partners

8.4.3.1. Informal International Partners

We have regular scientific relationships with research laboratories in

- North America: Univ. of Waterloo (Tamer Özsu), Mc Gill, Montreal (Bettina Kemme).
- Asia: National Univ. of Singapore (Beng Chin Ooi, Stéphane Bressan), Wonkwang University, Korea (Kwangjin Park)
- Europe: Univ. of Amsterdam (Naser Ayat, Hamideh Afsarmanesh), Univ. of Madrid (Ricardo Jiménez-Periz), UPC Barcelona (Josep Lluís Larriba Pey, Victor Muñoz)

8.4.4. Inria International Labs

The Bigdatanet associated team takes part in the Inria@SiliconValley lab.

8.4.5. Participation In other International Programs

We are involved in the following international actions:

- FAPERJ-Inria project SwfP2Pcloud (Data-centric workflow management in hybrid P2P clouds, 2011-2013) with UFRJ (Marta Mattoso, Vanessa Braganholo, Alexandre Lima) and LNCC, Rio de Janeiro (Fabio Porto) to work on large scale scientific workflows in hybrid P2P clouds;
- CNPq-Inria project Hoscarr (HPC and data management, 2012-2015) with LNCC (Fabio Porto), UFC, UFRGS (Philippe Navaux), UFRJ (Alvaro Coutinho, Marta Mattoso) to work on data management in high performance computing environments.

8.5. International Research Visitors

8.5.1. Visits of International Scientists

Dennis Shasha (NYU, USA) gave a seminar on “Storing Clocked Programs Inside DNA: A Simplifying Framework for Nanocomputing” in January.

Prof. Marta Mattoso (UFRJ, Rio de Janeiro) gave a seminar in the context of IBC on “Big Data Workflows – how provenance can help” in March and “Algebraic Dataflows for Big Data Analysis” in November.

Aravind Venkatesan (NTNU, Trondheim, Norway) gave a seminar in the context of IBC on “Bringing Semantic Web Technology to the Lab Bench” in October.

Sihem Amer-Yahia (LIG) gave a seminar on “New Perspectives in Social Data Management” in November.

Themis Palpanas (Univ. Trento, Italy) gave a seminar on “Enabling Exploratory Analysis on Very Large Scientific Data” in December.

8.5.2. Visits to International Teams

Reza Akbarinia and Florent Massgla visited UCSB (Prof. Divy Agrawal and Amr El Abbadi) in May. Esther Pacitti and Patrick Valduriez also visited UCSB and Lawrence Berkeley Laboratory, Berkeley (Dr. Arie Shoshani and Deb. Agrawal) in June.

COPRIN Project-Team

8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. ANR

8.1.1.1. ID4CS project

Participant: Yves Papegay.

The ID4CS project, supported by French National Research Agency (ANR) through COSINUS program has the ambition to propose a modeling and simulation environment for designing complex systems such as aircrafts, based on a self-adaptive, distributed and open multi-agent architecture distributing the optimization process inside the agents.

As a partner of the project we are mainly involved in the definition of the use case on preliminary aircraft design, in collaboration with Airbus (6.2.1), in development of uncertainty analysis algorithms, and in automatic generation of agents based on models.

8.1.1.2. COGIRO project

Participants: Julien Alexandre Dit Sandretto, David Daney [correspondant], Jean-Pierre Merlet.

We are collaborating with LIRMM, LASMEA and TECNALIA for the development of large scale wire-driven parallel robots¹. We are especially involved in the calibration of a prototype developed by LIRMM and TECNALIA, see section 6.1.1.2.

8.2. European Initiatives

8.2.1. FP7 Projects

8.2.1.1. CABLEBOT

Type: COOPERATION

Instrument: Specific Targeted Research Project

Objective: to develop a new generation of modular and reconfigurable robots able to perform many different steps in the post-production of large-scale structures.

Duration: November 2011 - October 2014

Coordinator: Ms. Mariola Rodríguez (TECNALIA, Spain)

Partner: TECNALIA (Spain), CNRS-LIRMM, FRAUNHOFFER-IPA, UDE, Inria, EADS, ACCIONA, VICINAY

Inria contact: Jean-Pierre Merlet

Abstract: The CABLEBOT project² deals with a novel methodology for designing, developing and evaluating cable robots customized for the automation in large-scale auxiliary processes. Parallel cable robots extend the payloads and workspace of conventional industrial robots by more than two orders of magnitude. The main objective is to develop a new generation of modular and reconfigurable robots able to perform many different steps in the post-production of large-scale structures. Three key technologies will be developed: a) Design of Cable Robot: Software tools to design the layout and geometry of cable robots, b) Industrial Process Planning: Simulation of cable robots

¹<http://www.lirmm.fr/cogiro/>

²<http://www.cablebot.eu/>

to verify the operation of cable robots in environments with large-scale structures c) Control Algorithms and Systems: Distributed control and kinematic transformation to operate modular cable robots. Two application examples are targeted in close cooperation to industry: aeronautical applications of maintenance and the handling of construction beams. In both cases existing automation can hardly be used due to maneuverability of heavy and big parts and the risk associated. The results are feasible for many other fields including large-workspace movements of products, with impact in logistics, transport, and warehousing. The exploitation and commercialization of CABLEBOT are driven by VICINAY CEMVISA, the application of industrial scenarios, two end-users of different sectors - EADS and ACCIONA - will automate their currently manual post-production. TECNALIA provides the technology for simulation in terms of productivity, cost, safety and robustness, whereas the design of the robots is in charge of LIRMM and Inria. IPA and UDE are in charge of the control algorithms, on distributed and force control of redundant systems. Benefits include an increase of production efficiency, a wider range of products, light and reconfigurable structure mechanisms and adaptable and more flexible operator assistance systems.

8.2.1.2. RAPP

Type: COOPERATION

Instrument: Specific Targeted Research Project

Objective: Robotic Applications for Delivering Smart User Empowering Applications

Duration: December 2013-December 2016

Coordinator: CERTH/ITI

Partner: CERTH/ITI(Greece), Inria, WUT (Poland), ORTELIO (UK), ORMYLIA (Greece), INGEMA (Spain)

Inria contact: David Daney, Jean-Pierre. Merlet, Manuel Serrano

Abstract: s our societies are affected by a dramatic demographic change, in the near future elderly and people requiring support in their daily life will increase and caregivers will not be enough to assist and support them. Socially interactive robots can help to confront this situation not only by physically assisting people but also functioning as a companion. The increasing sales figures of robots are pointing that we are in front of a trend break for robotics. To lower the cost for developers and to increase their interest on developing robotic applications, the RAPP introduces the idea of robots as platforms. RAPP (Robotic Applications for Delivering Smart User Empowering Applications) will provide a software platform in order to support the creation and delivery of robotics applications (RAPPs) targeted to people at risk of exclusion, especially older people. The open-source software platform will provide an API that contains the functionalities for implementing RAPPs and accessing the robot's sensors and actuators using higher level commands, by adding a middleware stack with added functionalities suitable for different kinds of robots. RAPP will expand the computational and storage capabilities of robots and enable machine learning operations, distributed data collection and processing, and knowledge sharing among robots in order to provide personalized applications based on adaptation to individuals. The use of a common API will assist developers in creating improved applications for different types of robots that target to people with different needs, capabilities and expectations, while at the same time respect their privacy and autonomy, thus the proposed RAPP Store will have a profound effect in the robotic application market. The results of RAPP will be evaluated through the development and benchmarking of social assistive RAPPs, which exploit the innovative features (RAPP API, RAPP Store, knowledge reuse, etc.) introduced by the proposed paradigm.

8.3. International Initiatives

8.3.1. Informal International Partners

Our collaboration are described in the figure 1 .



Figure 1. COPRIN collaboration. JP: joint project, JS: joint stay, Jphd: joint PhD students

IMARA Project-Team

8. Partnerships and Cooperations

8.1. Regional Initiatives

The Yvelines General Council has designated the winners of its second call for projects "Intelligent Car - City of the Future". Following a selection made by a jury, the winners were four consortia. IMARA was involved in two of the four winning projects: TRANS'YVES, coordinated by ADM Concept, and Link & Go coordinated by AKKA Technologies (with Controlsys, Inria and DBT) project. The Yvelines department wanted to promote the emergence of projects on sustainable development and automated driving with electric vehicles. On four projects selected, two of them are just referring to a concept of automatic parking, the vehicle comes to park all alone with no one on board. The call for proposals with a budget of 3 million Euros has been used to finance demonstrators that were exhibited at the Geneva Motor Show in 2013 as part of the Green Pavilion.

Link & Go was coordinated has been awarded the prestigious *2013 Grand National Engineering Award*.

8.2. National Initiatives

8.2.1. ANR

8.2.1.1. ABV

Title: Automatisation basse vitesse

Instrument: ANR

Duration: January 2009 - April 2013

Coordinator: IFFSTAR

Others partners: Continental, IBISC, IEF, Induct, Inria, LAMIH, Vismetris, UHA-MIPS, Veolia Environnement

See also: <http://www.projet-abv.fr/>

Abstract: This ambitious project aims at demonstrating automated driving at low speed in urban areas and on peri-urban roads. The aim is to demonstrate the technical feasibility of automating driving at low speeds, typically in situations of congestion or heavy traffic.

8.2.1.2. SCORE@F

Title: Système COopératif Routier Expérimental Français

Instrument: FUI

Duration: 2010-2013

Coordinator: Renault-REGIENOV

Others partners: UTAC, LAB, EURECOM, IFSTTAR, Inria, Télécom Ecole de Management

See also: <http://www.scoref.fr/>

Abstract: SCORE@F (French Experimental Road Cooperative System) is a collaborative research project, experimental road cooperative systems as part of a European framework for experimentation. The SCORE@F is intended to prepare the deployment of "road cooperative systems" on motorways and other road environments through the implementation of operational tests in an open environment. Road cooperative systems are based on wireless local communication between vehicles and road infrastructure (V2I - I2V) and between vehicles (V2V). The deployment of cooperative systems will be strongly influenced by road Framework Directive of the European Commission ITS.

8.2.1.3. COCOVEA

Title: Coopération Conducteur-Véhicule Automatisé

Instrument: ANR

Duration: 01/11/2013 – 30/04/2017

Coordinator: Jean-Christophe Popieul (LAMIH - University of Valenciennes)

Partners: LAMIH, IFSTTAR, Inria, University of Caen, COMETE, PSA, CONTINENTAL, VALEO, AKKA Technologies, SPIROPS

Inria contact: Fawzi Nashashibi

Abstract: CoCoVeA project aims at demonstrating the need to integrate from the design of the system, the problem of interaction with the driver in resolving the problems of sharing the driving process and the degree of freedom, authority, level of automation, prioritizing information and managing the operation of the various systems. This approach requires the ability to know at any moment the state of the driver, the driving situation in which he finds himself, the operating limits of the various assistance systems and from these data, a decision regarding activation or not the arbitration system and the level of response.

8.2.2. Competitivity Clusters

IMARA team is a very active partner in the competitiveness clusters, especially MOV'EO and System@tic. We are involved in several technical committees like the DAS SUR of MOV'EO for example. IMARA is also the main Inria contributor in the VeDeCoM institute (IEED). VeDeCoM is financing a PhD thesis of Pierre Merdrignac; his scientific research topic is on the fusion of perception and communication for pedestrian assistance, monitoring and tracking.

8.3. European Initiatives

8.3.1. FP7 Projects

8.3.1.1. DRIVE C2X

Type: COOPERATION

Defi: Driving implementation of car 2 x communication technology

Instrument: Integrated Project

Objectif: ICT for Mobility of the Future

Duration: January 2011 - December 2013

Coordinator: DAIMLER AG (Germany)

Partner: 31 partners from automotive industry, electronic and supplier industry, software development, traffic engineering, research institutes and road operators.

Inria contact: Thierry Ernst

Abstract: With 31 partners, 15 support partners and 18.8 million Euro budget, DRIVE C2X will lay the foundation for rolling out cooperative systems in Europe. Hence, lead to a safer, more economical and more ecological driving.

8.3.1.2. ITSSV6

Type: COOPERATION

Defi: IPV6 ITS Station Stack for Cooperative Systems FOTs

Instrument: Specific Targeted Research Project

Objectif: ICT for Mobility of the Future

Duration: February 2011 - January 2014

Coordinator: Inria (France)

Partner: Universidad de Murcia (Spain), Institut Télécom (France), Mines ParisTech (France), Inria (France), Lesswire (Germany), SZTAKI (Hungary), IPTE (Austria), BlueTechnix (Austria).

Inria contact: Thierry Ernst

Abstract: ITSSv6 builds on the base of existing standards from ETSI, ISO and IETF and IPv6 software available from CVIS and GeoNet projects. Its main objective is to deliver an optimized IPv6.

See also: <http://itssv6.inria.fr/>

8.3.1.3. SANDRA

Type: COOPERATION

Instrument: Integrated Project

Objectif: NC

Duration: October 2009 - September 2013

Coordinator: SELEX ES SPA (Italy)

Partner: Acreo (Sweden), Airtel ATN (Ireland), Alenia Aermacchi (Italy), Altys (France), Bradford University (United Kingdom), Cyner (Netherlands), Dassault Aviation (France), Deutsche Flugsicherung GmbH (Germany), Deutsches Zentrum für Luft- und Raumfahrt e.V. (Germany), EADS Innovation Works (France), Gatehouse (Denmark), IMST GmbH (Germany), Inria (France), Intecs (Italy), LionixBV (Netherlands), Monitorsoft (Russian Federation), Nationaal Lucht- en Ruimtevaartlaboratorium - NLR (Netherlands), Paris Lodron Universität (Salzburg), RadioLabs (Italy), SITA (Switzerland), Slot Consulting (Hungary), Thales Aerospace (United Kingdom), Thales Alenia Space (France), Thales Avionics (France), Thales TRT-UK (United Kingdom), TriaGnoSys GmbH (Germany), University of Pisa (Italy), University of Twente (Netherlands).

Inria contact: Thierry Ernst

Abstract: The SANDRA concept consists of the integration of complex and disparate communication media into a lean and coherent architecture for aeronautical networking.

See also: <http://sandra.aero/2013/>

8.3.1.4. CATS

Title: City Alternative Transport System

Type: COOPERATION (TRANSPORTS)

Instrument: Specific Targeted Research Project (STREP)

Objectif: NC

Duration: January 2010 - December 2013

Coordinator: Lohr Industrie (France)

Partner: Inria (France), CTL (Italy), EPFL (Switzerland), TECHNION (Israel), GEA (Switzerland), ERT (France), and the cities of Formello (Italy), Strasbourg (France) and Ploiesti (Romania).

Inria contact: Michel Parent

Abstract: CATS' aim is the full development and experimentation of a new urban transport service based on a new generation of vehicle. Its major innovation is the utilization of a single type of vehicle for two different uses: individual use or semi collective transport. This new transport service is aimed at filling the gap between public mass transport and private individual vehicles.

See also: <http://www.cats-project.org>

8.3.1.5. FURBOT

Title: Architectures of Light Duty Vehicles for urban freight transport

Type: COOPERATION (TRANSPORTS)

Instrument: Specific Targeted Research Project (STREP)

Objectif: NC

Duration: November 2011 - October 2014

Coordinator: Genova University (Italy)

Partner: Bremach (Italy), ZTS (Slovakia), Universite di Pisa (Italy), Persico (Italy), Mazel (Spain), TCB (Portugal), Inria (France).

Inria contact: Fawzi Nashashibi

Abstract: The project proposes novel concept architectures of light-duty, full-electrical vehicles for efficient sustainable urban freight transport and will develop FURBOT, a vehicle prototype, to factually demonstrate the performance expected.

8.3.1.6. CityMobil2

Type: COOPERATION (TRANSPORTS)

Instrument: Large-scale integrating project

Objectif: NC

Duration: September 2012 - August 2016

Coordinator: University of Rome La Sapienza, CTL (Italy)

Partner: Inria (France), DLR (germany), GEA Chanard (Switzerland), POLIS (Belgium), ERT (Belgium), EPFL (Switzerland),...(45 partners!)

Inria contact: Fawzi Nashashibi

Abstract: The CityMobil2 goal is to address and to remove three barriers to the deployment of automated road vehicles: the implementation framework, the legal framework and the unknown wider economic effect. CityMobil2 features 12 cities which will revise their mobility plans and adopt wherever they will prove effective automated transport systems. Then CityMobil2 will select the best 5 cases (among the 12 cities) to organize demonstrators. The project will procure two sets of automated vehicles and deliver them to the five most motivated cities for a 6 to 8 months demonstration in each city. CityMobil2 will establish a workgroup that will deliver a proposal for a European Directive to set a common legal framework to certify automated transport systems.

See also: <http://www.citymobil2.eu/en/>

8.3.1.7. DESERVE

Title: DEvelopment platform for Safe and Efficient dRiVE

Objectif: NC

Duration: September 2012 - August 2015

Coordinator: VTT (Finland)

Partner: CRF (Italy), Armines (France), CONTINENTAL AUTOMOTIVE FRANCE SAS (France), FICOSA (Italy), Inria (France), TRW (Great Britain), AVL (Austria), BOSCH (Germany), DAIMLER (Germany), VOLVO (Sweden),...(26 partners)

Inria contact: Fawzi Nashashibi

Abstract: To manage the expected increase of function complexity together with the required reduction of costs (fixed and variable) DESERVE will design and build an ARTEMIS Tool Platform based on the standardization of the interfaces, software (SW) reuse, development of common non-competitive SW modules, and easy and safety-compliant integration of standardized hardware (HW) or SW from different suppliers. With innovative design space exploration (DSE) methods system design costs can be reduced by more than 15%. Hence, DESERVE will build an innovation ecosystem for European leadership in ADAS embedded systems, based on the automotive R&D actors, with possible applications in other industrial domains.

See also: <http://www.artemis-ia.eu/project/index/view/?project=38>

8.3.1.8. Mobility2.0

Title: Co-operative ITS systems for enhanced electric vehicle mobility

Type: COOPERATION (TRANSPORTS)

Objectif: NC

Duration: September 2012 - February 2015

Coordinator: Broadbit (Slovakia)

Partner: ETRA (Spain), Barcelona Digital (Spain), ICCS (Greece), MRE (Italy), Armines (France), University of Twente (Netherlands), Privé (Italy), NEC (United Kingdom)

Inria contact: Jean-Marc Lasgouttes

Abstract: Mobility2.0 will develop and test an in-vehicle commuting assistant for FEV mobility, resulting in more reliable and energy-efficient electro-mobility. In order to achieve a maximum impact, Mobility2.0 takes an integrated approach of addressing the main bottlenecks of urban FEV mobility: “range anxiety” related to the limited FEV range, scarcity of parking spaces with public recharging spots, and the congestion of urban roads. Our integrated approach means the application developed by Mobility2.0 will utilize co-operative systems to simultaneously consider these bottlenecks, so that such an optimization can be achieved which still guarantees reliable transportation for each FEV owner. Mobility2.0 will focus on assisting the daily urban commute, which represents the bulk of urban mobility.

See also: <http://mobility2.eu/>

8.3.2. Collaborations with Major European Organizations

- IMARA is a full partner of VRA:
VRA – Vehicle and Road Automation is a support action funded by the European Union to create a collaboration network of experts and stakeholders working on deployment of automated vehicles and its related infrastructure. VRA project is considered as the cooperation interface between EC funded projects, international relations and national activities on the topic of vehicle and road automation. It is financed by the European Commission DG CONNECT and coordinated by ERTICO – ITS Europe.
- IMARA is member of the Working Group on Automation. This group has been created and is animated by ERTICO ITS Europe. The Automation Working Group was formed under the iMobility Forum, with the initial high level aims of exploring and promoting the potential of highly automated vehicles and applications and working towards the development of a roadmap for the deployment of automated systems.

8.4. International Initiatives

8.4.1. Inria International Partners

8.4.1.1. Declared Inria International Partners

IMARA has developed a wide collaboration network with international partners from both academia and industry.

- **NAIST** : IMARA has signed a MoU with the Nara Institute of Science and Technology (NAIST). The research themes of cooperation are in the area of *advanced intelligent transportation systems (ITS)*.
- **YAMAHA** : IMARA has signed a MoU with YAMAHA to conduct joint research on the *New Generation of AGV projects (Autonomous Ground Vehicles)*.
- **AXTER Technologies** : IMARA has signed a MoU with AXTER Technologies for the cooperation on the *autonomous navigation in indoor environments for automated industrial vehicles*.
- **Simon Bolívar University** : IMARA and University Simon Bolivar (Venezuela) have started a privileged cooperation thanks to the ECOS Nord Program. The collaboration will start effectively in 2014. Researchers and PhD from both institutes will visit each other and conduct common research on the benefits of ITS solutions for an enhanced mobility in congested cities. IMARA has already hosted in the past 3 engineers as trainees working in the field of intelligent control.

8.4.1.2. Informal International Partners

CITRIS : IMARA has been part of Inria's teams involved in the cooperation with the CITRIS (Center for Information Technology Research in the Interest of Society, California), as a key actor of the joint research between Inria and the University of Berkeley around the smart city.

8.4.2. Participation In other International Programs

ECOS Nord : Since December 4th (2013), Inria and the University of Simon Bolivar (Venezuela) are partners of a project financed by the ECOS Nord Program (ECOS Nord No. V14M01). This project is co-financed by the Ministries of Foreign Affairs of Venezuela and France.

8.5. International Research Visitors

8.5.1. Visits of International Scientists

- **Prof. Plamen PETROV** : professor at the Technical University of Sofia (Bulgaria). He has been an invited professor at Inria from June to September 2013. During this period he made joint research on intelligent adaptive control applied to vehicle manoeuvring (automated parking and assisted overtaking).
- **Satoshi MATSUURA** : He has been a Visiting Professor from NAIST (Nara Institute of Science and Technology, Japan). Until March 2013, he has been working in the area of telecommunications applied to ITS. He was also the initiator of the signed MoU between NAIST and IMARA.

8.5.1.1. Internships

- M. Kenta Mori : he was an intern from NAIST, working in the field of telecommunications applied to ITS applications, under the supervision of Mrs. Oyunchimeg Shagdar.
- M. José Javier Anaya Catala : he was an intern from the Technical University of Madrid (UPM, Spain). He developed a vehicle-to-pedestrian communication protocol using WiFi devices.
- Miss Oriana Rojas-Michelena : she was an intern from Simón Bolívar University and she developed an on-board vehicle controller dedicated to the management of the approach of traffic lights.
- M. Ray Lattarulo Arias : he was an intern from Simón Bolívar University (Venezuela). He developed a fuzzy controller to follow Bezier-like trajectories executed by a cybercar.
- Ernest Creiser : he was an intern from ENSAE ParisTech / Univ. Paris Dauphine. He worked on the development of man-machine interfaces dedicated to the EU-FURBOT project.
- Mohamed Maddouri : he was intern from Télécom SudParis and he developed a tool dedicated to the calibration of a laser-camera set used in a moving vehicle.