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FIELD

Activity Report 2016

Section Partnerships and Cooperations

Edition: 2017-08-25

CAIRN Project-Team

8. Partnerships and Cooperations

8.1. Regional Initiatives

8.1.1. Images & Réseaux Competitivity Cluster - Embrace (2014-2016)

Participants: Raphaël Bardoux, Arnaud Carer, Olivier Sentieys.

Embrace (Embedded Radio Accelerator) is a project which involves CAIRN and two Small Medium Enterprises (SMEs): Digidia and PrimeGPS. Embrace aims at developing a software radio platform to enable the digital demodulation of HF signals. Both SMEs will use this platform as the first step to implement new products. These products will be dedicated to two different applications (Global Navigation Satellite System and Navigation Safety) at the heart of the markets of the SMEs. CAIRN goal is the technological transfer of the methods proposed by the team that enable the rapid prototyping of digital radios.

8.2. National Initiatives

8.2.1. ANR Blanc - PAVOIS (2012–2016)

Participants: Arnaud Tisserand, Emmanuel Casseau, Jérémie Métairie, Karim Bigou, Pierre Guilloux.

PAVOIS is a project on Arithmetic Protections Against Physical Attacks for Elliptic Curve based Cryptography that will provide novel implementations of curve based cryptographic algorithms on custom hardware platforms. A specific focus is placed on trade-offs between efficiency and robustness against physical attacks. It involves IRISA-CAIRN (Lannion) and LIRMM (Perpignan and Montpellier). Theoretical aspects 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 design innovative cryptographic hardware architectures of a specific processor based on the theoretical advancements described above to implement curve based protocols. For more details see http://pavois.irisa.fr.

8.2.2. ANR Ingénérie Numérique et Sécurité - ARDyT (2011-2016)

Participants: Arnaud Tisserand, Pierre Guilloux.

ARDyT 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. For more details see http://ardyt.irisa.fr.

8.2.3. Labex CominLabs - BoWI (2012-2016)

Participants: Olivier Sentieys, Arnaud Carer.

The BoWi project (Body Wold Interactions) project aims at designing an accurate gesture and body movement estimation using very-small and low-power wearable sensor nodes, to propose pioneer interfaces for an emerging interacting world based on smart environments (house, media, information and entertainment systems...). Relying on Wireless Body Areas Sensor Networks, we propose an accurate Gesture and Body Movement estimation with extremely severe constraints in terms of footprint and energy consumption. The BoWI geolocation approach will combine radio communication distance measurement and inertial sensors and will also strongly benefit from cooperative techniques based on multiple observations and distributed computation. Different types of applications, such as health care, activity monitoring and environment control, are considered and prototyped. BoWI involves CAIRN, IRISA Granit (Lannion), IETR (Rennes), and Lab-STICC (Brest, Lorient, Vannes). For more details see http://www.bowi.cominlabs.ueb.eu.

8.2.4. Labex CominLabs - 3DCORE (2014-2018)

Participants: Olivier Sentieys, Daniel Chillet, Cédric Killian, Jiating Luo, Van Dung Pham, Ashraf El-Antably.

3DCORE (3D Many-Core Architectures based on Optical Network on Chip) is a project investigating new solutions based on silicon photonics to enhance by 2 to 3 magnitude orders energy efficiency and data rate of on-chip interconnect in the context of a many-core architecture. Moreover, 3DCore will take advantage of 3D technologies to design a specific optical layer suitable for a flexible and energy efficient high-speed optical network on chip (ONoC). 3DCORE involves CAIRN, FOTON (Rennes, Lannion) and Institut des Nanotechnologies de Lyon. For more details see http://www.3d-opt-many-cores.cominlabs.ueb.eu.

8.2.5. Labex CominLabs - RELIASIC (2014-2018)

Participants: Emmanuel Casseau, Arnaud Tisserand.

RELIASIC (Reliable Asic) will address the issue of fault-tolerant computation with a bottom-up approach, starting from an existing application as a use case (a GPS receiver) and adding some redundant mechanisms to allow the GPS receiver to be tolerant to transient errors due to low voltage supply. RELIASIC involves CAIRN, Lab-STICC (Lorient) and IETR (Rennes). For more details see http://www.reliasic.cominlabs.ueb.eu In this project, CAIRN is in charge of the analysis and design of arithmetic operators for fault tolerance. We focus on the hardware implementations of conventional arithmetic operators such as adders, multipliers and MACs but also higher level operators like butterfly computation operator for FFT algorithm.

8.2.6. Labex CominLabs & Lebesgue - H-A-H (2014-2017)

Participants: Arnaud Tisserand, Karim Bigou, Gabriel Gallin, Audrey Lucas.

H-A-H for *Hardware and Arithmetic for Hyperelliptic Curves Cryptography* is a project on advanced arithmetic representation and algorithms for hyper-elliptic curve cryptography. It will provide novel implementations of HECC based cryptographic algorithms on custom hardware platforms. H-A-H involves CAIRN (Lannion) and IRMAR (Rennes). For more details see http://h-a-h.inria.fr/.

8.3. European Initiatives

8.3.1. H2020 ARGO

Participants: Steven Derrien, Olivier Sentieys, Imen Fassi, Ali Hassan El-Moussawi.

Program: H2020-ICT-04-2015
Project acronym: ARGO
Project title: WCET-Aware Parallelization of Model-Based Applications for Heterogeneous Parallel Systems
Duration: Feb. 2016 - Feb. 2019
Coordinator: KIT
Other partners: KIT (DE), UR1/Inria/CAIRN (FR), Recore Systems (NL), TEI-WG (GR), Scilab Ent. (FR), Absint (DE), DLR (DE), Fraunhofer (DE)

Increasing performance and reducing cost, while maintaining safety levels and programmability are the key demands for embedded and cyber-physical systems, e.g. aerospace, automation, and automotive. For many applications, the necessary performance with low energy consumption can only be provided by customized computing platforms based on heterogeneous many-core architectures. However, their parallel programming with time-critical embedded applications suffers from a complex toolchain and programming process. ARGO will address this challenge with a holistic approach for programming heterogeneous multi- and many-core architectures using automatic parallelization of model-based real-time applications. ARGO will enhance WCET-aware automatic parallelization by a cross-layer programming approach combining automatic tool-based and user-guided parallelization to reduce the need for expertise in programming parallel heterogeneous architectures. The ARGO approach will be assessed and demonstrated by prototyping comprehensive time-critical applications from both aerospace and industrial automation domains on customized heterogeneous many-core platforms.

8.3.2. ANR International ARTEFaCT

Participants: Olivier Sentieys, Benjamin Barrois, Tara Petric, Tomofumi Yuki.

Program: ANR International France-Switzerland

Project acronym: ARTEFaCT

Project title: AppRoximaTivE Flexible Circuits and Computing for IoT

Duration: Feb. 2016 - Dec. 2019

Coordinator: CEA

Other partners: CEA-LETI (FR), CAIRN (FR), EPFL (SW)

The ARTEFaCT project aims to build on the preliminary results on inexact and exact near-threshold and sub-threshold circuit design to achieve major energy consumption reductions by enabling adaptive accuracy control of applications. ARTEFaCT proposes to address, in a consistent fashion, the entire design stack, from physical hardware design, up to software application analysis, compiler optimizations, and dynamic energy management. We do believe that combining sub-near-threshold with inexact circuits on the hardware side and, in addition, extending this with intelligent and adaptive power management on the software side will produce outstanding results in terms of energy reduction, i.e., at least one order of magnitude, in IoT applications. The project will contribute along three research directions: (1) approximate, ultra low-power circuit design, (2) modeling and analysis of variable levels of computation precision in applications, and (3) accuracy-energy trade- offs in software.

8.4. International Initiatives

8.4.1. Inria Associate Teams

8.4.1.1. HARDIESSE

Title: Heterogeneous Accelerators for Reconfigurable DynamIc, Energy efficient, Secure SystEms

International Partner (Institution - Laboratory - Researcher):

University of Massachusetts at Ahmerst (United States) - Reconfigurable Computing Group - Russel Tessier

Start year: 2014

See also: https://team.inria.fr/cairn/hardiesse/

Rapid evolutions of applications and standards require frequent in-the-field system modifications and thus strengthens the need for adaptive devices. This need for a strong flexibility, combined with technology evolution (and the so-called power wall) has motivated the surge towards the use of multiple processor cores on a single chip (MPSoC). While it is now clear that we have entered the multi-core era, it is however indisputable that, especially for energy-efficient embedded systems, these architectures will have to be heterogeneous, by combining processor cores and specialized accelerators. We foresee a need for systems able to continuously adapt themselves to changing environments where software updates alone will not be enough for tackling energy management and error tolerance challenges. We believe that a dynamic and transparent adaptation of the hardware structure is the key to success. Security will also be an important challenge for embedded devices. Protections against physical attacks will have to be integrated in all secured components. In this Associated Team, we study new reconfigurable structures for such hardware accelerators with specific focus on: energy efficiency, runtime dynamic reconfiguration, security, and verification.

8.4.2. Inria International Partners

8.4.2.1. Declared Inria International Partners

8.4.2.1.1. LRS

Title: Loop unRolling Stones: compiling in the polyhedral model

International Partner (Institution - Laboratory - Researcher):

Colorado State University (United States) - Department of Computer Science - Prof. Sanjay Rajopadhye

8.4.2.1.2. HARAMCOP

Title: Hardware accelerators modeling using constraint-based programming

International Partner (Institution - Laboratory - Researcher):

Lund University (Sweden) - Department of Computer Science - Prof. Krzysztof Kuchcinski

8.4.2.1.3. SPINACH

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

International Partner (Institution - Laboratory - Researcher):

University College Cork (Ireland) - Department of Electrical and Electronic Engineering - Prof. Liam Marnane and Prof. Emanuel Popovici

Arithmetic operators for cryptography, side channel attacks for security evaluation, energy-harvesting sensor networks, and sensor networks for health monitoring.

8.4.2.2. Informal International Partners

Imec (Belgium), Fault-tolerant computing architectures.

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

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

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

Department of Electrical and Computer Engineering, University of Patras (Greece), Wireless Sensor Networks, Worst-Case Execution Time, priority scheduling, loop transformations for memory optimizations.

Karlsruhe Institute of Technology - KIT (Germany), Loop parallelization and compilation techniques for embedded multicores.

Ruhr - University of Bochum - RUB (Germany), Reconfigurable architectures.

University of Science and Technology of Hanoi (Vietnam), Participation of several CAIRN's members in the Master ICT / Embedded Systems.

8.5. International Research Visitors

8.5.1. Visits of International Scientists

Prof. Maciej Cieselski, University of Massachusetts, Amherst, US, for three weeks in July. This visit was partly funded by HARDIESSE Inria Associate Team.

Prof. Daniel Massicotte, Université du Québec à Trois-Rivières, CA, for three weeks in December. This visit was funded by ISTIC.

Maroua Gam, LabTim (Technologie Imagerie Médicale), Monastir, Tunisia, for one month in March.

8.5.2. Visits to International Teams

Angeliki Kritikakou visited University of Patras, Greece, for 1 week in November. This visit was funded by U. Rennes 1.

Patrice Quinton visited University of Massachusetts, Amherst, US, for 1 week in December. This visit was funded by HARDIESSE Inria Associate Team.

Tomofumi Yuki visited University of Arizona, US, in June.

8.5.2.1. Sabbatical programme

Casseau Emmanuel

Date: Aug 2016 - Jul 2017

Institution: University of Auckland (New Zealand), Parallel and Reconfigurable Research Lab. of the Electrical and Computer Engineering department.

The goal of the project is to propose dynamic mapping and scheduling algorithms dedicated to unreliable heterogeneous platforms, enabling self-adaptive and resource-aware computing.

CELTIQUE Project-Team

5. Partnerships and Cooperations

5.1. Regional Initiatives

5.1.1. Labex COMIN Labs Seccloud project

Participants: Frédéric Besson, Thomas Jensen, Alan Schmitt, Thomas Genet, Martin Bodin, Gurvan Cabon.

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.

5.2. National Initiatives

5.2.1. The ANR VERASCO project

Participants: Sandrine Blazy, Delphine Demange, David Pichardie.

Static program analysis, Certified static analysis

The VERASCO project (2012–06/2016) 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.

5.2.2. The ANR AnaStaSec project

Participants: Frédéric Besson, Sandrine Blazy, Thomas Jensen, Alexandre Dang, Julien Lepiller.

Static program analysis, Security, Secure compilation

The AnaStaSec project (2015–2018) aims at ensuring security properties of embedded critical systems using static analysis and security enhancing compiler techniques. The case studies are airborne embedded software with ground communication capabilities. The Celtique project focuses on software fault isolation which is a compiler technology to ensure by construction a strong segregation of tasks.

This is a joint project with the Inria teams ANTIQUE and PROSECCO, CEA-LIST, TrustInSoft, AMOSSYS and Airbus Group.

5.2.3. The ANR Binsec project

Participants: Frédéric Besson, Sandrine Blazy, Pierre Wilke, Julien Lepiller.

Binary code, Static program analysis

The Binsec project (2013–2017) is funded 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 and EADS IW.

5.2.4. The ANR MALTHY project

Participant: David Cachera.

The MALTHY project, funded by ANR in the program INS 2013, aims at advancing the state-of-the-art in real-time and hybrid model checking by applying advanced methods and tools from linear algebra and algebraic geometry. MALTHY is coordinated by VERIMAG, involving CEA-LIST, Inria Rennes (Tamis and Celtique), Inria Saclay (MAXPLUS) and VISEO/Object Direct.

5.2.5. The ANR AJACS project

Participants: Martin Bodin, Gurvan Cabon, Thomas Jensen, Alan Schmitt.

The goal of the AJACS project is to provide strong security and privacy guarantees on the client side for web application scripts. To this end, we propose to define a mechanized semantics of the full JavaScript language, the most widely used language for the Web. We then propose to develop and prove correct analyses for JavaScript programs, in particular information flow analyses that guarantee no secret information is leaked to malicious parties. The definition of sub-languages of JavaScript, with certified compilation techniques targeting them, will allow us to derive more precise analyses. Finally, we propose to design and certify security and privacy enforcement mechanisms for web applications, including the APIs used to program real-world applications.

The project partners include the following Inria teams: Celtique, Indes, Prosecco, and Toccata; it also involves researchers from Imperial College as external collaborators. The project runs from December 2014 to June 2018.

5.2.6. The ANR DISCOVER project

Participants: Sandrine Blazy, Delphine Demange, Thomas Jensen, David Pichardie, Yon Fernandez de Retana.

The DISCOVER project project aims at leveraging recent foundational work on formal verification and proof assistants to design, implement and verify compilation techniques used for high-level concurrent and managed programming languages. The ultimate goal of DISCOVER is to devise new formalisms and proof techniques able to scale to the mechanized correctness proof of a compiler involving a rich class of optimizations, leading to efficient and scalable applications, written in higher-level languages than those currently handled by cutting-edge verified compilers.

In the light of recent work in optimizations techniques used in production compilers of high-level languages, control-flow-graph based intermediate representations seems too rigid. Indeed, the analyses and optimizations in these compilers work on more abstract representations, where programs are represented with data and control dependencies. The most representative representation is the sea-of-nodes form, used in the Java Hotspot Server Compiler, and which is the rationale behind the highly relaxed definition of the Java memory model. DISCOVER proposes to tackle the problem of verified compilation for shared-memory concurrency with a resolute language-based approach, and to investigate the formalization of adequate program intermediate representations and associated correctness proof techniques.

The project runs from October 2014 to September 2018.

5.3. European Initiatives

5.3.1. Collaborations in European Programs, Except FP7 & H2020

Program:CA COST Action CA15123

Project acronym: EUTYPES

Project title: European research network on types for programming and verification

Duration: 03/2016 to 03/2020

Coordinator: Herman Geuvers (Radboud University Nijmegen, The Netherlands)

Other partners: Austria, Belgium, Czech Republic, Denmark, Estonia, Finland, France, Macedonia, Germany, Hungary, Israel, Italy, Lithuania, Netherlands, Norway, Poland, Portugal, Romania, Serbia, Slovenia, Spain, Sweden, United Kingdom

Abstract: Types are pervasive in programming and information technology. A type defines a formal interface between software components, allowing the automatic verification of their connections, and greatly enhancing the robustness and reliability of computations and communications. In rich dependent type theories, the full functional specification of a program can be expressed as a type. Type systems have rapidly evolved over the past years, becoming more sophisticated, capturing new aspects of the behaviour of programs and the dynamics of their execution.

This COST Action will give a strong impetus to research on type theory and its many applications in computer science, by promoting (1) the synergy between theoretical computer scientists, logicians and mathematicians to develop new foundations for type theory, for example as based on the recent development of "homotopy type theory", (2) the joint development of type theoretic tools as proof assistants and integrated programming environments, (3) the study of dependent types for programming and its deployment in software development, (4) the study of dependent types for verification and its deployment in software analysis and verification. The action will also tie together these different areas and promote cross-fertilisation.

5.4. International Initiatives

5.4.1. Inria Associate Teams Not Involved in an Inria International Labs

5.4.1.1. JCERT

Title: Verified Compilation of Concurrent Managed Languages

International Partner (Institution - Laboratory - Researcher):

Purdue University (United States) - School of Electrical and Computer Engineering (ECE) - Jan Vitek

Start year: 2014

See also: http://www.irisa.fr/celtique/ea/jcert/

Safety-critical applications demand rigorous, unambiguous guarantees on program correctness. While a combination of testing and manual inspection is typically used for this purpose, bugs latent in other components of the software stack, especially the compiler and the runtime system, can invalidate these hard-won guarantees. To address such concerns, additional laborious techniques such as manual code reviews of generated assembly code are required by certification agencies. Significant restrictions are imposed on compiler optimizations that can be performed, and the scope of runtime and operating system services that can be utilized. To alleviate this burden, the JCert project is implementing a verified compiler and runtime for managed concurrent languages like Java or C#.

5.4.2. Inria International Partners

5.4.2.1. WEBCERT

Title: Verified Trustworthy web Applications

International Partner (Institution - Laboratory - Researcher):

Imperial College (United Kingdom) - Department of Computing - Philippa Gardner

Duration: 2015 - 2019

Start year: 2015

See also: JSCert web page

The goal of the WebCert partnership is to extend the development of the JSCert formal semantics of JavaScript in the following domains: further mechanized specification, human-readable formal specification, program logic, verification tools, and the formalization of Defensive JavaScript.

5.4.2.2. Informal International Partners

Alan Schmitt is part of a Polonium Hubert Curien Partnership (PHC) with the University of Wrocław. This partnership is led by Sergueï Lenglet, from Loria, Nancy (currently visiting member of the Celtique project).

5.5. International Research Visitors

5.5.1. Visits of International Scientists

5.5.1.1. Internships

Thomas Wood

Date: Oct 2016 - Dec 2016

Institution: Imperial College (United Kingdom)

Ahmad Salim Al-Sibahi

Date: Sep 2016 - Jan 2017

Institution: IT University of Copenhagen (Denmark)

HYCOMES Project-Team

8. Partnerships and Cooperations

8.1. Regional Initiatives

- Ayman Aljarbouh's PhD is partially funded by an ARED grant of the Brittany Regional Council. His doctoral work took place in the context of the Modrio (completed in 2016) and Sys2Soft (completed in 2015) projects on hybrid systems modeling. Ayman Aljarbouh is working on accelerated simulation techniques for hybrid systems. In particular, he is focusing on the regularisation, at runtime, of chattering behaviour and the approximation of Zeno behaviour.
- Benoît Caillaud and Aurélien Lamercerie are participating to the S3PM and SUNSET projects of the CominLabs excellence laboratory [0]. This project focuses on the computation of surgical procedural knowledge models from recordings of individual procedures, and their execution [31]. 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 [9], [5].

8.2. European Initiatives

8.2.1. Collaborations in European Programs, Except FP7 & H2020

Program: ITEA2

Project acronym: Modrio

Project title: Model Driven Physical Systems Operation

Duration: September 2012 – May 2016

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).

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.

[0] http://www.s3pm.cominlabs.ueb.eu/

PACAP Project-Team

9. Partnerships and Cooperations

9.1. National Initiatives

9.1.1. Capacités: Projet "Investissement d'Avenir", 1/11/14 to 31/01/2018

Participants: Damien Hardy, Isabelle Puaut, Viet Anh Nguyen, Sébastien Martinez.

The project objective is to develop a hardware and software platform based on manycore architectures, and to demonstrate the relevance of these manycore architectures (and more specifically the Kalray manycore) for several industrial applications. The Kalray MPPA manycore architecture is currently the only one able to meet the needs of embedded systems simultaneously requiring high performance, lower power consumption, and the ability to meet the requirements of critical systems (low latency I/O, deterministic processing times, and dependability). The project partners are Kalray (lead), Airbus, Open-Wide, Safran Sagem, IS2T, Real Time at Work, Dassault Aviation, Eurocopter, MBDA, ProbaYes, IRIT, Onera, Verimag, Inria, Irisa, Tima and Armines.

9.1.2. Multicore: Inria Project Lab, 2013-2016

Participants: Erven Rohou, Nabil Hallou.

Multicore is an Inria Project Lab (IPL, formerly *Action d'Envergure*) started in 2013. It is entitled "Large scale multicore virtualization for performance scaling and portability". Partner project-teams include: PACAP, 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.

9.1.3. ANR Continuum 2015–2019

Participants: Erven Rohou, Rabab Bouziane.

The CONTINUUM project aims to address the energy-efficiency challenge in future computing systems by investigating a design continuum for compute nodes, which seamlessly goes from software to technology levels via hardware architecture. Power saving opportunities exist at each of these levels, but the real measurable gains will come from the synergistic focus on all these levels as considered in this project. Then, a cross-disciplinary collaboration is promoted between computer science and microelectronics, to achieve two main breakthroughs: i) combination of state-of-the-art heterogeneous adaptive embedded multicore architectures with emerging communication and memory technologies and, ii) power-aware dynamic compilation techniques that suitably match such a platform.

Continuum started on Oct 1st 2015. Partners are LIRMM and Cortus SAS.

9.1.4. ANR CHIST-ERA SECODE 2016-2018

Participants: Nicolas Kiss, Damien Hardy, Erven Rohou.

In this project, we specify and design error correction codes suitable for an efficient protection of sensitive information in the context of Internet of Things (IoT) and connected objects. Such codes mitigate passive attacks, like memory disclosure, and active attacks, like stack smashing. The innovation of this project is to leverage these codes for protecting against both cyber and physical attacks. The main advantage is a full coverage of attacks of the connected embedded systems, which is considered as a smart connected device and also a physical device. The outcome of the project is first a method to generate and execute cyber-resilient software, and second to protect data and its manipulation from physical threats like side-channel attacks. Theses results are demonstrated by using a smart sensor application with hardened embedded firmware and tamper-proof hardware platform.

Partners are Télécom Paris Tech, Université Paris 8, University of Sabancı(Turkey), and Université Catholique de Louvain (Belgium).

9.1.5. ANR W-SEPT 2012-2016

Participants: 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.

9.1.6. PEPS INS2I gDGA

Participant: Sylvain Collange.

This interdisciplinary project aims at extending the definition and the range of applicability of distance geometry, with a particular attention to its discretization. As it is already possible to remark from recent publications in the scientific literature, the distance geometry can nowadays be seen as a classical problem in operational research, with a wide range of potential applications. Among the possible extensions, this project will mainly focus on dynamical problems, motivated by a certain number of novel applications that we have identified. These include interaction motion adaptation, the simulation of crowd behaviors, and the conception of recommender systems that are able to satisfy modern privacy regulations. The classical application of the distance geometry arising in the biological field will also be considered in this project. The necessity of a strong computational power for the mentioned applications motivates the need of implementing our algorithms in environments capable of exploiting the resources in GPU cards.

Partners are: Inria, Unviersité de Rennes 2, INSA Rennes, Université d'Avignon, CNRS.

9.2. European Initiatives

9.2.1. FP7 & H2020 Projects

9.2.1.1. ANTAREX

Participants: Erven Rohou, Imane Lasri.

Title: Auto-Tuning and Adaptivity appRoach for Energy efficient exascale HPC Systems

Programm: H2020

Duration: September 2015 - September 2018

Coordinator: Politecnico di Milano, Italy (POLIMI)

Partners:

- Consorzio Interuniversitario Cineca (Italy)
- Dompé Farmaceutici Spa (Italy)
- Eidgenoessische Technische Hochschule Zürich (Switzerland)
- Vysoka Skola Banska - Technicka Univerzita Ostrava (Czech Republic)
- Politecnico di Milano (Italy)
- Sygic As (Slovakia)
- Universidade do Porto (Portugal)

Inria contact: Erven Rohou

Energy-efficient heterogeneous supercomputing architectures need to be coupled with a radically new software stack capable of exploiting the benefits offered by the heterogeneity at all the different levels (supercomputer, job, node) to meet the scalability and energy efficiency required by Exascale supercomputers. ANTAREX will solve these challenging problems by proposing a disruptive holistic approach spanning all the decision layers composing the supercomputer software stack and exploiting effectively the full system capabilities (including heterogeneity and energy management). The main goal of the ANTAREX project is to provide a breakthrough approach to express application self-adaptivity at design-time and to runtime manage and autotune applications for green and heterogenous High Performance Computing (HPC) systems up to the Exascale level.

9.2.1.2. Eurolab-4-HPC

Participant: André Seznec.

Title: EuroLab-4-HPC: Foundations of a European Research Center of Excellence in High Performance Computing Systems

Programm: H2020

Duration: September 2015 - September 2017

Coordinator: CHALMERS TEKNISKA HOEGSKOLA AB

Partners:

Barcelona Supercomputing Center - Centro Nacional de Supercomputacion (Spain)

Chalmers Tekniska Hoegskola (Sweden)

École Polytechnique Federale de Lausanne (Switzerland)

Foundation for Research and Technology Hellas (Greece)

Universität Stuttgart (Germany)

Rheinisch-Westfaelische Technische Hochschule Aachen (Germany)

Technion - Israel Institute of Technology (Israel)

Universitaet Augsburg (Germany)

The University of Edinburgh (United Kingdom)

Universiteit Gent (Belgium)

The University of Manchester (United Kingdom)

Inria contact: Albert Cohen (Inria Paris)

Europe has built momentum in becoming a leader in large parts of the HPC ecosystem. It has brought together technical and business stakeholders from application developers via system software to exascale systems. Despite such gains, excellence in high performance computing systems is often fragmented and opportunities for synergy missed. To compete internationally, Europe must bring together the best research groups to tackle the longterm challenges for HPC. These typically cut across layers, e.g., performance, energy efficiency and dependability, so excellence in research must target all the layers in the system stack. The EuroLab-4-HPC project's bold overall goal is to build connected and sustainable leadership in high-performance computing systems by bringing together the different and leading performance oriented communities in Europe, working across all layers of the system stack and, at the same time, fueling new industries in HPC.

9.2.1.3. DAL

Participants: Pierre Michaud, Sylvain Collange, Erven Rohou, André Seznec, Arthur Perais, Sajith Kalathingal, Andrea Mondelli, Aswinkumar Sridharan.

Title: DAL: Defying Amdahl's Law

Program: FP7

Type: ERC

Duration: April 2011 - March 2016

Coordinator: Inria

Inria contact: André Seznec

Multicore processors have now become mainstream for both general-purpose and embedded computing. Instead of working on improving the architecture of the next generation multicore, with the DAL project, we deliberately anticipate the next few generations of multicores. While multicores featuring 1000's of cores might become feasible around 2020, there are strong indications that sequential programming style will continue to be dominant. Even future mainstream parallel applications will exhibit large sequential sections. Amdahl's law indicates that high performance on these sequential sections is needed to enable overall high performance on the whole application. On many (most) applications, the effective performance of future computer systems using a 1000-core processor chip will significantly depend on their performance on both sequential code sections and single thread. We envision that, around 2020, the processor chips will feature a few complex cores and many (may be 1000's) 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.

9.2.1.4. ARGO

Participants: Isabelle Puaut, Damien Hardy.

Title: Argo: WCET-Aware Parallelization of Model-Based Applications for Heterogeneous Parallel Systems

Program: H2020

Type: RIA

Duration: Jan 2016 - Dec 2018

Coordinator: Karlsruher Institut fuer Technologie (KIT)

Université Rennes I contact: Steven Derrien

Partners:

Karlsruher Institut fuer Technologie (KIT)

SCILAB enterprises SAS

Recore Systems BV

Université de Rennes 1

Technologiko Ekpaideftiko Idryma (TEI) Dytikis Elladas

Absint GmbH

Deutsches Zentrum fuer Luft - und Raumfahrt EV

Fraunhofer

Increasing performance and reducing costs, while maintaining safety levels and programmability are the key demands for embedded and cyber-physical systems in European domains, e.g. aerospace, automation, and automotive. For many applications, the necessary performance with low energy consumption can only be provided by customized computing platforms based on heterogeneous many-core architectures. However, their parallel programming with time-critical embedded applications suffers from a complex toolchain and programming process. Argo (WCET-Aware PaRallelization of Model-Based Applications for HeteroGeneOus Parallel Systems) will address this challenge with a holistic approach for programming heterogeneous multi- and many-core architectures using automatic parallelization of model-based real-time applications. Argo will enhance WCET-aware automatic parallelization by a crosslayer programming approach combining automatic tool-based and user-guided parallelization to reduce the need for expertise in programming parallel heterogeneous architectures. The Argo approach will be assessed and demonstrated by prototyping comprehensive time-critical applications from both aerospace and industrial automation domains on customized heterogeneous many-core platforms.

Argo also involves Steven Derrien, Angeliki Kritikakou, and Imen Fassi from the CAIRN team.

9.2.2. Collaborations in European Programs, Except FP7 & H2020

9.2.2.1. COST Action TACLe - Timing Analysis on Code-Level 10-2012/09-2016

Participants: Damien Hardy, Isabelle Puaut, Benjamin Rouxel.

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

Isabelle Puaut is in the management committee of the COST Action TACLe - Timing Analysis on Code-Level (http://www.tacle.eu). She is responsible of Short Term Scientific Missions (STSM) within TACLe.

9.2.3. Collaborations with Major European Organizations

9.2.3.1. HiPEAC4 NoE

Participants: Pierre Michaud, Erven Rohou, André Seznec.

P. Michaud, A. Seznec and E. Rohou are members of the European Network of Excellence HiPEAC4.

HiPEAC4 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.

9.3. International Initiatives

9.3.1. PHC IMHOTEP

Participant: Erven Rohou.

Title: Thoth – An Automatic Dynamic Binary Parallelisation System

International Partner (Institution - Laboratory - Researcher):

Egypt-Japan University of Science and Technology - Prof. Ahmed ElMahdy.

Dates: 2016–2017

With the current global trend towards utilizing cloud computing and smart devices, executing the same application across becomes a necessity. Moreover, parallelism is now abundant with various forms that include thread- and data-parallel execution models. Such diversity in ISA and explicit parallelism makes software development cost prohibitive, especially for natively optimized binaries. This project leverages dynamic binary translation technology to provide for exploiting the underlying parallel resources without the need of having the source code of the application. In particular the project integrates low overhead dynamic profiling, novel OSR parallel de-optimization and a retargetable parallelization modules to allow for dynamic parallelization of binaries.

9.3.2. Inria Associate Teams Not Involved in an Inria International Labs

9.3.2.1. PROSPIEL

Participant: Sylvain Collange.

Title: Profiling and specialization for locality

International Partner (Institution - Laboratory - Researcher):

Universidade Federal de Minas Gerais (Brazil) - DCC - Fernando Magno Quintão Pereira

Start year: 2015

See also: https://team.inria.fr/pacap/prospiel/

The PROSPIEL project aims at optimizing parallel applications for high performance on new throughput-oriented architectures: GPUs and many-core processors. Traditionally, code optimization is driven by a program analysis performed either statically at compile-time, or dynamically at run-time. Static program analysis is fully reliable but often over-conservative. Dynamic analysis provides more accurate data, but faces strong execution time constraints and does not provide any guarantee. By combining profiling-guided specialization of parallel programs with runtime checks for correctness, PROSPIEL seeks to capture the advantages of both static analysis and dynamic analysis. The project relies on the polytope model, a mathematical representation for parallel loops, as a theoretical foundation. It focuses on analyzing and optimizing performance aspects that become increasingly critical on modern parallel computer architectures: locality and regularity.

9.3.3. Inria International Partners

9.3.3.1. Informal International Partners

The PACAP project-team has informal collaborations (visits, common publications) with University of Wisconsin at Madison (Pr Wood), University of Toronto (Pr Moshovos), University of Ghent (Dr Eyerman), University of Uppsala (Pr Hagersten), University of Cyprus (Pr Sazeides), the Egyptian-Japanese University of Science and Technology (Pr Ahmed El-Mahdy), Intel Haifa (Dr Zaks, Eng Nuzman), Barcelona Supercomputing Center (Dr Cazorla, Dr Abella), ISEP Porto (Dr Nelissen, Dr Nélis).

9.4. International Research Visitors

9.4.1. Visits of International Scientists

9.4.1.1. Internships

Rubens Emilio Alves Moreira, student at Universidade Federal de Minas Gerais, visited from Feb 2016 to May 2016 within the context of the PROSPIEL associated team.

Stefano Cherubin, PhD student at Politecnico di Milano for one month in Oct 2016, within the context of the ANTAREX H2020 project.

Anita Tino, PhD student at Ryerson University, visited from Oct 2016 within the context of a MITACS grant.

SUMO Project-Team

9. Partnerships and Cooperations

9.1. National Initiatives

9.1.1. ANR

ANR STOCH-MC: Model-Checking of Stochastic Systems using approximated algorithms, 2014-2018, http://perso.crans.org/~genest/stoch.htmlweb site.
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.

ANR HeadWorks: Human-Centric Data-oriented WORKflows , 2016-2020
Led by Université Rennes 1.
Partners: Inria Project Team VALDA (LSV and ENS-ULM), Univestité Rennes 1 (DRUID), Inria SUMO, Inria Lille (LINKs), MNHN, Foule Factory.
Headwork was accepted in 2016. Participants : Loïc Hélouët, Éric Badouel.

Partners: IRISA (DRUID), ENS ULM (VALDA), Inria SUMO, Inria Lille (LINKs), MNHN, Foule Factory.

The objective of this project is to develop techniques to facilite development, deployment, and monitring of crowd-based participative applications. This requires handling complex workflows with multiple participants, incertainty in data collections, incentives, skills of contributors, ... To overcome these challenges, Headwork will define rich workflows with multiple participants, data and knowledge models to capture various kind of crowd applications with complex data acquisition tasks and human specificities. We will also address methods for deploying, verifying, optimizing, but also monitoring and adapting crowd- based workflow executions at run time.

9.1.2. IPL HAC SPECIS

The Inria Project Lab HAC SPECIS (High-performance Application and Computers, Studying PErformance and Correctness In Simulation, 2016-2020: http://hacspecis.gforge.inria.fr/) is a transversal project internal to Inria. The goal of the HAC SPECIS project is to answer the methodological needs raised by the recent evolution of HPC architectures by allowing application and runtime developers to study such systems both from the correctness and performance point of view. Inside this project, we collaborate with Martin Quinson (Myriads team) on the dynamic formal verification of high performance runtimes and applications. The PhD of The Anh Pham is granted by this project.

Partners: Inria teams AVALON (Lyon), POLARIS (Grenoble), HIEPACS, STORM (Bordeaux), MEXICO (Paris), MYRIADS, SUMO (Rennes), VERIDIS (Nancy).

Participants: Thierry Jéron, The Anh Pham.

9.1.3. National informal collaborations

The team collaborates with the following researchers:

- Yliès Falcone (CORSE LIG/Inria team in Grenoble) and Antoine Rollet (Labri Bordeaux) on the enforcement of timed properties,
- Arnaud Sangnier (IRIF) on the parameterized verification of probabilistic systems,
- Béatrice Bérard (LIP6) and Serge Haddad (LSV) on problems of opacity and diagnosis.
- Thomas Chatain, on problems related to concurrency and time,
- Eric Rutten and Gwenael delaval on the control of reconfigurable systems as well as making the ling between Reax and Heptagon / BZR (http://bzr.inria.fr/),
- Patricia Bouyer (LSV, ENS Cachan) on the analysis of probabilistic timed systems and quantitative aspects of verification,
- François Laroussinie (IRIF, UP7-Diderot) on logics for multi-agent systems.

9.2. European Initiatives

9.2.1. FP7 & H2020 Projects

Nicolas Markey is a member of Project ERC EQualIS whose principal investigator is Patricia Bouyer from LSV.

9.3. International Initiatives

9.3.1. Inria Associate Teams Not Involved in an Inria International Labs

9.3.1.1. QuantProb

Title: Quantitative analysis of non-standard properties in probabilistic models

International Partner (Institution - Laboratory - Researcher):

Technical University of Dresde (Germany) - Saxe - Christel Baier

Start year: 2016

See also: http://www.irisa.fr/sumo/QuantProb/

Quantitative information flow and fault diagnosis share two important characteristics: quantities (in the description of the system as well as in the properties of interest), and users partial knowledge. Yet, in spite of their similar nature, different formalisms have been proposed. Beyond these two motivating examples, defining a unified framework can be addressed by formal methods. Formal methods have proved to be effective to verify, diagnose, optimize and control qualitative properties of dynamic systems. However, they fall short of modelling and mastering quantitative features such as costs, energy, time, probabilities, and robustness, in a partial observation setting. This project proposal aims at developing theoretical foundations of formal methods for the quantitative analysis of partially observable systems.

9.3.2. Inria International Partners

9.3.2.1. Informal International Partners

The team collaborates on runtime enforcement with the group of Prof. Stavros Tripakis (http://users.ics.aalto.fi/stavros/) at Aalto University (Finland), where our former PhD student Srinivas Pinisetty is doing a Post-doc and with Thomas Brihaye (University of Mons) on the analysis of probabilistic timed systems.

The team has well-established collaborations with several institutes in India. CMI (Chennai Mathematical Institute, M. Mukund and N.K. Kumar), IIT Bombay (S. Akshay).

The team is building a new collaboration with Ecole Polytechnique Montreal (J. Mullins).

9.4. International Research Visitors

9.4.1. Visits of International Scientists

L. Ricker visited the SUMO team for 2 months in May-June 2016.

9.4.1.1. Internships

Robert Nsaibirni from the University of Yaoundé I joined the team from Sept. 2016 in the context of an Eiffel grant.

9.4.2. Visits to International Teams

9.4.2.1. Research Stays Abroad

Nathalie Bertrand spent a month at the Simons Institute for the theory of computing, UC Berkeley, California. She participated to the program Logical Structure in Computation (https://simons.berkeley.edu/programs/logic2016).

TAMIS Team

9. Partnerships and Cooperations

9.1. Regional Initiatives

ARED grant for Nisrine Jafri.

Postdocs grants for Fabrizio Biondi, Jeffrey Paul Burdges, Florian Dold, Ronan Lashermes.

9.2. National Initiatives

9.2.1. ANR

- ANR MALTHY, Méthodes ALgèbriques pour la vérification de modèles Temporisés et HYbrides, Thao Dang, 4 years, Inria and VISEO and CEA and VERIMAG
- ANR COGITO, Runtime Code Generation to Secure Devices,, 3 years, Inria and CEA and ENSMSE and XLIM.

9.3. European Initiatives

9.3.1. FP7 & H2020 Projects

9.3.1.1. ACANTO

Participants: Axel Legay, Thomas Given-Wilson, Sean Sedwards, Olivier Zendra.

Start: 2015. End: 2018.

The population of the advanced countries is ageing. This simple and widely recognised fact has important implications for health, society and economics. The most evident is in the number of people who report activity limitations, which grows significantly with age as clearly shown in the following chart. Activity limitations have an adverse effect on a person's productivity, on the quality of her social relations and, ultimately, on her quality of life. Policy makers confronted with a problem of challenging complexity: how to develop an effective strategy to fight the physical and cognitive decline of older adults in the face of ever shrinking financial resources for health care and social services.

In this context, technology can be of considerable help to care–givers to extend the range and the efficacy of their actions. The ACANTO project (http://www.ict-acanto.eu) aims to develop a portfolio of technical solution that can serve this purpose. More specifically, our goal is to spur older adults into a sustainable and regular level of physical exercise under the guidance and the supervision of their carers.

The key elements of ACANTO are a robotic friend (the FriWalk) that sup-ports the user in the execution of daily activities that require physical exercise and an intelligent system that recommends activites that a senior user perceives as compelling and rewarding.

The FriWalk takes the form of a standard walking assistant, but it is in fact an intelligent robot that is able to localise itself, to sense the surrounding environment, to plan a course of action that suits the user needs and to guide the user along safe routes. The FriWalk is also a personal trainer that can support the user in the execution of a training programme, monitor the motion of the user in search of muscular or gait problems and report them into the user profile (that can be inspected by doctors and physicians).

The second key idea of ACANTO is that physical exercise is actually "concealed" within compelling activities (such as shopping, taking walks in museums and exhibitions etc.). Such activities have a social dimension (they are proposed to group of users) and are chosen based on the interest and on the past experiences of the user. At the heart of the recommendation system there is a social network which is created and developed by primarily using information collected by the FriWalk using "physical" observations on her behaviour and on her emotional state. For this reason, we call this social network "cyberphysical".

This project aims at developping an autonomous system to drive groups of citizens with respect to point of interest. Those citizens are supposed to communicate, and one of the objective of Tamis is to build a robust and secure system to guarantee this communication. Axel Legay and Olivier Zendra are the permanent researchers of Tamis involved in this project. The project supports two postdocs in Tamis.

9.3.1.2. DIVIDEND

Participant: Laurent Morin.

Start: 2014. End: 2017.

The DIVIDEND project (http://www.chistera.eu/projects/dividend) attacks the data centre energy efficiency bottleneck through vertical integration, specialisation, and cross-layer optimization. Our vision is to present heterogeneous data centres, combining CPUs, GPUs, and task-specific accelerators, as a unified entity to the application developer and let the runtime optimize the utilization of the system resources during task execution. DIVIDEND embraces heterogeneity to dramatically lower the energy per task through extensive hardware specialisation while maintaining the ease of programmability of a homogeneous architecture. To lower communication latency and energy, DIVIDEND refers a lean point-to-point messaging fabric over complex connection-oriented network protocols. DIVIDEND addresses the programmability challenge by adapting and extending the industry-led heterogeneous systems architecture programming language and runtime initiative to account for energy awareness and data movement. DIVIDEND provides for a cross-layer energy optimization framework via a set of APIs for energy accounting and feedback between hardware, compilation, runtime, and application layers. The DIVIDEND project will usher in a new class of vertically integrated data centres and will take a first stab at resolving the energy crisis by improving the power usage effectiveness of data centres.

Laurent Morin from Tamis is involved in this project

9.3.1.3. EMC^2

Participants: Axel Legay, Olivier Zendra.

Start: 2014. End: 2017.

EMC^2 (Embedded Multi-Core systems for Mixed Criticality applications in dynamic and changeable real-time environments https://www.artemis-emc2.eu) is an ARTEMIS Joint Undertaking project in the Innovation Pilot Programme 'Computing platforms for embedded systems' (AIPP5). Embedded systems are the key innovation driver to improve almost all mechatronic products with cheaper and even new functionalities. They support today's information society as inter-system communication enabler. A major industrial challenge arises from the need to face cost efficient integration of different applications with different levels of safety and security on a single computing platform in an open context. EMC^2 finds solutions for dynamic adaptability in open systems, provides handling of mixed criticality applications under real-time conditions, scalability and utmost flexibility, full scale deployment and management of integrated tool chains, through the entire lifecycle. The objective of EMC^2 is to establish Multi-Core technology in all relevant Embedded Systems domains. EMC^2 is a project of 99 partners of embedded industry and research from 19 European countries with an effort of about 800 person years and a total budget of about 100 million Euro.

EMC2 (2014–2017) is at the border between formal methods and security. We in Tamis are mainly using the fundings to develop the Plasma toolset that is used by our statistical model checking and symbolic model checking tools. The permanent members of Tamis who are involved are Axel Legay and Olivier Zendra. The project was initiated during the lifetime of the ESTASYS.Inria team.

9.3.1.4. ENABLE-S3

Participants: Axel Legay, Jean-Louis Lanet.

Start: 2016. End: 2019.

The objective of ENABLE-S3 (http://www.enable-s3.eu) is to establish cost-efficient cross-domain virtual and semi-virtual V&V platforms and methods for ACPS. Advanced functional, safety and security test methods will be developed in order to significantly reduce the verification and validation time but preserve the validity of the tests for the requested high operation range. ENABLE-S3 aspires to substitute today's physical validation and verification efforts by virtual testing and verification, coverage-oriented test selection methods and standardization. ENABLE-S3 is use-case driven; these use cases represent relevant environments and scenarios. Each of the models, methods and tools integrated into the validation platform will be applied to at least one use case (under the guidance of the V&V methodology), where they will be validated (TRL 5) and their usability demonstrated (TRL6). Representative use cases and according applications provide the base for the requirements of methods and tools, as well as for the evaluation of automated systems and respective safety.

This project is industry driven and has the objective of designing new technologies for autonomous transportation, including to secure them. Tamis tests its results on the case studies of the project. Axel Legay and Jean-Louis Lanet are involved in this project. The project supports one postdoc in Tamis starting in 2017.

9.4. International Research Visitors

9.4.1. Visits of International Scientists

- Clémentine MAURICE (Graz University of Technology, Institute of Applied Information Processing and Communications, Austria) visited Tamis and also gave a talk on Reverse-engineering CPUs for fun and profit.

9.4.2. Visits to International Teams

- Axel Legay stayed at Namur University, Belgium.
- Axel Legay stayed at University of Limerick, Ireland.
- Axel Legay and Sean Sedwards stayed at Aalborg University, Denmark.
- Axel Legay, Fabrizio Biondi and Thomas Given-Wilson stayed at John Hopkins University, USA.

TASC Project-Team

9. Partnerships and Cooperations

9.1. Regional Initiatives

9.1.1. EPOC

With the emergence of the Future Internet and the dawning of new IT models such as cloud computing, the usage of data centers (DC), and consequently their power consumption, increase dramatically. Besides the ecological impact, the energy consumption is a predominant criteria for DC providers since it determines the daily cost of their infrastructure. As a consequence, power management becomes one of the main challenges for DC infrastructures and more generally for large-scale distributed systems. In this paper, the EPOC project which focuses on optimising the energy consumption of mono-site DCs connected to the regular electrical grid and to renewable energy sources.

9.1.2. SmartCat

Participants: Eric Monfroy, Charlotte Truchet.

Title: Online optimization for chemical reactions.

Others partners: CEISAM.

The SmartCat project, started in 2015 on regional fundings, aims at developing an intelligent automatised tool for online chemistry. Contrarily to the traditional batch chemistry, where reactants are mixed in a glass, online chemistry consists in having a flow of reactants in a tube, possibly passing through ovens are pressure control mechanisms. This way, the reaction happens continuously and it can produce much more products within a system of reasonable size. SmartCat integrates a controller for which intelligent tools need to be developed. These tools will analyse the product of the reaction and adapt the conditions (stoechiometry, pressure, temperature, catalysis) in order to optimise the yield. TASC contributes to this project by developing these methods, based on local search techniques.

9.1.3. Atlanstic 1

Participant: Florian Richoux.

Title: Atlanstic project about deep learning for games.

Duration: 2016.

Topic: deep learning for games.

9.1.4. Atlanstic 2

Participant: Charles Prud Homme.

Title: CoMe4ACloud.

Duration: 2016.

Topic: CoMe4ACloud is an Atlanstic2020 funded project whose objective is to provide an end-to-end solution for autonomic Cloud services. To that end, we rely on techniques of Constraint Programming so as a decision-making tool and Model-driven Engineering to ease the automatic generation of the so-called autonomic managers as well as their communication with the managed system (see Constraints and Model Engineering for Autonomic Clouds). The project is led by ASCOLA research team and involves also AtlanModels and TASC.

9.2. National Initiatives

9.2.1. ANR NetWMS2

Participants: Gilles Chabert, Ignacio Salas Donoso, Nicolas Beldiceanu.

Title: Networked Warehouse Management Systems 2: packing with complex shapes.

Duration: 2011-2014.

Type: cosinus research program.

Budget: 189909 Euros.

Others partners: KLS Optim and CONTRAINTES (Inria Rocquencourt).

This project builds on the former European FP6 Net-WMS Strep project that has shown that constraint-based optimisation techniques can considerably improve industrial practice for box packing problems, while identifying hard instances that cannot be solved optimally, especially in industrial 3D packing problems with rotations, the needs for dealing with more complex shapes (e.g. wheels, silencers) involving continuous values. This project aims at generalizing the geometric kernel *geost* for handling non-overlapping constraints for complex two and three dimensional curved shapes as well as domain specific heuristics. This will be done within the continuous solver IBEX, where discrete variables will be added for handling polymorphism (i.e., the fact that an object can take one shape out of a finite set of given shapes). A filtering algorithm has been devised in the case of objects described by nonlinear inequalities and is now under testing with the Ibex library. This work has been presented in a workshop on interval methods & geometry in ENSTA Bretagne.

9.3. European Initiatives

9.3.1. FP7 & H2020 Projects

Within the context of the First Future and Emerging Technologies (FET) Proactive projects under Horizon 2020 Framework Programme the GRACeFUL project started this year. From an application point of view the project develops scalable rapid assessment tools for collective policy making in global systems, and test these on climate-resilient urban design. From a technical point of view it provides domain specific languages that are embedded in functional programming and constraint programming languages. Within the project TASC is responsible for the constraint part. To interact with policy makers it uses some qualitative network model (see Figure 10) embedded with constraint programming models that also capture dependancy between potential actions as well as costs.

9.4. International Initiatives

9.4.1. Inria Associate Teams Not Involved in an Inria International Labs

9.4.1.1. TASCMELB

Title: Synergy between Filtering and Explanations for Scheduling and Placement Constraints

International Partner (Institution - Laboratory - Researcher):

NICTA (Australia) - Optimisation Research Group (Optimisation) - Pascal van Hentenryck

Start year: 2014

See also: http://www.normalesup.org/~truchet/TASCMELB.html

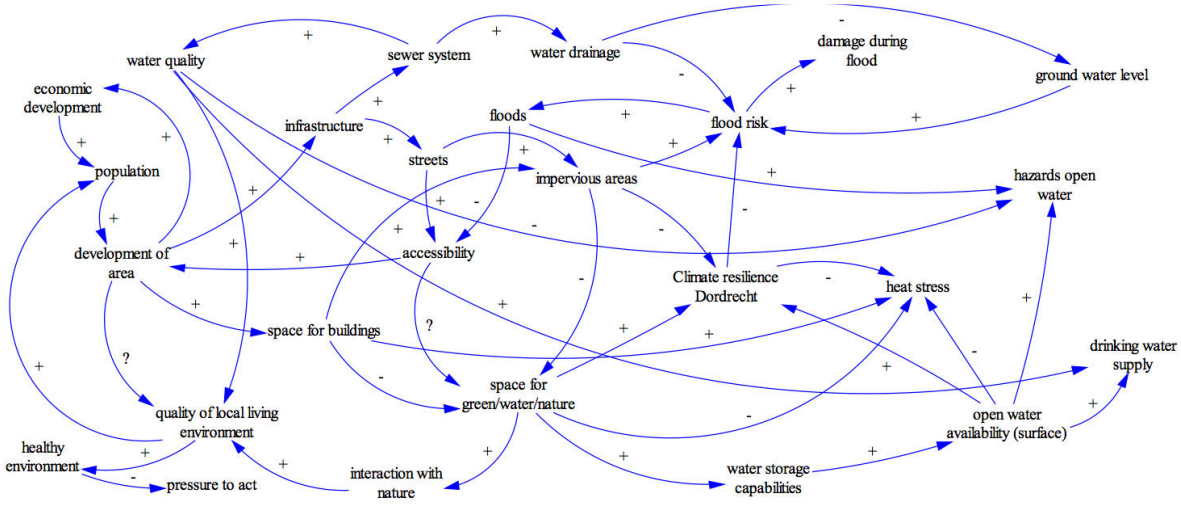

Figure 10. Illustration of some qualitative network capturing causality in the context of flooding prevention

In the context of Constraint Programming and SAT the project addresses the synergy between filtering (removing values from variables) and explanations (explaining why values were removed in term of clauses) in order to handle in a more efficient way correlated resource scheduling and placement constraints. It combines the strong point of Constraint Programming, namely removing value that leads to infeasibility, with the strong point of SAT, namely taking advantage from past failure in order to quickly identify infeasible sub-problems. In 2016 we got the following the following new result *using rewriting for synthesising filtering algorithm for the Allen constraint*: For all 8192 combinations of Allen's 13 relations between one task with origin oi and fixed length li and another task with origin oj and fixed length lj, we give a formula evaluating to a set of integers which are infeasible for a task origin for the given combination. Such forbidden regions are useful e.g. in a range-consistency maintaining propagator for an Allen constraint in finite domain constraint programming. No visit to Melbourne was done this year because of VISA problem. Consequently we also did remotly (i.e. from Nantes) the following result: the availability of the time-series constraints of the time-series constraint catalog available in the MiniZinc modelling language (and consequently made them accessible to solvers like Choco or Cplex).

9.5. International Research Visitors

9.5.1. Visits of International Scientists

- A visit regarding time-series constraints of Andreina Francisco RodriguezHelmut Simonis, Pierre Flener and Justin Pearson in Nantes in May.
- A visit regarding time-series constraints of Helmut Simonis, in July in May.

9.5.2. Visits to International Teams

- Two visits of E. Arafailova regarding time-series constraints in Cork (March 2016) and in Uppsala (April 2016)
- Three visits of N. Beldiceanu regarding time-series constraint in Cork (June 2016) and in Uppsala (February 2016, August 2016)

TEA Project-Team

9. Partnerships and Cooperations

9.1. National Initiatives

9.1.1. ANR

Program: ANR

Project acronym: **Feever**

Project title: Faust Environment Everyware

Duration: 2014-2016

Coordinator: Pierre Jouvelot, Mines ParisTech

Other partners: Grame, Inria Rennes, CIEREC

URL: http://www.feever.fr

Abstract:

The aim of project FEEVER is to ready the Faust music synthesis language for the Web. In this context, we collaborate with Mines ParisTech to define a type system suitable to model music signals timed at multiple rates and to formally support playing music synthesized from different physical locations.

9.1.2. PAI 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...

Abstract:

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

9.2. International Initiatives

9.2.1. International Project Grants

9.2.1.1. US Air Force Office for Scientific Research – 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 (Institution - Laboratory - Researcher):

Virginia Tech Research Laboratories, Arlington (United States)

Embedded Systems Group, Teschnische Universität Kaiserslautern (Germany)

Duration: 2013 - 2016

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

Abstract: 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.

9.2.1.2. Applied Science & Technology Research Institute (ASTRI, Hong Kong)

Title: Virtual Prototyping of Embedded Software Architectures

Inria principal investigator: Jean-Pierre Talpin

International Partner: ASTRI, Hong Kong

Duration: 2015 - 2016

Abstract: the topics of our present collaboration is essentially on heterogeneous time modeling for virtual prototyping in cyber-physical systems. Our project covers a wide spectrum of area of experience developed since 2012 and comprising

- model-based design and analysis of cyber-physical systems;
- system-level virtual prototyping and validation;
- design space exploration and system synthesis;

9.2.2. Inria International Labs

9.2.2.1. SACCADES

Title: Saccades

International Partner:

LIAMA

East China Normal University

Inria project-teams Aoste and Tea

Duration: 2003 - now

The SACCADES project is a LIAMA project hosted by East China Normal University and jointly led by Vania Joloboff (Inria) and Min Zhang (ECNU). The SACCADES project aims at improving the development of reliable cyber physical systems and more generally of distributed systems combining asynchronous with synchronous aspects, with different but complementary angles:

- develop the theoretical support for Models of Computations and Communications (MoCCs) that are the fundamentals basis of the tools.
- develop software tools (a) to enable the development and verification of executable models of the application software, which may be local or distributed and (b) to define and optimize the mapping of software components over the available resources.
- develop virtual prototyping technology enabling the validation of the application software on the target hardware platform.

The ambition of SACCADES project is to develop

- Theoretical Support for Cyber Physical Systems
- Software Tools for design and validation of CPS
- Virtual Prototyping of CPS

9.2.3. Inria International Partners

9.2.3.1. POLYCORE

Title: Models of computation for embedded software design

International Partner:

Virginia Tech Research Laboratories (USA)

University of Kanpur (India)

Duration: 2002 - now

Team TEA collaborates with Sandeep Shukla (now with IIT Kanpur) and his team at Virginia Tech, since 2002 (NSF-Inria BALBOA and Polycore projects, USAF OSR grant).

To date, our fruitful and sustained collaboration has yield the creation of the ACM-IEEE MEMOCODE conference series in 2003, of the ACM-SIGDA FMGALS workshop series, and of a full-day tutorial at ACM-IEEE DATE'09 on formal methods in system design. We have jointly edited two books with Springer [00], two special issues of the IEEE Transactions on Computers and one of the IEEE Transactions on Industrial Informatics, and published more than 40 joint journal articles and conference papers. We published a joint paper at the 52nd. Digital Automation Conference in San Francisco [11].

9.2.3.2. VESA

Title: Virtual Prototyping of embedded software architectures

International Partner:

Applied Science & Technology Research Institute (ASTRI, Hong Kong)

The University of Hong Kong

Duration: 2012 - now

We collaborate with John Koo, now with ASTRI, and LIAMA since 2012 through visiting grants of the Chinese Academy of Science and of the University of Rennes on the topics of heterogeneous time modeling and virtual prototyping in cyber-physical systems.

In the context of project ITF ARD159 (System-Level Virtual Prototyping of Embedded Systems), ASTRI has used Polychrony and AADL to collaboratively develop a platform for conducting the design of an hardware-in-the-loop simulation of an UR5 robot arm, from its physical model described using Matlab/Simulink and powered using an Opal-RT/RT-Lab workstation, structured around an AADL system model, and using Polychrony to orchestrate real-time simulation down to FPGA analog outputs.

9.2.3.3. TIX

Title: Time In Cybernetic Systems

International Partner:

Rajesh Gupta, UCSD

Mani Srivastava, UCLA

Start year: 2015

The first topic of our collaboration is the formal definition of cross-domains clock models in system design and the formal verification of time stabilization and synchronization protocols used in distributed systems (sensor networks, data-bases). In this prospect, the NSF project Roseline is our basis of investigation (https://sites.google.com/site/roselineproject). Roseline aims at enabling robust, secure and efficient knowledge of time across the system stack.

Our second topic of collaboration is the refoundation of time modeling in high-level reactive and scripting languages, for application to the above using uni-kernels to cut through system stacks. We aim at applying the concepts of refinement types to formally specify and infer timing properties in CPS models from different system design view-point (physical, hardware, software) and using different levels of abstraction into multi-sorted 1st order logic (delta-decidability, linear arithmetic, Boolean logic, temporal logic).

9.3. International Research Visitors

9.3.1. Visits of International Scientists

Rajesh Gupta (UC San Diego) visited project TEA in July 2016 in the context of IIP TIX.

[0] *Formal methods and models for system design*, R. Gupta, S. Shukla, J.-P. Talpin, Eds. ISBN 1-4020-8051-4. Springer, 2004.

[0] *Synthesis of embedded systems*. S. Shukla, J.-P. Talpin, Eds. ISBN 978-1-4419-6399-4. Springer, 2010

Brian Larson (FDA) visited project TEA in January and July 2016.

9.3.1.1. Internships

Daian Yue that was selected in the joint program between ENS Rennes and ECNU and joined project TEA for a six month internship in 2016.

9.3.2. Visits to International Teams

Vania Joloboff was invited for two short stays at University of East China Normal University in Shanghai and UC San Diego.

Jean-Pierre Talpin visited ASTRI in May and December, in the context of IIP VESA.

Jean-Pierre Talpin visited UC San Diego in October, in the context of IIP TIX.

Jean-Pierre Talpin visited IIT Kanpur in February and November for the preparation and Chair of MEMOCODE'16.

ANJA Team (section vide)

ASPI Project-Team

8. Partnerships and Cooperations

8.1. Regional initiatives

8.1.1. Stochastic Model-Data Coupled Representations for the Upper Ocean Dynamics (SEACS) — inter labex project

Participants: François Le Gland, Valérie Monbet.

January 2015 to December 2017.

This is a joint research initiative supported by the three labex active in Brittany, CominLabs (Communication and Information Sciences Laboratory), Lebesgue (Centre de Mathématiques Henri Lebesgue) and LabexMER (Frontiers in Marine Research).

This project aims at exploring novel statistical and stochastic methods to address the emulation, reconstruction and forecast of fine–scale upper ocean dynamics. The key objective is to investigate new tools and methods for the calibration and implementation of novel sound and efficient oceanic dynamical models, combining

- recent advances in the theoretical understanding, modeling and simulation of upper ocean dynamics,
- and mass of data routinely available to observe the ocean evolution.

In this respect, the emphasis will be given to stochastic frameworks to encompass multi–scale/multi–source approaches and benefit from the available observation and simulation massive data. The addressed scientific questions constitute basic research issues at the frontiers of several disciplines. It crosses in particular advanced data analysis approaches, physical oceanography and stochastic representations. To develop such an interdisciplinary initiative, the project gathers a set of research groups associated with these different scientific domains, which have already proven for several years their capacities to interact and collaborate on topics related to oceanic data and models. This project will place Brittany with an innovative and leading expertise at the frontiers of computer science, statistics and oceanography. This transdisciplinary research initiative is expected to resort to significant advances challenging the current thinking in computational oceanography.

8.2. National initiatives

8.2.1. Computational Statistics and Molecular Simulation (COSMOS) — ANR challenge Information and Communication Society

Participant: Frédéric Cérou.

Inria contract ALLOC 9452 — January 2015 to December 2017.

The COSMOS project aims at developing numerical techniques dedicated to the sampling of high–dimensional probability measures describing a system of interest. There are two application fields of interest: computational statistical physics (a field also known as molecular simulation), and computational statistics. These two fields share some common history, but it seems that, in view of the quite recent specialization of the scientists and the techniques used in these respective fields, the communication between molecular simulation and computational statistics is not as intense as it should be.

We believe that there are therefore many opportunities in considering both fields at the same time: in particular, the adaption of a successful simulation technique from one field to the other requires first some abstraction process where the features specific to the original field of application are discarded and only the heart of the method is kept. Such a cross–fertilization is however only possible if the techniques developed in a specific field are sufficiently mature: this is why some fundamental studies specific to one of the application fields are still required. Our belief is that the embedding in a more general framework of specific developments in a given field will accelerate and facilitate the diffusion to the other field.

8.2.2. Advanced Geophysical Reduced–Order Model Construction from Image Observations (GERONIMO) — ANR programme Jeunes Chercheuses et Jeunes Chercheurs

Participant: Patrick Héas.

Inria contract ALLOC 8102 — March 2014 to February 2018.

The GERONIMO project aims at devising new efficient and effective techniques for the design of geophysical reduced–order models (ROMs) 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. Our research activities are concerned by the exploitation of the huge amount of information contained in image data in order to reduce the uncertainty on the unknown parameters of the models and improve the reduced–model accuracy. In other words, the objective of our researches to process the large amount of incomplete and noisy image data daily captured by satellites sensors to devise new advanced model reduction techniques. The construction of ROMs is placed into a probabilistic Bayesian inference context, allowing for the handling of uncertainties associated to image measurements and the characterization of parameters of the reduced dynamical system.

8.3. European initiatives

8.3.1. Molecular Simulation: Modeling, Algorithms and Mathematical Analysis (MSMaths) — ERC Consolidator Grant

Participant: Mathias Rousset.

January 2014 to December 2019.

PI: Tony Lelièvre, Civil Engineer in Chief, Ecole des Ponts Paris-Tech.

Note that $1/3$ of Mathias Rousset research activities are held within the MSMath ERC project.

With the development of large-scale computing facilities, simulations of materials at the molecular scale are now performed on a daily basis. The aim of these simulations is to understand the macroscopic properties of matter from a microscopic description, for example, its atomistic configuration.

In order to make these simulations efficient and precise, mathematics have a crucial role to play. Indeed, specific algorithms have to be used in order to bridge the time and space scales between the atomistic level and the macroscopic level. The objective of the MSMath ERC project is thus to develop and study efficient algorithms to simulate high-dimensional systems over very long times. These developments are done in collaboration with physicists, chemists and biologists who are using these numerical methods in an academic or industrial context.

In particular, we are developping mathematical tools at the interface between the analysis of partial differential equations and stochastic analysis in order to characterize and to quantify the metastability of stochastic processes. Metastability is a fundamental concept to understand the timescale separation between the microscopic model and the macroscopic world. Many algorithms which aim at bridging the timescales are built using this timescale separation.

8.3.2. Design of Desalination Systems Based on Optimal Usage of Multiple Renewable Energy Sources (DESIRES) — ERANETMED NEXUS–14–049

Participant: Valérie Monbet.

January 2016 to December 2018.

This project is funded by the ERA–NET Initiative ERANETMED (Euro–Mediterranean Cooperation through ERA–NET Joint Activities and Beyond). It is a collaboration with Greece, Tunisia and Marocco, coordinated by Technical University of Crete (TUC). The French staff includes: Pierre Ailliot (Université de Bretagne Occidentale, Brest), Denis Allard (INRA Avignon), Anne Cuzol (Université de Bretagne Sud, Vannes), Christophe Maisondieu (IFREMER Brest) and Valérie Monbet.

The aim of DESIRES is to develop an Internet–based, multi–parametric electronic platform for optimum design of desalination plants, supplied by renewable energy sources (RES). The platform will rely upon (i) a solar, wind and wave energy potential database, (ii) existing statistical algorithms for processing energy-related data, (iii) information regarding the inter-annual water needs, (iv) a database with the technical characteristics of desalination plant units and the RES components, and (v) existing algorithms for cost effective design, optimal sizing and location selection of desalination plants.

8.4. International initiatives

8.4.1. Rare event simulation in epidemiology — PhD project at université de Ziguinchor

Participants: Ramatoulaye Dabo, Frédéric Cérou, François Le Gland.

This is the subjet of the PhD project of Ramatoulaye Dabo (université Assane Seck de Ziguinchor and université de Rennes 1).

The question here is to develop adaptive multilevel splitting algorithms for models that are commonly used in epidemiology, such as SIR (susceptible, infectious, recovered) models [32], or more complex compartmental models. A significant advantage of adaptive multilevel splitting is its robustness, since it does not require too much knowledge about the behavior of the system under study. An interesting challenge would be to understand how to couple the algorithm with numerically efficient simulation methods such as τ–leaping [42]. Complexity bounds and estimation error bounds could also be studied.

I4S Project-Team

9. Partnerships and Cooperations

9.1. Regional Initiatives

9.1.1. MONEOL - project with CEAtech Pays de Loire

Participants: Ivan Guéguen, Guillaume Gautier, Laurent Mevel.

Type: CEAtech PDL

Objectif: Modal analysis of wind turbines using new sensors

Duration: 11/2015 to 11/2017.

Coordinator: Louis Marie Cotineau (IFSTTAR)

Inria contact: Guillaume Gautier

Abstract: The MONEOL project aims to demonstrate the feasibility of using Morphosense as a vibration monitoring system for wind turbines. It is proposed to set up a demonstrator consisting of a monitoring system placed in the mast of the wind turbine, a vibration analysis system and a visualization of the vibratory state at the CEA-Tech premises, located on the Technocampus Ocean of Nantes allowing to visualize in real time (quasi) the modal deformations of the mast of the wind turbine. This system consists of the following elements:

The demonstrator consists of the monitoring system placed in the wind turbine of a video screen displaying in real time indicators to evaluate the state of health of the structure:

- Modal parameters (eigen frequencies, modal damping, modal deformations) over time and associated uncertainties.
- Indicators of detection and localization of damage.

The demonstrator will also be able to display a video of the wind turbine in operation. In order to validate the Morphosense sensor, a reference system is added to it, consisting of conventional accelerometer sensors.

9.1.2. Interactive Communication (InterCom): Massive random access to subsets of compressed correlated data

Participants: Jean Dumoulin, Antoine Crinière.

Type: Labex COMINLABS

Objectif: Massive random access to large-scale sensor network (Smart Cities)

Duration: Since November 2016 to Nov. 2019.

Coordinator :Aline Roumy, Thomas Maugey (Sirocco), Jean Dumoulin (I4S)

Partners: Elsa Dupraz (Lab-STICC), Aline Roumy (IRISA, Sirocco team), Michel Kieffer (L2S), Thomas Maugey(IRISA, Sirocco team), CentraleSupelec, Univ. Paris Sud.

Inria contact: Jean Dumoulin

Abstract: This project aims to develop novel compression techniques allowing massive random access to large databases. Indeed, we consider a database that is so large that, to be stored on a single server, the data have to be compressed efficiently, meaning that the redundancy/correlation between the data have to be exploited. The dataset is then stored on a server and made available to users that may want to access only a subset of the data. Such a request for a subset of the data is indeed random, since the choice of the subset is user-dependent. Finally, massive requests are made, meaning that, upon request, the server can only perform low complexity operations (such as bit extraction but no decompression/compression).

Algorithms for two emerging applications of this problem will be developed: Free-viewpoint Television (FTV) and massive requests to a database collecting data from a large-scale sensor network (such as Smart Cities) in which I4S is involved.

9.1.3. MAG2C-Pont Tabarly

Participants: Ivan Guéguen, Jean Dumoulin.

Type: GIS

Objectif: bridge instrumentation

Duration: Since 2014

Coordinator: LIRGEC

Partners: IFSTTAR, CSTB, Nantes Métropole, Université de Nantes

Inria contact: Ivan Guéguen

Abstract: The project deals with the instrumentation of the Tabarly Bridge.

Based on accelerometer measurements, the vibration behaviour will be monitored and structural defects detected. Coupled with a wireless data transmission system type or wifi 3g, remote monitoring is envisaged. The different objectives are

- Experimentation on a bridge
- Equipment qualification in real conditions over long term
- Apply different vibration processing algorithms
- Monitoring and detection
- Measurement database

An accelerometer-based distributed network on the structure is installed and connected to a data acquisition system and a modem 3g for continuous remote measurements, which will be available on the internet.

9.1.4. MAG2C-MOSIWIND (MOnitoring of Structural Integrity of an onshore WIND turbine's slab foundation and tower)

Participants: Xavier Chapeleau, Ivan Guéguen.

Type: GIS

Objectif: MOnitoring of Structural Integrity of an onshore WIND turbine's slab foundation and tower

Duration: Since 2015

Coordinator : LIRGEC

Partners: IFSTTAR, CSTB, Nantes Métropole, Université de Nantes, ECN, Valorem, Valréa and Valémo

Inria contact: Xavier Chapeleau

Abstract: The project deals with the instrumentation of an onshore WIND turbine's slab foundation and tower. The aim is to experiment sensors and methods for structural integrity monitoring of an onshore wind turbine under real conditions and to qualify them over long term. Before casting, the concrete slab foundation (20m in diameter, 3.85m high, 450m3 of concrete, 48T of reinforcement) was first instrumented with continuous optical fibers, optical strain gauges, temperature sensors and accelerometers. Afterwards, accelerometers were placed in the mast. Data obtained by these different sensors will help, on the one hand, to monitor changes in the dynamic behavior of the structure in order to verify that they remain within the limits fixed during the design and, on the other hand, to detect any damage that could be critical for the safety of the structure. For this, SSI methods under ambient vibration will be applied.

9.1.5. Collaboration with GEM

Participants: Laurent Mevel, Michael Doehler, Md Delwar Hossain Bhuyan.

Md Delwar Hossain Bhuyan has started a PhD on Damage localisation on offshore platforms, The thesis is co-directed by L. Mevel and F. Schoefs from GEM, Nantes, with supervision shared with M. Doehler and Y. Lecieux from GEM. It is funded by the Brittany region for 3 years.

9.2. National Initiatives

9.2.1. High speed rail track instrumentation

Participant: Ivan Guéguen.

Type: IRT

Objective: rail track SHM

Duration: 11/2014 to 11/2018

Coordinator: RAILENIUM

Partners: IFSTTAR, EIFFAGE, RFF, LGCgE

Inria contact: Ivan Guéguen

Abstract: This project aims at instrumenting multiple sections of a high-speed route (classical section with granular layer, transition zone). The proposed instrumentation concerns all the different layers of the structure, and is designed to allow monitoring of the overall track behavior.

The instrumentation will include:

- A weather station for environmental conditions (temperature, precipitation on the site).
- Accelerometers, to monitor the dynamic behavior of the track, with measurements at several levels: the hammer beams on top of the grave-bitumen layer, on top of the soil.
- Instrumentation of severe bitumen strain gauges for measuring the longitudinal and transverse tensile strains, and temperature probes (top and bottom layer). This instrumentation will estimate the fatigue life of the GB, temperature changes in this layer, and will calculate a temperature equivalent to the layer of GB.
- Instrumentation subgrade by means of measurement gauges at the top of the vertical deformation of the soil, and TDR probes to measure changes in water content. Its objective is to measure the levels of distortion in the upper part of the soil, and their variations, in conjunction with the seasonal variations in water content.
- An anchored sensor, measuring the total deflection between the top of the GB and a reference point that is 4 m deep. This sensor will measure the total displacement of the structure beneath the ballast (GB + layer of granular soil leveling + support). These will also serve as a reference for comparison with the movements deducted from accelerometer measurements.
- Continuous optical fiber, to measure static permanent deformation in the transverse direction over the entire width of the structure at the base of the sub-layer.

9.2.2. ANR Resbati

Participant: Jean Dumoulin.

Type: ANR

Objectif: In-situ measurements of thermal wall resistance

Duration: 10/2016 to 10/2019

Coordinator: Laurent ibos

Partners : IFSTTAR, CERTES, CEREMA, CSTB, LNE, THEMACS, AFNOR

Inria contact: Jean Dumoulin

Abstract: Thermal insulation of opaque walls remains an essential point for improving the energy efficiency in buildings. Indeed, the number of badly insulated buildings in France is still very important. In addition, current thermal regulations set high requirements in terms of thermal insulation and will continue to be more rigorous as new building will be energy-positive with the French RT2020. However, there is no systematic method for measuring the thermal insulation level of the building walls. Their thermal performance must be controlled for renovation of the building, during its construction, for its delivery or during use. The need of a method of in-situ control of walls is more relevant than ever. Such a measurement at the wall level is an interesting complement to global methods (co-heating, etc.) that concern the whole building energy balance. The physical parameter representing the quality of the wall thermal insulation is its thermal resistance. Currently, methods for measuring this parameter exist, either in the form of laboratory or exploratory methods, or in the form of international standards or draft standards. However, each of these methods does not meet all the conditions guaranteeing a general measurement: use on any type of wall and at any time of the year, low measurement duration, ease of use, moderate cost. The RESBATI project (in-situ measurement of the thermal resistance of building walls) aims at developing an in-situ measurement device that respects these specifications. The measuring means is infrared thermography in active approach. The uncertainty and the limitations of the measurement will be identified during the project. Infrared thermography in passive mode has demonstrated for many years its ability to reveal the presence of insulation defects in buildings. However, it is essentially a qualitative tool. The active approach of infrared thermography is not very used for building investigation and is a promising way for obtaining quantitative information such as the thermal resistance of the wall to investigate. Indeed research results have already shown that this approach could be used to obtain quantitative estimations of the thermal resistance of opaque building walls. The RESBATI project will demonstrate the potential of the active approach so that control can be performed in any season, for any type of building and any use (occupied or not) and quickly. The passive approach might nevertheless be used as a complement because it does not require the use of additional equipment ensuring the thermal load of the wall to diagnose and provides access to larger wall surfaces to analyze. The consortium brings complementary partners together working at different levels of the building: research laboratories, technical center, national metrology laboratory, company and standards organization. The advanced knowledge and past achievements of the various partners on the subject make it possible to develop such a method with measurement uncertainty and the associated prototypes. Many facilities will be available for qualification of prototypes: climate rooms for laboratory testing, existing buildings for in-situ qualifications. Thus, a wide variety of walls (structure and isolation level) can be tested. Moreover, these buildings have different uses (residential or service buildings). In conclusion of the project, measurements will be carried out by future end-users of the device.

9.2.3. Equipex Sense-City

Participants: Jean Dumoulin, Laurent Mevel, Antoine Crinière.

Through the ADT Cloud2SM, participation of I4S in SenseCity was possible. IFSTTAR's SensorBox developed by Jean Dumoulin was installed and presented at SEnseCity Kick off and is installed on-site. Cloud2IR and Cloud2SM software have been deployed within the ADT of A. Crinière. (http://sense-city.ifsttar.fr/)

9.3. European Initiatives

9.3.1. FP7 & H2020 Projects

9.3.1.1. Built to Specifications (Built2Spec)

Participants: Jean Dumoulin, Alexandre Nassiopoulos, Jordan Brouns.

Type: Horizon 2020

Defi: Model Driven Physical Systems Operation

Objectif: Reduce the gap between a building?s designed and as-built energy performance.

Duration: January 2015 to January 2019

Coordinator: Manager and project head : NOBATEK, Germain Adell. For CERMA : Marjorie Musy

Inria teams I4S

Inria contact: J. Dumoulin

Partners: Consortium of 20 Public and Industrial actors

Website: http://built2spec-project.eu/

Abstract: Built to Specifications (Built2Spec) is a Horizon 2020 EU-funded project involving 20 European partners that seeks to reduce the gap between a building?s designed and as-built energy performance. To do this, the project will put a new set of breakthrough technological advances for self-inspection checks and quality assurance measures into the hands of construction professionals. This collection of smart tools will help building stakeholders at all levels in meeting EU energy efficiency targets, new build standards and related policy goals.
Built2Spec will deliver a new set of tools:

- 3D and Imagery Tools
- Building Information Modelling (BIM)
- Smart Building Components
- Energy Efficiency Quality Checks
- Indoor Air Quality Tools
- Airtightness Test Tools with Air-pulse Checks
- Thermal Imaging Tools
- Acoustic Tools

All connected to a Virtual Construction Management Platform supporting the collection and sharing of all project data, from initial design to the delivery. During the project, this platform will be integrated into the operations of small and medium-sized enterprise (SME) contractors, large construction firms and end user clients directly within the consortium and work program activities, assuring systematic and scientific performance measures, feedback and powerful exploitation.

9.3.1.2. INFRASTAR (Innovation and Networking for Fatigue and Reliability Analysis of Structures – Training for Assessment of Risk)

Participant: Xavier Chapeleau.

Call: H2020-MSCA-ITN-2015 (Horizon 2020 – Marie-Sklodowska Curie Actions – Innovative Training Networks)

Type of Action: MSCA-ITN-ETN

Objectif: Reduce the gap between a building?s designed and as-built energy performance.

Duration: 48 months since 2016 May 1st

Coordinator: Odile Abraham (IFSTTAR)

Academic and industrial Partners: IFSTTAR, UNIVERSITY OF AALBORG, BAM, EPFL, GuD Consult Gmbh, COWI A/S, NeoStrain, PHIMECA

Inria contact: X. Chapeleau

Website: http://infrastar.eu/

Abstract: The aim of INFRASTAR project is to develop tools combining modeling and measurements for the prediction of the fatigue behavior of concrete structures (bridges and foundations of wind turbines) with the ultimate objective of establishing an efficient strategy for inspection and reinforcement operations. In the second half of 2016, 12 young researchers were recruited to carry out and cross-examine research on monitoring and auscultation (WP 1), structural models (WP 2) and reliability of approaches for decision-making (WP 3). In this project, a phd student (Antoine Bassil) was recruited (Nov. 2016) on the fatigue monitoring of concrete structure by fibre-optic sensors.

9.3.2. Collaborations in European Programs, Except FP7 & H2020

9.3.2.1. European Research Network on System Identification (ERNSI)

Participants: Qinghua Zhang, Michael Doehler, Laurent Mevel.

The I4S project-team is involved in the activities of the European Research Network on System Identification (ERNSI) federating major European research teams on system identification. Modeling of dynamical systems is fundamental in almost all disciplines of science and engineering, ranging from life science to process control. System identification concerns the construction, estimation and validation of mathematical models of dynamical physical or engineering phenomena from experimental data.

9.3.2.2. COST Action TU 1402

Participants: Michael Doehler, Laurent Mevel.

L. Mevel is member of the management committee of the COST Action.

M. Doehler is co-leader of working group 2 "SHM strategies and structural performance" and member of the steering committee.

Type: COST

Objectif: Quantifying the value of structural health monitoring

Duration: 11/2014 - 11/2018

Coordinator: S. Thoens (DTU Denmark)

Partner: 23 countries, see http://www.cost.eu/COST_Actions/tud/Actions/TU1402

Inria contact: Laurent Mevel

Abstract: This COST Action enhances the benefit of Structural Health Monitoring (SHM) by novel utilization of applied decision analysis on how to assess the value of SHM - even before it is implemented. This improves decision basis for design, operation and life-cycle integrity management of structures and facilitates more cost efficient, reliable and safe strategies for maintaining and developing the built environment to the benefit of society. SHM is increasingly applied for collecting information on loads and aggressive environments acting on structures, structural performances, deterioration processes and changes in the use of structures. However, there is an urgent need to establish a better understanding of the value of SHM before its implementation, together with practically applicable methods and tools for its quantification. This Action thus aims to develop and describe a theoretical framework, together with methods, tools, guidelines, examples and educational activities, for the quantification of the value of SHM. The COST Action will be conducted with the support of the Joint Committee on Structural Safety (JCSS). The networks of researchers and industries established during COST Actions TU0601, C26, E55 and E24, the EU FP7 project IRIS, the Marie Curie Network SmartEn and the JCSS will ensure visibility, impact and dissemination.

9.3.3. Other European Programs

9.3.3.1. Innobooster

Participants: Michael Doehler, Laurent Mevel.

Together with SVS, we got the Danish Innobooster innovation grant "Robust Operational Modal Analysis using Modal Uncertainty Quantification" 2015-2016, for industrial research and transfer. The result of the development in this project is the transfer of our uncertainty quantification algorithm [19] to SVS' ARTeMIS software http://www.svibs.com/newsletter/newsletter_2016_09.aspx.

9.4. International Initiatives

9.4.1. Informal International Partners

9.4.1.1. Collaboration with CNR, Italy

Participants: Jean Dumoulin, Nicolas Le Touz.

Non destructive testing on outdoor structures by coupling infrared thermography with ground penetrating radar is one of the topic addressed in this collaboration. A new one about TerHertz is starting.

9.4.1.2. Collaboration with British Columbia University, Canada

Participants: Laurent Mevel, Michael Doehler, Saeid Allahdadian.

Saeid Allahdadian is currently PhD student of professor Carlos Ventura in Vancouver. Following our recent papers, Michael Doehler has been invited to co-supervise the PhD of Saeid Allahdadian starting in 2015 for 3 years.

9.4.1.3. Collaboration with BAM, Germany

Participants: Laurent Mevel, Michael Doehler, Eva Viefhues.

Eva Viefhues is currently PhD student of Laurent Mevel and Michel Doehler in Berlin, financed by BAM. M. Doehler is also associate researcher of the BAM institut since 2016.

9.4.1.4. Collaboration with Politecnico di Milano, Italy

Participants: Michael Doehler, Dominique Siegert, Ivan Guéguen, Xavier Chapeleau.

During COST Action TU 1402 and M.P. Limongelli's research stay at IFSTTAR, collaboration with Politecnico di Milano has started, resulting in several joint publications in 2016 [35], [18], [21]. A joint Master student project is in progress, and a french-italian PhD project is planned.

9.4.2. Participation in Other International Programs

The team has been awarded a MITACS grant. It allowed us to host S. Allahdadian for 3 months in 2016.

9.5. International Research Visitors

9.5.1. Visits of International Scientists

S. Allahdadian from British Columbia University has visited us for 3 months in 2016 thanks to a MITACS grant.

IPSO Project-Team

5. Partnerships and Cooperations

5.1. National Initiatives

5.1.1. ANR MOONRISE: 2015-2019

Participants: François Castella, Philippe Chartier, Nicolas Crouseilles, Mohammed Lemou, Florian Méhats.

The project *Moonrise* submitted by Florian Méhats has been funded by the ANR for 4 years, for the period 2015-2019. This project aims at exploring modeling, mathematical and numerical issues originating from the presence of high-oscillations in nonlinear PDEs from the physics of nanotechnologies (quantum transport) and from the physics of plasmas (magnetized transport in tokamaks). The partners of the project are the IRMAR (Rennes), the IMT (Toulouse) and the CEA Cadarache. In the IPSO team, François Castella, Philippe Chartier, Nicolas Crouseilles and Mohammed Lemou are members of the project Moonrise.

Postdocs

- Loïc Le Treust has been hired as a Postdoc, under the supervision of Philippe Chartier and Florian Méhats. His contract started in september 2015 and ended in august 2016. Loïc Le Treust is now assistant professor at the university of Marseille.
- Xiaofei Zhao has been hired as a Postdoc from september 2015 to september 2016 under the supervision of Florian Méhats.

5.1.2. ANR MFG: 2016-2020

Participant: Arnaud Debussche.

Mean Field Games (MFG) theory is a new and challenging mathematical topic which analyzes the dynamics of a very large number of interacting rational agents. Introduced ten years ago, the MFG models have been used in many areas such as, e.g., economics (heterogeneous agent models, growth modeling,...), finance (formation of volatility, models of bank runs,...), social sciences (crowd models, models of segregation) and engineering (data networks, energy systems...). Their importance comes from the fact that they are the simplest (“stochastic control"-type) models taking into account interactions between rational agents (thus getting beyond optimization), yet without entering into the issues of strategic interactions. MFG theory lies at the intersection of mean field theories (it studies systems with a very large number of agents), game theory, optimal control and stochastic analysis (the agents optimize a payoff in a possibly noisy setting), calculus of variations (MFG equilibria may arise as minima of suitable functionals) and partial differential equations (PDE): In the simplest cases, the value of each agent is found by solving a backward Hamilton-Jacobi equation whereas the distribution of the agents’ states evolves according to a forward Fokker-Planck equation. The “Master" equation (stated in the space of probability measures) subsumes the individual and collective behaviors. Finally, modeling, numerical analysis and scientific computing are crucial for the applications. French mathematicians play a world-leading role in the research on MFG: The terminology itself comes from a series of pioneering works by J.-M. Lasry and P.-L. Lions who introduced most of the key ideas for the mathematical analysis of MFG; the last conference on MFG was held last June in Paris and organized by Y. Achdou, P. Cardaliaguet and J.-M. Lasry. As testifies the proposal, the number of researchers working on MFG in France (and also abroad) is extremely fast-growing, not only because the theoretical aspects are exciting and challenging, but also because MFG models find more and more applications. The aim of the project is to better coordinate the French mathematical research on MFG and to achieve significant progress in the theory and its applications.

The partners of the project are the CEREMADE laboratory (Paris Dauphine), the IRMAR laboratory (Rennes I), the university of Nice and of Tours.

5.1.3. IPL (FRATRES)

IPSO is associated to IPL FRATRES which started in june 2015. The aim of this project is to organize Inria teams activities which develop mathematical and numerical tools in magnetically confined nuclear fusion. The ambition is to prepare the next generation of numerical modeling methodologies able to use in an optimal way the processing capabilities of modern massively parallel architectures. This objective requires close collaboration between a) applied mathematicians and physicists that develop and study mathematical models of PDE; b) numerical analysts developing approximation schemes; c) specialists of algorithmics proposing solvers and libraries using the many levels of parallelism offered by the modern architecture and d) computer scientists. The project road map ambitions to contribute in close connection with National and European initiatives devoted to nuclear Fusion to the improvement and design of numerical simulation technologies applied to plasma physics and in particular to the ITER project for magnetic confinement fusion.

Postdoc

- Xiaofei Zhao has been hired as a Postdoc, under the supervision of Nicolas Crouseilles and Sever Hirstoaga (Inria-Nancy). His contract started in october 2015 and will end in august 2016.

5.2. European Initiatives

5.2.1. FP7 & H2020 Projects

Project acronym: GEOPARDI

Program: FP7

Project title: Numerical integration of Geometric Partial Differential Equations

Duration: September 2011 - August 2016

Coordinator: Erwan Faou, Inria

Abstract: The goal of this project is to develop new numerical methods for the approximation of evolution equations possessing strong geometric properties such as Hamiltonian systems or stochastic differential equations. In such situations the exact solutions endow with many physical properties that are consequences of the geometric structure: Preservation of the total energy, momentum conservation or existence of ergodic invariant measures. However the preservation of such qualitative properties of the original system by numerical methods at a reasonable cost is not guaranteed at all, even for very precise (high order) methods. The principal aim of geometric numerical integration is the understanding and analysis of such problems: How (and to which extend) reproduce qualitative behavior of differential equations over long time? The extension of this theory to partial differential equations is a fundamental ongoing challenge, which require the invention of a new mathematical framework bridging the most recent techniques used in the theory of nonlinear PDEs and stochastic ordinary and partial differential equations. The development of new efficient numerical schemes for geometric PDEs has to go together with the most recent progress in analysis (stability phenomena, energy transfers, multiscale problems, etc..) The major challenges of the project are to derive new schemes by bridging the world of numerical simulation and the analysis community, and to consider deterministic and stochastic equations, with a general aim at deriving hybrid methods. We also aim to create a research platform devoted to extensive numerical simulations of difficult academic PDEs in order to highlight new nonlinear phenomena and test numerical methods.

Erwan Faou was the principal investigator of the ERC Starting Grant Project Geopardi (2011-2016).

Between 2011 and 2016, Erwan Faou was the principal investigator of this ERC Starting grant project. This research project is centered on the numerical simulation of geometric evolution partial differential equations (PDEs). Typical examples are given by Hamiltonian Partial Differential Equations (PDE) such as wave equations in nonlinear propagations problems, Schrödinger equations in quantum mechanics, or Vlasov equations in plasma physics. The main goals of the project can be summarized as follows:

- Analyze numerical schemes for Hamiltonian PDEs and stochastic differential equations as mathematical objects in their own right, and study their global behavior (invariant preservation, ergodicity with respect to some invariant measure, averaging properties, scattering, etc...)
- Develop new numerical methods in connection with the most recent advances in the theoretical studies, and devoted to specific situations (high frequency computations, stochastic and hybrid methods, Vlasov and Euler equations). In particular, an important objective is the analysis of the long time behavior of these equations.

The main originality of the Geopardi project is the combination of rigorous nonlinear analysis, numerical analysis and numerical simulations, as well as its hybrid nature mixing deterministic and stochastic problems. The project has an excellent international visibility. The participants have been invited in many conferences to present their works in the last year (Scicade 13 & 15, Numdiff 13, workhops in Toronto, Harvard, IHES, Oberwolfach or Luminy, etc..). The research outcomes are published in high level international journals such as J. Amer. Math. Soc., Numer. Math., SIAM J. Numer. Anal. or Math. Comp. The project has also been used to invite collaborators and researcher to visit Inria. In particular, E. Faou organized with T. Lelièvre and J. Erhel in september 2013 the NASPDE conference whose main topic is the numerical simulation of stochastic PDEs, and that was mainly funded by the Geopardi project.

5.2.2. Collaborations in European Programs, Except FP7 & H2020

Project acronym: WPENR

Program: EUROFusion Enabling Research project ER15-IPP-01

Project title: Verification and development of new algorithms for gyrokinetic codes

Duration: January 2015 - December 2018

Coordinator: Eric Sonnenndrücker (Max-Planck-Institut für Plasmaphysik (IPP), Germany)

Other partners: IPP (Germany), EPFL (Switzerland), CEA-Cadarache (France), university of Strasbourg, Toulouse, Marseille, Paris 6 (France).

Abstract: Gyrokinetic codes play a major role in understanding the development and saturation of micro- turbulence in a magnetic fusion plasma and its influence on energy confinement time. The first aim of this proposal is to assess the reliability of gyrokinetic codes by extensive verification and benchmarking. All the major european gyrokinetic codes are involved in the proposal and this will enable them to define comparison elements, which ultimately will also facilitate the cross-validation of new physics. On the other hand we will develop new algorithms for extending the physics capabilities or the computational efficiency of different gyrokinetic codes. Finally we will also perform a prospective investigation of models and numerical methods that could help in the future to address physics where kinetic effects might play an important role but that cannot be handled with today's gyrokinetic codes, like L-H (low to high confinement) transition, edge physics or MHD time scales simulations.

5.3. International Research Visitors

5.3.1. Visits of International Scientists

- Philippe Chartier and Nicolas Crouseilles invited Eric Sonnendrücker (IPP Max Planck) for one week in june 2016.
- Nicolas Crouseilles and Mohammed Lemou invited Shi Jin and Liu Liu (university of Wisconsin) for two weeks in june 2016.
- Arnaud Debussche invited Martina Hofmanova (TU Berlin) for one week in november 2016.
- Erwan Faou invited Chuchu Chen (Michigan state university) for two weeks in november 2016.

5.3.2. Visits to International Teams

5.3.2.1. Research Stays Abroad

- Philippe Chartier was invited for a one-week working visit by Gilles Vilmart, university of Geneva (Switzerland).
- Nicolas Crouseilles was invited for a one-week working visit by Gilles Vilmart, university of Geneva (Switzerland).
- Arnaud Debussche was invited at SNS Pisa (Italy) for two periods of one week in april and november 2016.
- Erwan Faou was invited in the university of Trondheim (Norway) in october 2016.

DYLISS Project-Team

8. Partnerships and Cooperations

8.1. Regional Initiatives

8.1.1. Regional initiative: the Ecosyst project

Participants: Damien Eveillard, Marie Chevallier, Clémence Frioux, Anne Siegel, Camille Trottier.

EcoSyst is a Biogenouest inter-regional federating project (Brittany â Pays de la Loire) aiming at the emergence of Systems Ecology at the level of western regions. Drawing on the strengths and skills involved, EcoSyst targets the incubation of new ideas and new projects at disciplinary interfaces. Thanks to this community project, we want to develop the skills of Ecology, Environment, Modeling, Bioinformatics and Systems Biology and their application to organisms and ecosystems of interest in agronomy, sea and health. EcoSyst includes also the identification of the major issues and concerns, the fundamental and essential methods and the very real needs of the community (training, tools, ...); this in order to consider the construction of a community platform (or an offer of service within an existing platform) on complex systems modeling, meeting expectations of the community as fully as possible.

8.1.2. Regional partnership with computer science laboratories in Nantes

Participants: Anne Siegel, Jérémie Bourdon, Damien Eveillard, François Coste, Jacques Nicolas.

Methodologies are developed in close collaboration with university of Nantes (LINA) and Ecole centrale Nantes (IRCCyN). This is acted through the Biotempo and Idealg ANR projects and co-development of common software toolboxes within the Renabi-GO platform support. C. Trottier is a co-supervised bioianalysis and software development engineer within the Idealg project. M. Chevallier is a co-supervised development and animation engineer within the regional initiative "Ecosyst". In addition, the former Ph-D student V. Picard and the ongoing Ph-D student J. Laniau are also co-supervised with members of the LINA laboratory.

8.1.3. Regional partnership in Marine Biology

Participants: Catherine Belleannée, Jérémie Bourdon, Jean Coquet, François Coste, Damien Eveillard, Olivier Dameron, Clémence Frioux, Jeanne Got, Julie Laniau, Jacques Nicolas, Camille Trottier, Anne Siegel.

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). In addition, the team participates to a collaboration program (Inria Project Lab) with the Biocore and Ange teams, together with Ifremer-Nantes, focused on the understanding on micro-algae (Ph-D thesis of J. Laniau).

8.1.4. Regional partnership in agriculture and bio-medical domains

Participants: Aymeric Antoine-Lorquin, Catherine Belleannée, François Coste, Jean Coquet, Olivier Dameron, Victorien Delannée, Aurélie Evrard, François Moreews, Jacques Nicolas, Anne Siegel, Nathalie Théret, Denis Tagu, Pierre Vignet.

We have a strong and long term collaboration with biologists of INRA in Rennes : PEGASE and IGEPP units. F. Morrews is a permanent engineer from PEGASE center hosted in the team to develop methods for integrative biology applied to species of interest in agriculture. D. Tagu is a research director at INRA who spends 20% of his time in the team to develop collaborative projects. This partnership is supported by the co-supervision of one post-doctoral student and the co-supervision of several PhD students. The Ph-D thesis of V. Wucher was supported by collaborations with the IGEPP laboratory. The former post-doc of Ch. Bettembourg strengthened these collaborations. This collaboration was also reinforced by collaboration within ANR contracts (MirNadapt, FatInteger). Lately, A. Evrard joined the team at mid-part of her time in collaboration with Agrocampus Ouest and INRA to apply the semantic web to technologies developed within the mirnAdapt framework to new agriculture applications (Brassicae).

We also have a strong and long term collaboration in the bio-medical domain, namely with the IRSET laboratory at Univ. Rennes 1/Irset. N. Théret, research director at INSERM, is hosted in the team to strenghen our collaborative projects. Our collaborations are acted by the co-supervised Ph-D theses of V. Delannée (Metagenotox project, funded by Anses) and J. Coquet. This partnership was reinforced in the former years by the ANR contract Biotempo ended at the end of 2014. In 2015, the project of combining semantic web technologies and bi-clustering classification based on formal concept analysis was applied to systems biology within the PEPS CONFOCAL project. This scientific project has been recently pushed forward in the recent TGFSYSBio project funded by Plan Cancer on the modelling of the microenvironment of TGFbeta signaling network (P. Vignet has been recruited on this contract at the end of 2016).

8.2. National Initiatives

8.2.1. Long-term contracts

8.2.1.1. "Omics"-Line of the Chilean CIRIC-Inria Center

Participants: Meziane Aite, Jérémie Bourdon, François Coste, Marie Chevallier, Damien Eveillard, Clémence Frioux, Jacques Nicolas, Anne Siegel.

We have a cooperation with Univ. of Chile (MATHomics, A. Maass) on methods for the identification of biomarkers and software for biochip design, supported by a national Inria initiative. 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. The program is co-funded by Inria and CORFO-chile from 2012 to 2022. 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 2016.

8.2.1.2. ANR Idealg

Participants: Jérémie Bourdon, Marie Chevallier, François Coste, Damien Eveillard, Clémence Frioux, Jeanne Got, Jacques Nicolas, Anne Siegel.

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 in the tasks related to the establishment of a virtual platform for integrating omics studies on seaweed) and the 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) [More details].

8.2.2. Programs funded by research institutions

8.2.2.1. PEPS PEPS: a platform for supporting studies in pharmaco-epidemiology using medico-administrative databases

Participants: Olivier Dameron, Yann Rivault.

As a partner of the PEPS platform, IRISA develops generic methods supporting efficient and semantically-rich queries for pharmaco-epidemiology studies on medico-administrative databases. The leader is Thomas Guyet (IRISA team Lacodam). We showed that Semantic Web technologies are technically suited for representing patients' data from medico-administrative databases as RDF and querying them using SPARQL. We also demonstrated that this approach is relevant as it supports the combination of patients' data with hierarchical knowledge in order to address the problem of reconciling precise patients data with more general query criteria [33], [31], [30]. This work is mostly conducted by Yann Rivault, whose PhD thesis is supervized by Olivier Dameron and Nolwenn LeMeur (Ecole des Hautes Etudes en Santé Publique).

8.2.2.2. Cancer Plan: TGFSYSBIO

Participants: Nathalie Théret, Jacques Nicolas, Olivier Dameron, Anne Siegel, Jean Coquet.

The TGFSYSBIO project aims to develop the first model of extracellular and intracellular TGF-beta system that might permit to analyze the behaviors of TGF-beta activity during the course of liver tumor progression and to identify new biomarkers and potential therapeutic targets. Based on collaboration with Jerome Feret from ENS, Paris,we will combine a rule-based model (Kappa language) to describe extracellular TGF-beta activation and large-scale state-transition based (Cadbiom formalism) model for TGF-beta-dependent intracellular signaling pathways. The multi-scale integrated model will be enriched with a large-scale analysis of liver tissues using shotgun proteomics to characterize protein networks from tumor microenvironment whose remodeling is responsible for extracellular activation of TGF-beta. The trajectories and upstream regulators of the final model will be analyzed with symbolic model checking techniques and abstract interpretation combined with causality analysis. Candidates will be classified with semantic-based approaches and symbolic bi-clustering technics. The project is funded by the national program "Plan Cancer - Systems biology" from 2015 to 2018.

8.2.2.3. ANR Samosa

Participants: Damien Eveillard, Jeanne Got, Anne Siegel.

Oceans are particularly affected by global change, which can cause e.g. increases in average sea temperature and in UV radiation fluxes onto ocean surface or a shrinkage of nutrient-rich areas. This raises the question of the capacity of marine photosynthetic microorganisms to cope with these environmental changes both at short term (physiological plasticity) and long term (e.g. gene alterations or acquisitions causing changes in fitness in a specific niche). Synechococcus cyanobacteria are among the most pertinent biological models to tackle this question, because of their ubiquity and wide abundance in the field, which allows them to be studied at all levels of organization from genes to the global ocean.

The SAMOSA project is funded by ANR from 2014 to 2018, coordinated by F. Gaczarek at the Station Biologique de Roscoff/UPMC/CNRS. The goal of the project is to develop a systems biology approach to characterize and model the main acclimation (i.e., physiological) and adaptation (i.e. evolutionary) mechanisms involved in the differential responses of Synechococcus clades/ecotypes to environmental fluctuations, with the goal to better predict their respective adaptability, and hence dynamics and distribution, in the context of global change. For this purpose, following intensive omics experimental protocol driven by our colleagues from − Station Biologique de Roscoff −, we aim at constructing a gene network model sufficiently flexible to allow the integration of transcriptomic and physiological data.

8.2.2.4. ADT Complex-biomarkers and ADT Proof of concept

Participants: Jeanne Got, Marie Chevallier, Meziane Aite, Anne Siegel.

This project started in Oct. 2014 and aims at designing a working environment based on workflows to assist molecular biologists to integrate large-scale omics data on non-classical species. The main goal of the workflows will be to facilitate the identification of set of regulators involved in the response of a species when challenged by an environmental stress. Applications target extremophile biotechnologies (biomining) and marine biology (micro-algae).

8.2.2.5. ANSES Mecagenotox

Participants: Victorien Delannée, Anne Siegel, Nathalie Théret.

The objective of Mecagenotox project is to characterize and model the human liver ability to bioactivate environmental contaminants during liver chronic diseases in order to assess individual susceptibility. Indeed, liver pathologies which result in the development of fibrosis are associated with a severe dysfunction of liver functions that may lead to increased susceptibility against contaminants. In this project funded by ANSES and coordinated by S. Langouet at IRSET/inserm (Univ. Rennes 1), we will combine cell biology approaches, biochemistry, biophysics, analytical chemistry and bioinformatics to 1) understand how the tension forces induced by the development of liver fibrosis alter the susceptibility of hepatocytes to certain genotoxic chemicals (especially Heterocyclic Aromatic Amines) and 2) model the behavior of xenobiotic metabolism during the liver fibrosis. Our main goal is to identify "sensitive" biomolecules in the network and to understand more comprehensively bioactivation of environmental contaminants involved in the onset of hepatocellular carcinoma.

8.2.2.6. PEPS CONFOCAL

Participants: Olivier Dameron, Jean Coquet, Nathalie Théret, Jacques Nicolas, Anne Siegel, Pierre Vignet.

PEPS CONFOCAL aims at developing new bioinformatics methods for analyzing heterogeneous *omics data and for filtering them according to domain knowledge. The current approaches are facing four main limitations: (1) classic biclustering methods do not support partial overlap of clusters, which is too restrictive considering some genes' pleiotropic nature, (2) they assume that the items to analyze (the genes, the molecules, the signaling pathways...) are independent, (3) they tend to generate numerous clusters leaving to the experts the task of identifying the relevant ones, and (4) they are sensitive to noisy or incomplete data. We investigate the extension of Formal Concept Analysis (FCA) with symbolic knowledge from ontologies in order to process large and complex sets of associations between genes, signaling pathways and the molecules involved in these pathways. Future applications cover the discrete model analysis in molecular biology. CONFOCAL initiated a collaboration with Amedeo Napoli (LORIA Nancy) and Elisabeth Remy (Mathematics Institute Luminy, "Mathematical Methods for Genomics" team).

8.3. European Initiatives

8.3.1. Collaborations with Major European Organizations

Partner: Aachen university (Germany)

Title: Modeling the logical response of a signalling network with constraints-programming.

Partner: Potsdam university (Germany)

Title: Constraint-based programming for the modeling and study of biological networks.

8.4. International Initiatives

8.4.1. 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 (2012) and the co-supervision of A. Aravena (2010-2013) contributed to reinforce the complementarity of both Chilean and French teams. In 2013, a workshop was organized in Chile to develop new French-Chilean collaborations within the framework of the CIRIC center. In 2014, Marie Chevallier and Meziane Aite joined the team as engineers to improve softwares resulting from collaborations. Maria-Paz Cortes visited the team during 6 monthes in the framework of her ph-D thesis.

Inria Chile
Associate Team involved in the International Lab:

8.4.1.1. BIOINTEGRATIVECHILE

Title: Integrative Biology in Extreme Environments

International Partner (Institution - Laboratory - Researcher):

Universidad de Chile (Chile) - Center for Mathematical Modeling (CMM) - Maass Alejandro

Start year: 2014

See also: http://www.irisa.fr/dyliss/public/EA/index.html

The project is in the area of bioinformatics, with a special focus on bacteria living in extreme environments, more precisely on microorganisms involved in bio-remediation or bio-production processes. We are particularly interested in bioprocesses such as copper extraction, salmon lethality, metal-resistance, all having an economical interest in Chile. Since the last decade, huge databases of microbial genomic sequences, together with multi-scale and large-scale cellular observations (genomics, transcriptomics, proteomics, metabolomics) have been produced. Each one can be viewed as a different scale of a biological process, either in time or space, but ultimately are related through networks of biological interactions that control the behavior of the system The reconstruction, analysis and modeling of such networks using all levels of information are biologically, mathematically and computationally challenging. Applied on microorganisms living in extreme environments, this question is even more challenging since relatively few knowledge is publicly available on the species, requiring to develop methods which are robust to uncertainty. We are developing methods to integrate and manage heterogeneous omics and uncertain data. This in the purpose of extracting suitable biomarkers from this multi-level information. This question will be addressed by coupling probabilistic and static dynamical systems methods with recent and efficient paradigms of constraint programming (Answer Set Programming).

8.5. International Research Visitors

8.5.1. Visits of International Scientists

- **Argentina**. Fundation Leloir, Buenos Aeres [S. Videla]
- **Chile**. Centro de Modelimiento Matematico, Santiago [A. Maass, N. Loiraâ , M. Latorre, M.-P. Cortes]
- **Niger**. University of Maradi [O. Abdou-Arbi]
- **Germany**. Max Planck Institute for Biophysical Chemistry [C. Galiez]

8.5.2. Research stays abroad

- **Germany**. University of Kaiserslautern [A. Antoine-Lorquin, 2 months]
- **Germany**. University of Potsdam [C. Frioux, 2 months]
- **Japan**. National Institute of Informatics in Tokyo [J.Coquet, 3 months]

8.5.3. Visits to International Teams

- **Chile**. Centro de Modelimiento Matematico, Santiago de Chile [J. Bourdon, M. Aite, F. Coste, A. Siegel]
- **Germany**. Frei Berlin University [A. Siegel]
- **Poland**. Wroclaw University of Science and Technology [F. Coste]
- **Netherland**. Utrecht University [F. Coste]

FLUMINANCE Project-Team

8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. Comins'lab: SEACS : Stochastic modEl-dAta-Coupled representationS for the analysis, simulation and reconstruction of upper ocean dynamics

Participant: Etienne Mémin.

duration 48 months. The SEACS project whose acronym stands for: "Stochastic modEl-dAta-Coupled representationS for the analysis, simulation and reconstruction of upper ocean dynamics" is a Joint Research Initiative between the three Britanny clusters of excellence of the "Laboratoires d'Excellence" program: Cominlabs, Lebesgue and LabexMer centered on numerical sciences, mathemathics and oceanography respectively. Within this project we aim at studying the potential of large-scale oceanic dynamics modeling under uncertainty for ensemble forecasting and satellite image data assimilation.

8.1.2. ANR JCJC GERONIMO : Advanced GEophysical Reduced-Order Model construction from IMage Observations

Participant: Cédric Herzet.

duration 48 months. The GERONIMO project which started in March 2014 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 at 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.

8.1.3. ANR BECOSE : Beyond Compressive Sensing: Sparse approximation algorithms for ill-conditioned inverse problems.

Participants: Dominique Heitz, Cédric Herzet.

duration 48 months. The BECOSE project aims to extend the scope of sparsity techniques much beyond the academic setting of random and well-conditioned dictionaries. In particular, one goal of the project is to step back from the popular L1-convexification of the sparse representation problem and consider more involved nonconvex formulations, both from a methodological and theoretical point of view. The algorithms will be assessed in the context of tomographic Particle Image Velocimetry (PIV), a rapidly growing imaging technique in fluid mechanics that will have strong impact in several industrial sectors including environment, automotive and aeronautical industries. The consortium gathers the Fluminance and Panama Inria research teams, the Research Center for Automatic Control of Nancy (CRAN), The Research Institute of Communication and Cybernetics of Nantes (IRCCyN), and ONERA, the French Aerospace Lab.

8.1.4. ANR-MN: H2MNO4 project

Participants: Yvan Crenner, Benjamin Delfino, Jean-Raynald de Dreuzy, Jocelyne Erhel, Lionel Lenôtre.

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 Cuyollaa.
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. We presented a poster at the ANR-day (rencontre du numérique, Parius, Nov. 2016)

8.1.5. INSU-LEFE: Toward new methods for the estimation of sub-meso scale oceanic streams

Participant: 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 collaboration with the Laboratoire de Météorologie Dynamique, Ecole Normale Supérieure, Paris.

8.1.6. INSU-LEFE: MODELER

Participant: Etienne Mémin.

duration 24 months. This project with MeteoFrance aims at exploring error modeling and stochastic parameterization in geophysical flow dynamics. The theory explored in this context should enable the construction of unified image data assimilation strategies.

8.1.7. Inria Project Lab: C2S@EXA project

Participants: Yvan Crenner, Jocelyne Erhel.

Title: C2S@EXA - Computer and Computational Scienecs at Exascale
Duration: from January 2012 until April 2017
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. The team participated in several workshops.

8.1.8. GENCI: project on advanced linear solvers

Participants: Yvan Crenner, Jocelyne Erhel, David Imberti.

Title: Numerical models for hydrogeology
Duration: 2016
Coordination: J. Erhel
Webpage: http://www.genci.fr/
Abstract: To run large scale simulations, we defined a project, based on the platform H2OLab and on a new GMRES solver. We obtained and used computing time on machines located at GENCI supercomputing centers.

8.1.9. GDR MANU

Participants: Benjamin Delfino, Jocelyne Erhel.

Title: Mathematics for Nuclear industry
Duration: From 2016 to 2019
Coordination: C. Cancès
Webpage: http://gdr-manu.math.cnrs.fr/
Abstract: The working group MANU is a follow-up to the group MOMAS. It covers many subjects related to mathematical modeling and numerical simulations for problems arising from nuclear industry and nuclear waste disposal. The team participated in the conference JEMP2016.

8.2. European Initiatives

8.2.1. EXA2CT

Participants: Jocelyne Erhel, David Imberti.

Title: EXascale Algorithms and Advanced Computational Techniques

Programm: FP7

Duration: September 2013 - August 2016

Coordinator: S. Ashby, IMEC, Belgium

Partners:

Fraunhofer-Gesellschaft Zur Foerderung Der Angewandten Forschung E.V (Germany)

Interuniversitair Micro-Electronica Centrum Vzw (Belgium)

Intel Corporations (France)

Numerical Algorithms Group Ltd (United Kingdom)

Systems Solutions for Research (Germany)

Universiteit Antwerpen (Belgium)

Universita della Svizzera italiana (Switzerland)

Universite de Versailles Saint-Quentin-En-Yvelines. (France)

Vysoka Skola Banska - Technicka Univerzita Ostrava (Czech Republic)

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. 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.

8.2.2. EOCOE project

Participant: Jocelyne Erhel.

Program: EINFRA-5-2015

Project acronym: EoCoE

Project title: Energy oriented Center of Excellence for computer applications

Duration: 36 months

Coordinator: CEA

Other partners: organisme, labo (pays) : 12 other partners

Abstract: the EoCoE objectives aims at firstly, to design, test and spread new methodological and organisational paradigms (Objectives 1, 3, and 4) driven by the users communities and, secondly, to contribute to mathematical and computer sciences challenges on the whole HPC tool chain (Objective 2).

8.3. International Initiatives

8.3.1. Inria Associate Teams Not Involved in an Inria International Labs

8.3.1.1. LFD-FLU

Title: Large-scale Fluid Dynamics analysis from FLow Uncertainty

International Partner (Institution - Laboratory - Researcher):

Universidad de Buenos Aires (Argentina) - Department of Computer Science and Electrical Engineering - Guillermo Artana

Start year: 2016

See also: http://www.irisa.fr/prive/memin/LFD-FLU/

The first objective of this associate team is primarily concerned with the establishment of efficient fluid flow image data analysis procedures. This concerns for instance data assimilation issues to reconstruct meaningful numerical representation of experimental fluid flows for analysis purpose. The second objective focuses on the incorporation of uncertainties in the flow dynamical evolution models

8.3.2. Inria International Partners

8.3.2.1. Informal International Partners

Imperial College (London, UK) We have initiated a collaboration with the Department of Aeronautics within the PhD thesis of Pranav Chandramoulli

Chico California State University (USA), We have pursue our collaboration with the group of Shane Mayor on the GPU implementation of wavelet based motion estimator for Lidar data. This code is developped in coproperty between Inria and Chico.

College of Control Science & Engineering of Zhejiang University We have initiated a collaboration with Prof. Chao Xu on the study of fluid motion estimator.

8.4. International Research Visitors

8.4.1. Visits of International Scientists

- 2 month sojourn of Gisela Charo (PhD student University of Buenos Aires) to work with Etienne Mémin and Valentin Resseguier within the associate team LFD
- 2 weeks visit of Alejandro Gronskis (Researcher Conicet Argentina) to work with Dominique Heitz, Etienne Mémin and Pranav Chandramouli within the associate team LFD
- Sojourn of 9 month of Shengze Cai PhD student in the College of Control Science & Engineering, Zhejiang University to work with Etienne Mémin
- 2 weeks visit of Prof. Luigi Berselli (U. Pisa) to work with Roger Lewandowski.

GENSCALE Project-Team

9. Partnerships and Cooperations

9.1. Regional Initiatives

9.1.1. Rennes Hospital, Hematology service, Genetic service

Participants: Patrick Durand, Dominique Lavenier, Claire Lemaitre, Pierre Peterlongo, Guillaume Rizk.

The collaboration with the Hematology service and with the Genetic service of the Rennes hospital aims to set up advanced bioinformatics pipelines for cancer diagnosis. More precisely, we are in the process of setting up and evaluating a new method of predictions of small cancer-related mutations (such as SNPs and small insertions/deletions) from raw DNA sequencing data. The method relies on the use of k-mers and clustering of reads to call for mutations. Current prototype relies on Python programming language just for the purpose of evaluating the prediction quality of the software. However, final software is expected to use GATB library to highly increase the performance of the new tool.

9.1.2. Partnership with INRA in Rennes

Participants: Cervin Guyomar, Dominique Lavenier, Fabrice Legeai, Claire Lemaitre, Sébastien Letort, Pierre Peterlongo.

The GenScale team has 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 one INRA engineer (F. Legeai) and one PhD student (C. Guyomar).

9.2. National Initiatives

9.2.1. ANR

9.2.1.1. Project ADA-SPODO: Genetic variation of Spodoptera Frugiperda

Participants: Claire Lemaitre, Fabrice Legeai, Anaïs Gouin, Dominique Lavenier, Pierre Peterlongo.

Coordinator: E. D'Alençon (Inra, Montpellier)
Duration: 45 months (Oct. 2012 – May 2016)
Partners: DGIMI Inra Montpellier, CBGP Inra Montpellier, URGI Inra Versailles, Genscale Inria/IRISA Rennes.

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 postgenomic and regulatory data.

9.2.1.2. Project COLIB'READ: Advanced algorithms for NGS data

Participants: Pierre Peterlongo, Antoine Limasset, Camille Marchet, Claire Lemaitre, Dominique Lavenier, Fabrice Legeai, Guillaume Rizk, Chloé Riou.

Coordinator: P. Peterlongo (Inria, GenScale, Rennes)
Duration: 45 months (Mar. 2013 – Dec. 2016)
Partners: LIRMM Montpellier, Erable Inria Lyon, Genscale Inria/IRISA Rennes.

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. The goal is to avoid the assembly step that often leads to a significant loss of information, or generates chimerical results due to complex heuristics. Instead, the strategy proposes a set of innovative approaches that bypass the assembly phase, and that do not require the availability of a reference genome. https://colibread.inria.fr/

9.2.1.3. Project HydroGen: Metagenomic applied to ocean life study

Participants: Dominique Lavenier, Pierre Peterlongo, Claire Lemaitre, Guillaume Rizk, Gaëtan Benoit.

Coordinator: P. Peterlongo (Inria/Irisa, GenScale, Rennes)
Duration: 42 months (Nov. 2014 – Apr. 2018)
Partners: CEA (GenosScope, Evry), INRA (AgroParisTech, Paris – MIG, Jouy-en-Jossas).

The HydroGen project aims to design new statistical and computational tools to measure and analyze biodiversity through comparative metagenomic approaches. The support application is the study of ocean biodiversity based on the analysis of seawater samples available from the Tara Oceans expedition.

9.2.1.4. Project SpeCrep: speciation processes in butterflies

Participants: Dominique Lavenier, Pierre Peterlongo, Claire Lemaitre, Fabrice Legeai.

Coordinator: M. Elias (Museum National d'Histoire Naturelle, Institut de Systematique et d'Evolution de la Biodiversite, Paris)
Duration: 48 months (Jan. 2015 – Dec. 2018)
Partners: MNHN (Paris), INRA (Versailles-Grignon), Genscale Inria/IRISA Rennes.

The SpeCrep project aims at better understanding the speciation processes, in particular by comparing natural replicates from several butterfly species in a suture zone system. GenScale's task is to develop new efficient methods for the assembly of reference genomes and the evaluation of the genetic diversity in several butterfly populations.

9.2.2. PIA: Programme Investissement d'Avenir

9.2.2.1. RAPSODYN: Optimization of the rapeseed oil content under low nitrogen

Participants: Dominique Lavenier, Claire Lemaitre, Sebastien Letort, Pierre Peterlongo.

Coordinator: N. Nesi (Inra, IGEPP, Rennes)
The objective of the Rapsodyn project is the optimization of the rapeseed oil content and yield under low nitrogen input. GenScale is involved in the bioinformatics work package to elaborate advanced tools dedicated to polymorphism and application to the rapeseed plant.

9.2.2.2. France Génomique: Bio-informatics and Genomic Analysis

Participants: Laurent Bouri, Dominique Lavenier.

Coordinator: J. Weissenbach (Genoscope, Evry)
France Génomique gathers resources from the main French platforms in genomic and bio-informatics. It offers to the scientific community an access to these resources, a high level of expertise and the possibilities to participate in ambitious national and international projects. The GenScale team is involved in the work package "assembly" to provide expertise and to design new assembly tools for the 3rd generation sequencing.

9.2.3. Programs from research institutions

9.2.3.1. Inria ADT DiagCancer

Participants: Dominique Lavenier, Patrick Durand.

Since October 1st, 2016, Genscale has started a one-year Inria ADT called DiagCancer. It aims at: (1) including the DiscoSnp++ tool within the current data production pipeline at Pontchaillou Hospital (Rennes), (2) providing a new prediction tool applied to the calling of cancer related mutations from DNA sequencing data and (3) creating new analysis tools to facilitate the interpretation of results by end-users (biologists, doctors). The project is done in close collaboration with Haematology Service, CHU Pontchaillou, Rennes.

9.3. International Initiatives

9.3.1. Informal International Partners

- Free University of Brussels, Belgium: Genome assembly [P. Perterlongo, R. Andonov]
- IMECC, UNICAMP, Campinas, Brazil: Distance geometry problem [A. Mucherino]
- Los Alamos National Laboratory (LANL), Los Alamos: Graph structure, Parallelism, GPU [R. Andonov, D. Lavenier, G. Rizk]

9.4. International Research Visitors

9.4.1. Visits of International Scientists

- Visit of prof. Tomi Klein from Bar Ilan University (Israel). One week, december 2016. Collaboration for the application of approximate hash function to the TGS data analysis [P. Peterlongo]
- Visit of Hristo Djidjev from Los Alamos National Laboratory, June 2016. Graph algorithms for scaffolding problem, professeur invité, University of Rennnes 1, [R. Andonov]
- Visit of Guillaume Chapuis from Los Alamos National Laboratory, June 2016. Parallelism, GPU. [R. Andonov, D. Lavenier]

9.4.2. Internships

- Samyadeep Basu, BITS Pilani, India, May - July 2016. Development of a web server for assembling bacteria genomes [D. Lavenier, P. Durand, C. Deltel]

9.4.3. Visits to International Teams

9.4.3.1. Research Stays Abroad

- Visit of Guillaume Rizk to Los Alamos National Laboratory, USA, August - September 2016 (2 months). Efficient combinatorial optimization using quantum computing.

SERPICO Project-Team

9. Partnerships and Cooperations

9.1. Regional Initiatives

ENSAI-CREST: Statistical methods and models for image registration, Vincent Briane PhD thesis is co-funded by Inria and ENSAI-CREST and co-supervised by Myriam Vimond (ENSAI-CREST).

Région Bretagne: Identification, localization and enumeration of ribosomes within a tomogram by combining state-of-the-art denoising methods and object descriptor-based recognition (CATLAS, see Section 8.2.1).

BioGenOuest: Collaboration with S. Prigent (engineer) in charge of the organization of image processing services for Biogenouest bio-imaging facilities.

IGDR: Collaboration with J. Pecreaux, Y. Le Cunff (co-supervision of A.G. Caranfil's PhD thesis).

9.2. National Initiatives

9.2.1. France-BioImaging project

Participants: Charles Kervrann, Patrick Bouthemy, Thierry Pécot, Emmanuel Moebel, Ancageorgiana Caranfil.

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 ANR (2011-2016).
Partners: CNRS, Institut Jacques Monod, Institut Pasteur, Institut Curie, ENS Ulm, Ecole Polytechnique, INRA, INSERM.

9.2.2. ANR DALLISH project (2016-2020): Data Assimilation and Lattice LIght SHeet imaging for endocytosis/exocytosis pathway modeling in the whole cell

Participants: Charles Kervrann, Patrick Bouthemy, Vincent Briane, Ancageorgiana Caranfil.

The Lattice Light Sheet Microscopy (LLS-M) represents at present the novel generation of 3D fluorescence microscopes dedicated to single cell analysis, generating extraordinarily high resolved and sharp, but huge 3D images and videos: one single live cell experiment in one single condition, imaging two molecular markers of the endocytosis pathway and using cutting-edge LLS-M can result into up to one Terabyte of data, at the spatial resolution of 100-200 nanometers in 3D. In such a situation, it is found the usual conventional image reconstruction algorithms and image analysis methods developed for 3D fluorescence microscopy are likely to fail to process a deluge of voxels generated by LLS-M instruments. The goal of the project is then to develop new paradigms and computational strategies for image reconstruction and 3D molecule tracking/motion estimation. Furthermore, establishing correspondences between the image-based measurements and features (e.g., motion vectors, trajectories), stochastic motion models and the underlying biological and biophysical information remains a challenging task.

The impact of the project will be three-fold. First, our new image processing paradigms and improved algorithms (allowing faster, more resolved and more accurate results) will have direct benefits in modern bioimaging. Second, the methods and algorithms will apply to decipher molecular mechanisms of protein transports, here focused on endocytosis/exocytosis. Finally, in a larger perspective, the quantitative description of protein transport will be a prerequisite for understanding the functioning of a cell in normal and pathological situations, as default in protein transport appeared over the years, as a major contributory factor to a number of diseases, including cancer, viral infection and neurodegenerative diseases.

Funding: ANR - Agence Nationale de la Recherche

Partners: Inria (SERPICO, BEAGLE, Fluminance), INRA MaIAGE Unit Jouy-en-Josas, Institut Curie (UMR CNRS 144 & U1143 Inserm UMR 3666) Paris

9.3. European Initiatives

9.3.1. Major European Organizations with which the Team have followed Collaborations

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. SERPICO also participates to 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 9.2.1 .

9.4. International Initiatives

9.4.1. Informal International Partners

Collaboration with Max-Planck Institute, Martinsried (Germany), Dr. Julio Ortiz: Detection and segmentation of macromolecules in cryo electron tomography (project in progress with Emmanuel Moebel and Charles Kervrann).

Collaboration with Aalborg University (Denmark), Prof. Rasmus Waagepetersen : Estimating equations for inhomogeneous determinantal point processes (project in progress with Frédéric Lavancier).

Collaboration with EPFL (M. Unser's Team, Switzerland). D. Fortun: optical flow computing (project in progress with Charles Kervrann).

9.4.2. CytoDI Inria Associated-Team

Title: Quantitative Imaging of Cytoskeleton Dynamics in 3D

International Partner:

University of Texas, SouthWestern Medical Center, Dallas (United States) - Gaudenz Danuser

Start year: 2016

See also: http://serpico.rennes.inria.fr/doku.php?id=research:cytodi

The main scientific goal of the Associated-Team is the spatiotemporal characterization and comparison of cytoskeleton networks involved in cell migration and observed through live cell imaging in three dimensions (3D). Those networks include the cytoskeleton, i.e., microtubules (MT), intermediate filaments (IF), dynamically resolvable by Bessel Beam Light Sheet fluorescent microscopy. The goal will be achieved through the design of local and global descriptors of the spatial conformation and deformation of the cytoskeleton. Subsequently, general metrics to compare and classify the MT and IF networks will be investigated. This study will be carried out on oncogenically transformed lung cancer epithelial cells.

The first meeting took place in Dallas in May 2016 as originally scheduled, to discuss and update current research direction and discuss scientific progress.

9.5. International Research Visitors

9.5.1. Visits to International Teams

Visit of 3 months of Juan Manuel Perez Rua in the Philip Torr's team (University of Oxford, UK).
Visit of 1 one week of Vincent Briane to the ESGI (European Study Group in Industry) in Dublin (Ireland, July 2016).

Visit of 1 one week of Vincent Briane to the University of Limerick (K. Burke's team) (Ireland, November 2016).

VISAGES Project-Team

9. Partnerships and Cooperations

9.1. Regional Initiatives

9.1.1. 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.

9.1.2. Projet Fondation de France: PERINE

Participants: Élise Bannier, Isabelle Corouge, Olivier Commowick, Jean-Christophe Ferré, Christian Barillot.

This study evaluates the effect of prenatal exposure to neurotoxicants on the developing brain. Following previous studies in the PELAGIE cohort this MRI study involves ASL, Diffusion and working memory as well as motor inhibition BOLD fMRI together with neuropsychological tests in children. Inclusions have started in November 2014 and lasted for 2 years. The MRI acquisitions of the PERINE projects have all been performed and 101 children included. A post-doc will start in April 2017 to process the diffusion MRI and ASL data of this project.

9.1.3. Fondation de l'Avenir - Stroke, rehabilitation and fMRI

Participants: Élise Bannier, Isabelle Bonan, Isabelle Corouge, Jean-Christophe Ferré, Christian Barillot, Jean-Yves Gauvrit.

duration: 12 months from November 2012. Project extended in 2015.
A complementary funding (20 000€) was obtained to support a new research project on rehabilitation of stroke patients. The fMRI tasks were setup and validated on healthy controls (paper ready for submission). The project was extended in 2014 to recruit more patients.

9.1.4. Projet Fondation de France: EPMR-MA

Participants: Pierre-Yves Jonin, Élise Bannier, Christian Barillot, Isabelle Corouge, Quentin Duché, Jean-Christophe Ferré.

This project evaluates memory effects in healthy adults and in patients presenting cognitive impairments using BOLD fMRI and diffusion MRI. A pilot study has been completed in 2015 in order to optimize the experimental design. The inclusions of patients started in 2016 and are ongoing. A Post Doc was recruited to work on fMRI and DTI processing.

9.1.5. Allocation d'Installation Scientifique – Rennes Métropole

Participant: Emmanuel Caruyer.

Diffusion MRI has been a tremendous tool for the diagnosis of a number of brain pathologies such as abnormal development, neuro-degenerative or inflammatory disorders or brain tumors. Typical resolution in diffusion MRI is about 2mm – this suggests that in white matter, any volume element may contain millions of axons. Although currently we can characterize molecular diffusion, recent developments in diffusion MRI have shown the possibility to quantify more specifically some physical tissue parameters in white matter, such as axonal density and diameter: this means that we can retrieve information from a much smaller scale than the typical imaging resolution.

Acquisition time for this kind of measurements remains long and largely incompatible with in vivo application in humans. This projects aims at developing novel signal processing and acquisition methods for the reconstruction of microstructural informations in a reasonable acquisition time. We will study how sparse representations can be applied to the diffusion signal, in order to enable microstructure information reconstruction. In conjunction with this, we will develop acquisition sequences adapted to these sparse represnetations, in order to reconstruct the diffusion signal from fewer measurements, using results from the compressive sensing theory.

9.2. National Initiatives

9.2.1. ANR

9.2.1.1. ANR "MAIA", 2015 generic projects program

Participants: Maia Proisy, Pierre Maurel, Antoine Legouhy, Olivier Commowick, Isabelle Corouge, Jean-Christophe Ferré, Christian Barillot.

Each year in France, 55 000 children are born prematurely, i.e., before the 37th week of gestation. Long-term studies of the outcome of prematurely born infants have clearly documented that the majority of such infants may have significant motor, cognitive, and behavioral deficits.

However, there is a limited understanding of the nature of the cerebral abnormality underlying these adverse neurologic outcomes. In this context, the emergence of new modalities of 3D functional MRI, e.g., Arterial Spin Labeling (ASL), or optical imaging technologies, e.g., Near InfraRed Spectroscopy (NIRS), brings new perspectives for extracting cognitive information, via metabolic activity measures. Other classical technics devoted to cerebral signal measurement, such as ElectroEncephaloGraphy (EEG), provide cognitive information at the cortical level. Each of these various non-invasive imaging technologies brings substantial and specific information for the understanding of newborn brain development.

This project aims at developing innovative approaches for multi-image / multi-signal analysis, in order to improve neurodevelopment understanding methods. From a fundamental point of view, mathematics and computer science have to be considered in association with imaging physics and medicine, to deal with open issues of signal and image analysis from heterogeneous data (image, signal), considered in the multiphysics contexts related to data acquisition (magnetic, optic, electric signals) and biophysics modeling of the newborn brain. A sustained synergy between all these scientific domains is then necessary.

Finally, the sine qua non condition to reach a better understanding of the coupled morphological- cognitive development of premature newborns, is the development of effective software tools, and their distribution to the whole medical community. The very target of this project will be the design of such software tools for medical image / signal analysis, actually operational in clinical routine, and freely available. Academic researchers and industrial partners will work in close collaboration to reach that ambitious goal.

9.2.2. Competitivity Clusters

9.2.2.1. The HEMISFER Project

Participants: Élise Bannier, Jean-Marie Batail, 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" [0]. 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

[0] https://iww.inria.fr/cominlabs-newsletter/april-2013-four-projects-selected/#hemisfer

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).

9.2.2.2. France Life Imaging (FLI)

Participants: Christian Barillot, Olivier Commowick, Michael Kain, Florent Leray, Julien Louis, Aneta Morawin, Mathieu Simon, Yao Chi.

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; LSIIT/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.

9.2.2.3. OFSEP

Participants: Justine Guillaumont, Élise Bannier, Christian Barillot, Olivier Commowick, Gilles Edan, Jean-Christophe Ferré, Michael Kain, Inès Fakhfakh.

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 50,000 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.

9.2.2.4. PHRC EMISEP: Evaluation of early spinal cord injury and late physical disability in Relapsing Remitting Multiple Sclerosis

Participants: Élise Bannier, Christian Barillot, Emmanuel Caruyer, Benoit Combès, Olivier Commowick, Gilles Edan, Jean-Christophe Ferré, Anne Kerbrat, Haykel Snoussi.

Multiple Sclerosis (MS) is the most frequent acquired neurological disease affecting young adults (1/1000 inhabitants in France) and leading to impairment. Early and well adapted treatment is essential in patients presenting aggressive forms of MS. This PHRC project focusses on physical impairment and especially on the ability to walk. Several studies, whether epidemiolgic or based on brain MRI, have shown that several factors were likely to announce aggressive development of the disease, such as age, number of focal lesions on baseline MRI, clinical activity. However, these factors only partially explain physical impairment progression, preventing their use at the individual level. Spinal cord is often affected in MS, as demonstrated in postmortem or imaging studies. Yet, early radiological depiction of spinal cord lesions is not always correlated with clinical symptoms. Preliminary data, on reduced number of patients, and only investigating the cervical spinal cord have shown that diffuse spinal cord injury, observed via diffusion or magnetisation transfer imaging, would be correlated with physical impairment as evaluated by the EDSS score. Besides, the role of early spinal cord affection (first two years) in the evolution of physical impairment remains unknown.

In this project, we propose to address these different issues and perform a longitudinal study on Relapsing Remitting Multiple Sclerosis (RRMS) patients, recruited in the first year of the disease. Our goal is to show that diffuse and focal lesions detected spinal cord MRI in the first 2 years can be used to predict disease evolution and physical impairment at 5 years. Twelve centers are involved in the study to include 80 patients.

To date, 65 of the 80 subjects have been included. H. Snoussi is working in the scope of his PhD thesis on diffusion imaging in the spinal cord and has dedicated his first year to literature review and definition of methodological aspects to tackle starting with distortion correction. B. Combès started as a post doc in November 2016 to process the EMISEP imaging data, starting with morphological data processing (registration, segmentation) and magnetization transfer data processing.

9.3. European Initiatives

9.3.1. FP7 & H2020 Projects

9.3.1.1. EuroBioimaging

Type: CAPACITIES

Challenge: 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

Objective: Euro-BioImaging is a large-scale pan-European research infrastructure project on the

European Strategy Forum on Research Infrastructures (ESFRI) Roadmap.

Duration: December 2010 - 2016

Coordinators: Jan Ellenberg (EMBL) and Oliver Speck (University of Magdeburg)

Partner: EMBL (Germany); Erasmus Medical Center (Netherlands) for WG11

Inria contact: C. Kervrann, Christian Barillot

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.

9.3.1.2. H2020 OpenAire-Connect

Program: E-INFRA

Topic: EINFRA-22-2016

Type of Action: RIA

Project acronym: OpenAIRE-Connect

Project title: OpenAIRE - CONNECTing scientific results in support of Open Science

Acceptation date: 01/09/2016

Open Science is around the corner. Scientists and organizations see it as a way to speed up, improve quality and reward, while policy makers see it as a means to optimize cost of science and leverage innovation. Open Science is an emerging vision, a way of thinking, whose challenges always gaze beyond its actual achievements. De facto, today's scientific communication ecosystem lacks tools and practices to allow researchers to fully embrace Open Science. OpenAIREConnect aims to provide technological and social bridges, and deliver services enabling uniform exchange of research artefacts (literature, data, and methods), with semantic links between them, across research communities and content providers in scientific communication. It will introduce and implement the concept of Open Science as a Service (OSaaS) on top of the existing OpenAIRE infrastructure, delivering out-of-the-box, on-demand deployable tools. OpenAIRE-Connect will adopt an end-user driven approach (via the involvement of 5 prominent research communities), and enrich the portfolio of OpenAIRE infrastructure production services with a Research Community Dashboard Service and a Catch-All Notification Broker Service. The first will offer publishing, interlinking, packaging functionalities to enable them to share and re-use their research artifacts (introducing methods, e.g. data,software, protocols). This effort, supported by the harvesting and mining "intelligence" of the OpenAIRE infrastructure, will provide communities with the content and tools they need to effectively evaluate and reproduce science. OpenAIRE-Connect will combine dissemination and training with OpenAIRE's powerful NOAD network engaging research communities and content providers in adopting such services. These combined actions will bring immediate and long-term benefits to scholarly communication stakeholders by affecting the way research results are disseminated, exchanged, evaluated, and re-used.

In this project VisAGeS is acting, through CNRS, as the French coordinator to develop the link with the Neuroimaging research community. This will be performed in the context of the FLI-IAM national infrastructure

9.3.2. Collaborations in European Programs, Except FP7 & H2020

9.3.2.1. Kic-EIT-eHealth

Program: KIC-EIT: European Institute of Innovation and Technology

Project acronym: e-Health

Project title: Innovation for healthy living and active ageing

Acceptation date: 01/12/2014

website: http://eithealth.eu/about-us/

EIT Health aims to promote entrepreneurship and develop innovations in healthy living and active ageing, providing Europe with new opportunities and resources. EIT Health will enable citizens to lead healthier and more productive lives by delivering products, services and concepts that will improve quality of life and contribute to the sustainability of healthcare across Europe. EIT Health is a strong, diverse and balanced partnership of best-in-class organisations in education, research,

technology, business creation and corporate and social innovation. EIT Health intends to foster cooperation and unlock Europe's innovation and growth potential – developing and retaining the best talents, creating high-quality jobs and boosting the global competitiveness of European industry. VisAGeS is involved in this project through the Inserm and Inria institutions. Christian Barillot is representing Inria as one expert in the dedicated WG "Healthy Brain". VisAGeS is also concerned by the WG "big data".

9.4. International Initiatives

9.4.1. Inria Associate Teams Not Involved in an Inria International Labs

9.4.1.1. BARBANT

Title: Boston and Rennes, a Brain image Analysis Team

International Partner (Institution - Laboratory - Researcher):

Harvard University (United States) - Mathematics Department - Simon K. Warfield

Start year: 2015

See also: https://team.inria.fr/barbant/

BARBANT is an Inria associate team shared between Inria VisAGeS research team and the Computational Radiology Laboratory at the Boston Children's hospital (Harvard Medical School). This associate team aims at better understanding the behavior of normal and pathological Central Nervous System (CNS) organs and systems. Pathologies of particular interest to us are multiple sclerosis, psychiatric, and pediatric diseases such as pediatric multiple sclerosis or tuberous sclerosis. A major challenge is to characterize the future course of the pathological processes in each patient as early as possible in order to predict the progression of the disease and/or adverse neurological outcomes, and to develop better techniques for both monitoring response to therapy and for altering therapy (duration, dose and nature) in response to patient-specific changes in imaging characteristics. 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.

9.4.1.2. Informal International Partners

- Collaboration with Sherbrooke University (Sherbrooke, Canada): From Jun to Aug 2016, Michael Paquette, PhD student from Sherbrooke supervised by Maxime Descoteaux, visited the VisAGeS team to collaborate with Emmanuel Caruyer on the development on new analysis techniques for the structural brain connectome. This visit was funded by a MITACS/Inria scholarship.
- Collaboration with LTS5, EPFL (Lausanne, Switzerland) and Computer Science department, University of Verona (Verona, Italy): Alessandro Daducci, Gabriel Girard and Jean-Philippe Thiran visited the VisAGeS team for a 2 days workshop on the development of novel validation methods for the human brain connectome using software generated phantoms.
- Collaboration with the Mathematics department, Politecnico di Milano (Italy): Olivier Commowick and Christian Barillot visited the department for the annual meeting of the Italian statistical society and collaborated with Aymeric Stamm and Simone Vantini.
- Collaboration with the Microstructure Imaging Group, UCL (London, UK): Christian Barillot, Emmanuel Caruyer, Olivier Commowick and Sudhanya Chatterjee visited the group of Daniel Alexander for a workshop on "MRI based Virtual Histology: Meeting Tomorrow's Healthcare Challenges Today"
- visit of Tobias Kober and Bénédicte Maréchal from the ACIT Siemens research group in Lausanne [0] to discuss potential collaborations on the MP2Rage sequence and other brain MR imaging topics

[0] http://w1.siemens.ch/home/ch/de/healthcare/produkte/ACIT/Pages/ACIT.aspx

9.5. International Research Visitors

9.5.1. Visits of International Scientists

- Simon Warfield and Benoit Scherrer, Harvard University, visited the VisAGeS team for the annual seminar on Jun 9-10 2016.
- From Jun to Aug 2016, Michael Paquette, PhD student from Sherbrooke supervised by Maxime Descoteaux, visited the VisAGeS team to collaborate with Emmanuel Caruyer on the development on new analysis techniques for the structural brain connectome. This visit was funded by a MITACS/Inria scholarship.
- Alessandro Daducci, Gabriel Girard and Jean-Philippe Thiran visited the VisAGeS team for a 2 days workshop on the development of novel validation methods for the human brain connectome using software generated phantoms.

9.5.2. Visits to International Teams

- Sudhanya Chatterjee visited the Computational Radiology Lab, Boston Children's Hospital, Harvard University for 3 weeks in Oct-Nov 2016. This stay was funded by the international program of University of Rennes 1. Christian Barillot, Emmanuel Caruyer and Olivier Commowick visited the same lab for a 3 days workshop in the context of the Associate Team.
- Christian Barillot, Emmanuel Caruyer, Olivier Commowick and Sudhanya Chatterjee visited the Microstructure Imaging Group, UCL (London, UK) of Daniel Alexander for a workshop on "MRI based Virtual Histology: Meeting Tomorrow's Healthcare Challenges Today"
- Olivier Commowick and Christian Barillot visited the Mathematics department, Politecnico di Milano (Italy) for the annual meeting of the Italian statistical society and collaborated with Aymeric Stamm and Simone Vantini.

ASAP Project-Team

8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. ANR project SocioPlug

Participants: Davide Frey, Anne-Marie Kermarrec, Pierre-Louis Roman, Francois Taiani.

SocioPlug is a collaborative ANR project involving Inria (ASAP team), the Univ. Nantes, and LIRIS (INSA Lyon and Univ. 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 of 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.

8.1.2. DeSceNt CominLabs

Participants: Resmi Ariyattu Chandrasekharannair, Davide Frey, Michel Raynal, Francois Taiani.

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 (Gestion de Données Distribuées) at Univ. Nantes.

8.1.3. ANR Blanc project Displexity

Participants: George Giakkoupis, Anne-Marie Kermarrec, Michel Raynal.

The Displexity project started in 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.

8.1.4. ANR project PAMELA

Participants: Davide Frey, George Giakkoupis, Francois Taiani.

PAMELA is a collaborative ANR project involving ASAP, Inria Lille, UMPC, Mediego and Snips. The project aims at developing machine learning theories and algorithms in order to learn local and personalized models from data distributed over networked infrastructures. This project seeks to provide first answers to modern information systems built by interconnecting many personal devices holding private user data in the search of personalized suggestions and recommendations. More precisely, we will focus on learning in a collaborative way with the help of neighbors in a network. We aim to lay the first blocks of a scientific foundation for these new types of systems, in effect moving from graphs of data to graphs of data and learned models. We argue that this shift is necessary in order to address the new constraints arising from the decentralization of information that is inherent to the emergence of big data. We will in particular focus on the question of learning under communication and privacy constraints. A significant asset of the project is the quality of its industrial partners, SNIPS and MEDIEGO, who bring in their expertise in privacy protection and distributed computing as well as use cases and datasets. They will contribute to translate this fundamental research effort into concrete outcomes by developing personalized and privacy-aware assistants able to provide contextualized recommendations on small devices and smartphones.

8.1.5. ANR project OBrowser

Participants: David Bromberg, Davide Frey, Francois Taiani.

OBrowser is a collaborative ANR project involving Inria (ASAP team), the Univ. Nantes, the Bretagne Sud. University, and Orange. The project emerges from the vision of designing and deploying distributed application on millions of machines using web-enabled technologies without relying on a cloud or a central authority. OBrowser proposes to build collaborative applications through a decentralized execution environment composed of users' browsers that autonomously manages issues such as communication, naming, heterogeneity, and scalability. The introduction of browser-to-browser communication with WebRTC's Datachannel has made these scenarios closer, but today only experts can afford to tackle the technical challenges associated with large-scale browser-based deployments such as decentralized instant-messaging (Firechat) and Infrastructure-less Mission Critical Push To Talk. O'Browser aims to solve these challenges by means of a novel programming framework.

8.1.6. ANR project DESCARTES

Participants: George Giakkoupis, Michel Raynal, Francois Taiani.

DESCARTES is a collaborative ANR project involving ASAP, Labri (U. Bordeaux), Lafia (U. Paris Diderot), Vérimag (Grenoble), LIF (Marseilles), and LINA (Nantes). Despite the practical interests of reusable frameworks for implementing specific distributed services, many of these frameworks still lack solid theoretical bases, and only provide partial solutions for a narrow range of services. In this project, we argue that this is mainly due to the lack of a generic framework that is able to unify the large body of fundamental knowledge on distributed computation that has been acquired over the last 40 years. The DESCARTES project aims at bridging this gap, by developing a systematic model of distributed computation that organizes the functionalities of a distributed computing system into reusable modular constructs assembled via well-defined mechanisms that maintain sound theoretical guarantees on the resulting system. DESCARTES arises from the strong belief that distributed computing is now mature enough to resolve the tension between the social needs for distributed computing systems, and the lack of a fundamentally sound and systematic way to realize these systems.

8.1.7. ANR-ERC Tremplin project NDFUSION

Participant: George Giakkoupis.

NDFUSION is an 18-month ANR project awarded to the PI to support his preparation for his upcoming ERC grant application. The idea of intervening in a network diffusion process to enhance or retard its spread has been studied in various contexts, e.g., to increase the spread or speed of diffusion by choosing an appropriate set of seed nodes (a standard goal in viral marketing by word-of-mouth), or achieve the opposite effect either by choosing a small set of nodes to remove (a goal in immunization against diseases), or by seeding a competing diffusion (e.g., to limit the spread of misinformation in a social network). The aim of this project is to consolidate existing work under a single, comprehensive framework, and using this framework to develop

new, efficient algorithms for optimizing (maximizing or minimizing) the spread of diffusion processes. Novel aspects of the project involve issues of scalability, multiple concurrent diffusions, and the use of multistage online strategies to optimize diffusions. Results from this project are likely to be relevant to many different disciplines, from network optimization in computing to disease containment in medicine.

8.2. International Initiatives

8.2.1. Inria International Labs

Anne-Marie Kermarrec has been scientific collaborator at EPFL, Lausanne, since Feb 2014.

Anne-Marie Kermarrec has been the scientific coordinator of the EPFL/Inria International Lab since Feb 2015.

8.3. International Research Visitors

8.3.1. Visits of International Scientists

Antonio Carzaniga, Università della Svizzera italiana (USI), Apr 29.

Evangelos Bampas, Aix-Marseille Université, Mar 23.

Fábio Moreira Costa, Institute of Informatics, Federal University of Goiás, Goiânia-GO, Brazil, Sep 12–16.

Ricardo Couto Antunes da Rocha, Department of Computer Science, Federal University of Goiás, Catalão-GO, Brazil, Sep 12–16.

Rachid Guerraoui, EPFL, Switzerland, invited Professor at Univ. Rennes I / ISTIC, since September 2016.

Arvid Bosk, KTH Royal Institute of Technology, guest PhD Student, from Dec 2016.

8.3.1.1. Internships

Florestan De Moor, Collaborative Filtering Under a Sybil Attack, Univ. Rennes I, May to Jul 2016, supervised by Davide Frey.

Julien Lepiller, Private Decentralized Aggregation, Inria, Feb to Jun 2016, supervised by Davide Frey and Francois Taiani.

8.3.2. Visits to International Teams

8.3.2.1. Research Stays Abroad

David Bromberg visited UFG, Goiania, Brazil, from Jun to Jul 2016 (CONFAP CNRS project)

8.3.2.2. Internships

Pierre-Louis Roman did an internship at Vrije Universiteit Amsterdam, The Netherlands, from Jun to Aug 2016 under the supervision of Spyros Voulgaris, with a grant from Université Bretagne Loire.

Simon Bouget did an internship at Centre for Complex Systems and Big Data at University of Neuchatel, Switzerland, from May to Aug 2016, under the supervision of Etienne Rivière, with a grant from the “Outgoing Mobility for Doctoral Students” program of Rennes Métropole.

Stéphane Delbruel did an internship at Universita della Svizzera Italiana, Switzerland, from Jun to Jul 2016, under the supervision of Antonio Carzaniga.

ASCOLA Project-Team

9. Partnerships and Cooperations

9.1. Regional Initiatives

9.1.1. RFI Atlanstic 2020

9.1.1.1. CoMe4ACloud

Participants: Thomas Ledoux [coordinator], Frederico Alvares, Zakarea Al Shara.

The high-level objective of the 1-year CoMe4ACloud (Constraints and Model Engineering for Autonomic Clouds) project is to provide an end-to-end solution for autonomic Cloud services. To that end, we rely on techniques of Constraint Programming so as a decision-making tool and Model-driven Engineering to ease the automatic generation of the so-called autonomic managers as well as their communication with the managed system.

CoMe4ACloud is an Atlanstic2020 funded project and supports a post-doc position. The project is led by Ascola research team and involves also AtlanModels and TASC, all of them from the LINA (Nantes Computer Science Laboratory) and situated at Ecole des Mines de Nantes. See https://come4acloud.github.io for more information.

9.1.2. Pays de la Loire

9.1.2.1. SyMeTRIC

Participant: Jean-Marc Menaud.

SyMeTRIC is a regional federated project in Systems Medicine funded by the Pays de la Loire region. Systems Medicine approaches can be compared to Systems Biology. They aim at integrating several information sources to design and validate bio-models and biomarkers to anticipate and enhance patients following (diagnosis, treatment response prediction, prognosis).

The long term goal of SyMeTRIC is to build a common Systems Medicine computing infrastructure to accelerate the discovery and validation of biomarkers in the fields of oncology, transplantation, and chronic cardiovascular diseases.

9.2. National Initiatives

9.2.1. CominLabs laboratory of excellence

9.2.1.1. EPOC

Participants: Jean-Marc Menaud [coordinator], Thomas Ledoux, Md Sabbir Hasan, Yunbo Li.

The project EPOC (Energy Proportional and Opportunistic Computing system) is a project running for 4 years. Four other partners collaborate within the project that is coordinated by ASCOLA: Myriads team, and the three institutions ENIB, ENSTB and University of Nantes. In this project, the partners focus 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 project 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.

9.2.1.2. PrivGen

Participants: Fatima-Zahra Boujdad, Mario Südholt [coordinator].

PrivGen ("Privacy-preserving sharing and processing of genetic data") is a three-year project that has been started in Oct. 2016 and is conducted by three partners: a team of computer scientists from the LATIM Inserm institute in Brest mainly working on data watermarking techniques, a team of geneticians from an Inserm institute in Rennes working on the gathering and interpretation of genetic data, and the Ascola team. The project provides funding of 330 KEUR altogether with an Ascola share of 120 KEUR.

The project considers challenges related to the outsourcing of genetic data that is in the Cloud by different stakeholders (researchers, organizations, providers, etc.). It tackles several limitations of current security solutions in the cloud, notably the lack of support for different security and privacy properties at once and computations executed at different sites that are executed on behalf of multiple stakeholders.

The partners are working on three main challenges:

- Mechanisms for a continuous digital content protection
- Composition of security and privacy-protection mechanisms
- Distributed processing and sharing of genetic data

The Ascola team is mainly involved in providing solutions for the second and third challenges.

9.2.1.3. 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 finalized our proposal of extensible JavaScript modules and applied it to extend in a modular way the full-blown JavaScript interpreter Narcissus with several dynamic analyses including information-flow analyses.

9.2.2. ANR

9.2.2.1. SONGS (ANR/INFRA)

Participants: Adrien Lebre [coordinator], Jonathan Pastor, Anthony Simonet.

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.

9.2.3. FSN

9.2.3.1. OpenCloudware (FSN)

Participants: Jean-Marc Menaud [coordinator], Thomas Ledoux.

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. The project started in 2012 for a duration of 42 months.

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 across Cloud layers) and "Run" (virtual machine manager for datacenters and placement constraints). The team has developed btrCloudStack, a private cloud based on the OpenSource CloudStack and integrating the work on placement rules and energy optimization. This software system has been extended this year.

9.2.3.2. Hosanna (FSN)

Participants: Jean-Marc Menaud [coordinator], Rémy Pottier.

The Hosanna project (aims to scientifically and technically addresses the problem of deploying applications on a distributed multi-cloud virtual infrastructure (private cloud, Amazon, OVH, CloudWatt, Numergy etc.). This recent need is an important topic issue highlighted by recent major Outages in 2013 by the biggest players in the cloud such as Amazon or Netflix. This project aims to provide services that allow users to deploy their cloud multi-tier applications on hybrid Clouds infrastructures without any separation between IaaS. The Ascola team is extending its optimization solution to address the task placement problem in a multi-cloud environment and will develop a case study on a secure distributed file system. The project started in 2015 for a duration of 2 years.

9.2.4. CPER

9.2.4.1. SeDuCe

Participants: Jean-Marc Menaud [coordinator], Adrien Lebre.

The SeDuCe project (Sustainable Data Centers: Bring Sun, Wind and Cloud Back Together), aims to design an experimental infrastructure dedicated to the study of data centers with low energy footprint. This innovative data center will be the first experimental data center in the world for studying the energy impact of cloud computing and the contribution of renewable energy (solar panels, wind turbines) as well on the scientific, technological, that economical. This project is integrated in the national context of grid computing (Grid'5000), and the Constellation project, which will be an inter-node (Pays de la Loire, Brittany). He also participated in the validation of scientific work in interdisciplinary axis STIC and energy efficiency of the laboratory of excellence COMIN Labs.

9.2.5. Inria Project Labs

9.2.5.1. DISCOVERY

Participants: Ronan Alexandre Rcherreau, Adrien Lebre [coordinator], Anthony Simonet, Mario Südholt.

To accommodate the ever-increasing demand for Utility Computing (UC) resources, while taking into account both energy and economical issues, the current trend consists in building larger and larger Data Centers in a few strategic locations. Although such an approach enables UC providers to cope with the actual demand while continuing to operate UC resources through centralized software system, it is far from delivering sustainable and efficient UC infrastructures for future needs.

The DISCOVERY initiative [36] aims at exploring a new way of operating Utility Computing (UC) resources by leveraging any facilities available through the Internet in order to deliver widely distributed platforms that can better match the geographical dispersal of users as well as the ever increasing demand. Critical to the emergence of such locality-based UC (also referred as Fog/Edge Computing) platforms is the availability of appropriate operating mechanisms. The main objective of DISCOVERY is to design, implement, demonstrate and promote a new kind of Cloud Operting System (OS) that will enable the management of such a large-scale and widely distributed infrastructure in an unified and friendly manner.

The consortium is composed of experts in the following research areas: large-scale infrastructure management systems, networking and P2P algorithms. Moreover, two key network operators, namely Orange and RENATER, are involved in the project.

By deploying and using a Fog/Edge OS on backbones, our ultimate vision is to enable large parts of the Internet to be hosted and operated by its internal structure itself: a scalable set of resources delivered by any computing facilities forming the Internet, starting from the larger hubs operated by ISPs, governments and academic institutions, to any idle resources that may be provided by end users.

ASCOLA leads the DISCOVERY IPL and contributes mainly around two axes: VM life cycle management and security concerns.

9.2.6. InriaHub

9.2.6.1. MERCURY

Participants: Ronan-Alexandre Rcherrueau, Adrien Lebre [coordinator].

ASCOLA, in particular within the framework of the DISCOVERY initiative has been working on the massively distributed use case since 2013. With the development of several proof-of-concepts around OpenStack, the team has had the opportunity to start an InriaHub action. Named MERCURY, the goal of this action is twofold: (i) support the research development made within the context of DISCOVERY and (ii) favor the transfer toward the OpenStack community.
Further information available at: http://beyondtheClouds.github.io.

9.3. European Initiatives

9.3.1. FP7 & H2020 Projects

9.3.1.1. CoqHoTT

Title: Coq for Homotopy Type Theory

Programm: H2020

Type: ERC

Duration: June 2015 - May 2020

Coordinator: Inria

Inria contact: Nicolas TABAREAU

Every year, software bugs cost hundreds of millions of euros to companies and administrations. Hence, software quality is a prevalent notion and interactive theorem provers based on type theory have shown their efficiency to prove correctness of important pieces of software like the C compiler of the CompCert project. One main interest of such theorem provers is the ability to extract directly the code from the proof. Unfortunately, their democratization suffers from a major drawback, the mismatch between equality in mathematics and in type theory. Thus, significant Coq developments have only been done by virtuosos playing with advanced concepts of computer science and mathematics. Recently, an extension of type theory with homotopical concepts such as univalence is gaining traction because it allows for the first time to marry together expected principles of equality. But the univalence principle has been treated so far as a new axiom which breaks one fundamental property of mechanized proofs: the ability to compute with programs that make use of this axiom. The main goal of the CoqHoTT project is to provide a new generation of proof assistants

with a computational version of univalence and use them as a base to implement effective logical model transformation so that the power of the internal logic of the proof assistant needed to prove the correctness of a program can be decided and changed at compile time—according to a trade-off between efficiency and logical expressivity. Our approach is based on a radically new compilation phase technique into a core type theory to modularize the difficulty of finding a decidable type checking algorithm for homotopy type theory. The impact of the CoqHoTT project will be very strong. Even if Coq is already a success, this project will promote it as a major proof assistant, for both computer scientists and mathematicians. CoqHoTT will become an essential tool for program certification and formalization of mathematics.

9.3.1.2. BigStorage

Title: BigStorage: Storage-based Convergence between HPC and Cloud to handle Big Data

Programm: H2020

Duration: January 2015 - December 2018

Coordinator: Universidad politecnica de Madrid

Partners:

Storage Research Group, Barcelona Supercomputing Center - Centro Nacional de Supercomputacion (Spain)

Ca Technologies Development Spain (Spain)

Commissariat A L Energie Atomique et Aux Energies Alternatives (France)

Deutsches Klimarechenzentrum (Germany)

ICS, Foundation for Research and Technology Hellas (Greece)

Fujitsu Technology Solutions (Germany)

Johannes Gutenberg Universitaet Mainz (Germany)

Universidad Politecnica de Madrid (Spain)

Seagate Systems Uk (United Kingdom)

Inria contact: G. Antoniu & A. Lebre

The consortium of this European Training Network (ETN) 'BigStorage: Storage-based Convergence between HPC and Cloud to handle Big Data' will train future data scientists in order to enable them and us to apply holistic and interdisciplinary approaches for taking advantage of a data-overwhelmed world, which requires HPC and Cloud infrastructures with a redefinition of storage architectures underpinning them - focusing on meeting highly ambitious performance and energy usage objectives. There has been an explosion of digital data, which is changing our knowledge about the world. This huge data collection, which cannot be managed by current data management systems, is known as Big Data. Techniques to address it are gradually combining with what has been traditionally known as High Performance Computing. Therefore, this ETN will focus on the convergence of Big Data, HPC, and Cloud data storage, ist management and analysis. To gain value from Big Data it must be addressed from many different angles: (i) applications, which can exploit this data, (ii) middleware, operating in the cloud and HPC environments, and (iii) infrastructure, which provides the Storage, and Computing capable of handling it. Big Data can only be effectively exploited if techniques and algorithms are available, which help to understand its content, so that it can be processed by decision-making models. This is the main goal of Data Science. We claim that this ETN project will be the ideal means to educate new researchers on the different facets of Data Science (across storage hardware and software architectures, large-scale distributed systems, data management services, data analysis, machine learning, decision making). Such a multifaceted expertise is mandatory to enable researchers to propose appropriate answers to applications requirements, while leveraging advanced data storage solutions unifying cloud and HPC storage facilities.

CIDRE Project-Team

9. Partnerships and Cooperations

9.1. Regional Initiatives

- **Region Bretagne ARED Grant :** the PhD of Mourad Leslous on malicious codes in Android applications is supported by a grant from the Région Bretagne.
- **Labex COMINLAB contract (2012-2016): "SecCloud" -** http://www.seccloud.cominlabs.ueb.eu/ Attacks targeting web browsers constitute a major threat. We tackled in the context of the SecCloud project attacks induced by client-side code execution (javascript, flash or html5). Existing security mechanisms such as os-level access control often are not sufficient to pre- vent client-side browser attacks as the web browser is granted the same privileges as the user. The idea 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 in- formation flow rules between user data and distant web sites. We proposed a new secure information flow control model specifically designed for JavaScript. This study was 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 (2013-2018): "DeSceNt" -** http://www.descent.cominlabs.ueb.eu 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), Inria team ASAP)
- **Labex COMINLAB contract (2014-2017): "Kharon-Security" -** http://kharon.gforge.inria.fr

  Google Play offers more than 800'000 applications (apps), and this number increases every day. Google play users have performed more than 25 billion app downloads. These applications vary from games to music, video, books, tools, etc. Unfortunately, each of these application is an attack vector on Android. The number of malicious applications (pieces of malware) discovered during the first six months of 2013 exceeds the number of pieces of malware discovered during the 2010 to 2012 period, more than 700 thousand malicious and risky applications were found in the wild. In this context, we propose the Kharon-Security project to stem the progression of Android pieces of malware. We propose to combine static and dynamic monitoring to compute a behavioral signature of Android malware. Behavioral signatures are helpful to understand how malware infect the devices and how they spread information in the Android operating system. Static analysis is essential to understand which particular event or callback triggers malware payload.

  In the project we have already developed GroddDroid a tool dedicated to automatic identification and execution of suspicious code. We have also built a dataset of Android malware, it this dataset, all malware are entirely manually reverse and documented. We have also developed an analysis platform. This platform is currently under private deployment.

- **Labex COMINLAB contract (2015-2018): "HardBlare-Security" - http://www.hardblare.cominlabs.ueb.eu/**

  The general context of the HardBlare project is to address Dynamic Information Flow Control that generally consists in attaching marks to denote the type of information that is saved or generated within the system. These marks are then propagated when the system evolves and information flow control is performed in order to guarantee a safe execution and storage within the system. Existing solutions imply a large overhead induced by the monitoring process. Some attempts rely on a hardware-software approach where DIFC operations are delegated to a coprocessor. Nevertheless, such approaches are based on modified processors. Beyond the fact hardware-assisted DIFC is hardly adopted, existing works do not take care of coprocessor security and multicore/multiprocessor embedded systems.

  We plan to implement DIFC mechanisms on boards including a non-modified ARM processor and a FPGA such as those based on the Xilinx Zynq family. The HardBlare project is a multidisciplinary project between CentraleSupélec IETR SCEE research team, CentraleSupélec Inria CIDRE research team and UBS Lab-STICC laboratory. Mounir Nasr Allah is doing his PhD in the context of this project. The main objective of this PhD is to study how hybrid analysis could improve hardware assisted DIFC using static analysis performed at compile-time. Another objective is to manage labels for persistent memory (i.e., files) using a modified OS kernel.

9.2. National Initiatives

9.2.1. ANR

- **ANR INFRA Project: SOCIOPLUG (2013-2017) - http://socioplug.univ-nantes.fr/index.php/SocioPlug_Project**

  SocioPlug is a collaborative ANR project involving Inria (ASAP and CIDRE teams), the Nantes University, 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 of 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.

9.2.2. 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 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.

In addition of the scientific advances in the field of privacy, members of CAPPRIS are actively involved in the animation and federation of the French community on privacy, through the APVP workshop but also interdisciplinary colloquiums.

9.3. European Initiatives

9.3.1. FP7 & H2020 Projects

The **PANOPTESEC** project (http://www.panoptesec.eu) started on the 1st of November 2013 and ended in 2016. It deals with the automated and assisted security management of IT and SCADA system. The main objective of PANOPTESEC 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 (BE),
- Nokia-Lucent Bell Labs France (FR),
- Epistematica (IT),
- the University of Rome (IT),
- the University of Hamburg (GE),
- the Institut Mines-Telecom (FR),
- ACEA (IT),
- CentraleSupélec (FR).

This year, our work focused on design and implementation but also on the integration phase. Most of our work focused on WP5 and WP6, that deal with the IDS event correlation system and the visualization system.

9.4. International Initiatives

9.4.1. Inria International Partners

9.4.1.1. Informal International Partners

Emmanuelle Anceaume is actively working with Leonardo Querzoni from the University La Sapienza, Italy, on data streams algorithms and engines. Their cooperation gave rise to two conference publications in 2016, one in Middelware [25] and the other one in Algotel [26].

Since several years, Michel Hurfin works with Professor Yun Wang (Southeast University, Nanjing, China). Their joint work focuses on convergence and synchronization problems in unreliable distributed systems prone to byzantine failures. In 2016, we investigate the iterative approximate byzantine consensus problem during a joint work with Chuanyou Li [22]. A visit of Professor Yun Wang in Rennes is planned next year.

9.5. International Research Visitors

9.5.1. Visits of International Scientists

Prof. Jean-Marc Robert from ETS (Ecole Supérieure de Technologie) of Montréal has made several short visits in the CIDRE research group in 2016.

DIONYSOS Project-Team

9. Partnerships and Cooperations

9.1. National Initiatives

9.1.1. ANR

- Adlen Ksentini is participating at 20% of his time to the IRT BCOM granted by the ANR.
- Yassine Hadjadj-Aoul is participating at 20% of his time to the IRT BCOM granted by the ANR.
- Yann Busnel is a member of the two following projects: Inhare granted by the ANR (ANR-15-CE19-0024) and DeSCeNt granted by the LabEx CominLabs (ANR-10-LABX-07-01).

9.2. Inria Project Labs

Participants: Yassine Hadjadj-Aoul, Gerardo Rubino, Bruno Tuffin.

Inria Project Labs' (IPL) initiatives enable the launch of ambitious research projects directly linked with the institute.

9.2.1. BetterNet

BetterNet aims at building and delivering a scientific and technical collaborative observatory to measure and improve the Internet service access as perceived by users. In this Inria Project Lab, we will propose new original user-centered measurement methods, which will associate social sciences to better understand Internet usage and the quality of services and networks. Our observatory can be defined as a vantage point, where:

- tools, models and algorithms/heuristics will be provided to collect data,
- acquired data will be analyzed, and shared appropriately with scientists, stakeholders and civil society,
- and new value-added services will be proposed to end-users.

Inria Project Teams involved: Diana, Dionysos, Inria Chile, Madynes, Muse, Spirals

9.3. European Initiatives

9.3.1. FINTEROP

Program: H2020-ICT-12-2015

Project acronym: F-Interop

Project title: FIRE+ online interoperability and performance test tools to support emerging technologies from research to standardization and market launch

Duration: November 2015 – October 2018

Coordinator: UPMC-LIP6

Other partners: 9 partners including our team Dionysos (F. Sismondi and C. Viho), and Eva (T. Watteyne)

Abstract: The goal of F-Interop is to extend FIRE+ with online interoperability and performance test tools supporting emerging IoT-related technologies from research to standardization and to market launch for the benefit of researchers, product development by SME, and standardization processes.

9.3.2. Collaborations with Major European Organizations

Partner 1: Sapienza University of Rome, Italy.

We work with Nicoló Rivetti and Leonardo Querzoni on the analysis of stream processing systems.

9.4. International Initiatives

9.4.1. Inria International Partners

9.4.1.1. MOCQUASIN

Title: Monte Carlo and Quasi- Monte Carlo for rare event simulation

International Partner (Institution - Laboratory - Researcher):

University of Montreal (Canada)

Duration: started in 2013

See also: http://www.irisa.fr/dionysos/pages_perso/tuffin/MOCQUASIN/

The goal of this team is to compute integrals, sums or to solve equations or optimization problems by means of Monte Carlo methods, which are statistical tools used when the models have a high complexity (for instance a large dimension). They are unavoidable methods in areas such as finance, electronics, seismology, computer science, engineering, physics, transport, biology, social sciences... Nonetheless, they have the reputation of being slow, i.e. to require a large computational time to reach a given precision. The goal of the project is to work on acceleration techniques, meaning methods allowing to reach the targeted precision in a shorter computational time than with the standard procedure. A typical framework is that of rare event simulation for which getting even only one occurrence of the event could require a too long computing time. In this case, there are two main acceleration techniques: importance sampling and splitting, on which we work.

9.4.1.2. Collaborations with the UTFSM at Valparaíso, Chile

We maintain a strong line of collaborations with the Technical University Federico Santa María (UTFSM), Valparaíso, Chile. Over the years, this has taken different forms (associated team Manap, Stic AmSud project "AMMA", Stic AmSud project "DAT", see next module). Currently, we have a joint PhD work running (PhD of Nicolás Jara, to be defended in 2017), and a new joint PhD to be started in 2017 (PhD of Jonathan Olavarría). The first one is on optical network analysis and design, the second one on modeling evaluation techniques.

9.4.1.3. International Initiatives

DAT

Title: Dependability Analysis Tool

International Partners:

Prof. H. Cancela, Univ. of the Republic, Computer Science, Uruguay;

Prof. R. Vallejos, UTFSM, Valparaíso, Electrical Eng., Chile;

G. Rubino, Dionysos, Inria, general responsible for the project.

Duration: 2015 - 2016

Start year: 2015

The main scientific objective of this project is to develop new techniques to assess the most important dependability properties of a complex system subject to the failures and possible repairs of its components. The central argument behind our proposal is our previous work in the area and some unpublished preliminary and promising results that we believe deserve deep exploration and that should lead to faster evaluation procedures than those available today. We also intend to implement these techniques in an integrated software package usable both in industry and for teaching purposes. Concerning applications, again based on the skills of the participating teams and our past common work, we will illustrate our findings on problems coming from the wireless and optical networking domains.

SM-HCD-HDD

Title: Statistical methods for highly complex and/or high dimensional data

International Partners:

Prof. Ricardo Fraiman, Mathematics, Univ. of the Republic, Uruguay, head of the project;

many partners in Uruguay, Argentina and Chile,

G. Rubino for Dionysos, Inria

Duration: 2016 - 2017

Start year: 2016

The aim of this project is to develop theoretical and computational tools to solve statistical problems that occur when data leaves in high dimensional spaces and/or lives in complex spaces that induce complex geometries.

9.5. International Research Visitors

9.5.1. Visits of International Scientists

Jebali Ameni, from INSAT (Tunisia)

Jorge Graneri, from UDELAR, Uruguay

Héctor Cancela, from UDELAR, Uruguay

Franco Robledo, from UDELAR, Uruguay

Claudio Risso, from UDELAR, Uruguay

Reinaldo Vallejos, from UTFSM, Chile

Marta Barría, from university of Valparaíso, Chile

9.5.1.1. Research Stays Abroad

Yann Busnel has been granted as an invited professor at La Sapienza Universitá di Roma, Italy, for 3 months from March to June 2016.

DIVERSE Project-Team

8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. ANR

8.1.1.1. GEMOC

- Coordinator: Inria (DIVERSE)
- Other partners: ENSTA Bretagne, Inria, IRIT, I3S, Obeo, Thales
- Dates: 2012-2016
- Abstract: GEMOC 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.

8.1.1.2. SOPRANO

- Coordinator: CEA
- CEA, University of Paris-Sud, Inria Rennes, OcamlPro, Adacore
- Dates: 2014-2017
- Abstract: Today most major verification approaches rely on automatic external solvers. However these solvers do not fill the current and future needs for verification: lack of satisfying model generation, lack of reasoning on difficult theories (e.g. floating-point arithmetic), lack of extensibility for specific or new needs. The SOPRANO project aims at solving these problems and prepare the next generation of verification-oriented solvers by gathering experts from academia and industry. We will design a new framework for the cooperation of solvers, focused on model generation and borrowing principles from SMT (current standard) and CP (well-known in optimisation). These ideas will be implemented in an open-source platform, with regular evaluations from the industrial partners.

8.1.1.3. Gdiv MRSE

- Coordinator: B. Baudry
- Inria Rennes
- Dates: 2014-2016
- Abstract: The objective of GDiv is to setup a strong network of European partners around the core team composed of Inria and SINTEF. This network will gather another academic partner and between 3 and 5 industry partners in the areas of software development and deployment. The project proposal setup by the GDiv network will address the risks of large scale software reuse through integrated, multi-level software diversification techniques.

8.1.2. BGLE / LEOC

8.1.2.1. CONNEXION

- Coordinator: EDF
- Other partners: Atos WorldGrid, Rolls-Royce Civil Nuclear, Corys TESS, Esterel Technologies, All4Tec, Predict, CEA, Inria, CNRS / CRAN, ENS Cachan, LIG, Telecom ParisTech
- Dates: 2012-2016
- Abstract: The cluster CONNEXION (*digital command CONntrol 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.

8.1.2.2. CLARITY

- Coordinator: Obéo
- Other partners: AIRBUS, Airbus Defence and Space, All4tec, ALTRAN Technologies, AREVA, Artal, C.E.S.A.M.E.S., Eclipse Foundation Europe, Inria Sophia Antipolis Méditerranée, PRFC, Scilab Enterprises, Thales Global Services, Thales Alenia Space, Thales Research & Technology, Thales Systèmes Aéroportés, Université de Rennes 1.
- Dates: 2014-2017
- Abstract: The CLARITY project aims to establish an international dimension ecosystem around Melody/Capella modeling workbench for systems engineering (MBSE) and engineering architectures (system, software, hardware).

8.1.2.3. Occiware

- Coordinator: Open Wide
- Open Wide, ActiveEon SA, CSRT - Cloud Systèmes Réseaux et Télécoms, Institut Mines-Télécom/Télécom SudParis, Inria, Linagora, Obeo, OW2 Consortium, Pôle Numérique, Université Joseph Fourier,
- Dates: 2014-2017
- Abstract: The Occiware project aims to establish a formal and equipped framework for the management of all cloud resource based on the OCCI standard.

8.1.3. DGA

8.1.3.1. MOTIV

- Coordinator: InPixal
- Other partners: Bertin, DGA, Inria
- Dates: 2012-2014
- Abstract: This project investigates innovative software test generation and management solutions to handle the very high degrees of variability in video processing algorithmic chains. The objective is to provide systematic criteria to qualify the testing activity when developing video processing software and to tailor these criteria to the variability dimensions that emerge in the context of visible images.

8.1.3.2. FPML (CYBERDEFENSE)

- Coordinator: DGA
- Partners: DGA MI, Inria
- Dates: 2014-2016

- Abstract: in the context of this project, DGA-MI and the Inria team DiverSE explore the existing approaches to ease the development of formal specifications of domain-Specific Languages (DSLs) dedicated to paquet filtering, while guaranteeing expressiveness, precision and safety. In the long term, this work is part of the trend to provide to DGA-MI and its partners a tooling to design and develop formal DSLs which ease the use while ensuring a high level of reasoning.

8.1.4. Cominlabs

8.1.4.1. PROFILE

- Coordinator: Université de Rennes 1
- Partners: Inria, Université de Rennes 2
- Dates: 2016-2019
- Abstract: The PROFILE project brings together experts from law, computer science and sociology to address the challenges raised by online profiling, following a multidisciplinary approach. More precisely, the project will pursue two complementary and mutually informed lines of research: (i) Investigate, design, and introduce a new right of opposition into the legal framework of data protection to better regulate profiling and to modify the behavior of commercial companies towards being more respectful of the privacy of their users; (ii)S Provide users with the technical means they need to detect stealthy profiling techniques as well as to control the extent of the digital traces they routinely produce. As a case study, we focus on browser fingerprinting, a new profiling technique for targeted advertisement. The project will develop a generic framework to reason on the data collected by profiling algorithms, to uncover their inner working, and make them more accountable to users. PROFILE will also propose an innovative protection to mitigate browser fingerprinting, based on the collaborative reconfiguration of browsers.

8.2. European Initiatives

8.2.1. FP7 & H2020 Projects

8.2.1.1. FP7 FET STREP DIVERSIFY

- Coordinator: Inria (DIVERSE)
- Partners: SINTEF, Université de Rennes 1, Trinity College Dublin, Inria (DiverSE, SPIRALS)
- Dates: 2013-2016
- Abstract: DIVERSIFY explores diversity as the foundation for a novel software design principle and increased adaptive capacities in CASs. 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.

8.2.1.2. FP7 STREP HEADS

- Coordinator: SINTEF
- Other partners: Inria, Software AG, ATC, Tellu, eZmonitoring
- Dates: 2013-2016
- 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. We denote such services HD-services. HD-services (Heterogeneous and Distributed services) characterize the class of services or applications within the Future Internet whose logic and value emerges from a set of communicating software components distributed on a heterogeneous computing continuum from clouds to mobile devices, sensors and/or smart-objects.

8.2.1.3. H2020 ICT-10-2016 STAMP

- Coordinator: Inria (DIVERSE)
- Other partners: ATOS, ActiveEon, OW2, TellU, Engineering, XWiki, TU Delft, SINTEF
- Dates: 2016-2019
- Abstract: Leveraging advanced research in automatic test generation, STAMP aims at pushing automation in DevOps one step further through innovative methods of test amplification. It will reuse existing assets (test cases, API descriptions, dependency models), in order to generate more test cases and test configurations each time the application is updated. Acting at all steps of development cycle, STAMP techniques aim at reducing the number and cost of regression bugs at unit level, configuration level and production stage.

  STAMP will raise confidence and foster adoption of DevOps by the European IT industry. The project gathers 3 academic partners with strong software testing expertise, 5 software companies (in: e-Health, Content Management, Smart Cities and Public Administration), and an open source consortium. This industry-near research addresses concrete, business-oriented objectives. All solutions are open source and developed as microservices to facilitate exploitation, with a target at TRL 6.

8.2.2. Collaborations in European Programs, Except FP7 & H2020

8.2.2.1. ICT COST Action MPM4CPS (IC1404)

- Chair of the Action: Prof Hans Vangheluwe (BE)
- Dates: 2014-2018
- Abstract: Truly complex, designed systems, known as Cyber Physical Systems (CPS), are emerging that integrate physical, software, and network aspects. To date, no unifying theory nor systematic design methods, techniques and tools exist for such systems. Individual (mechanical, electrical, network or software) engineering disciplines only offer partial solutions. Multi-paradigm Modelling (MPM) proposes to model every part and aspect of a system explicitly, at the most appropriate level(s) of abstraction, using the most appropriate modelling formalism(s). Modelling languages' engineering, including model transformation, and the study of their semantics, are used to realize MPM. MPM is seen as an effective answer to the challenges of designing CPS. This COST Action promotes the sharing of foundations, techniques and tools, and provide educational resources, to both academia and industry. This is achieved by bringing together and disseminating knowledge and experiments on CPS problems and MPM solutions. Benoit Combemale is a member of the management committee.

8.2.3. Collaborations with Major European Organizations

SINTEF, ICT (Norway): Model-driven systems development for the construction of distributed, heterogeneous applications. We collaborate since 2008 and are currently in two FP7 projects together.

Université du Luxembourg, (Luxembourg): Models runtime for dynamic adaptation and multi-objective elasticity in cloud management; model-driven development.

Open University (UK): models runtime for the Internet of Things.

8.3. International Initiatives

- Université de Montréal (Canada)

- McGill University (Canada)
- University of Alabama (USA)
- TU Wien (Austria)
- Michigan State University (USA)
- Aachen University (Germany)

8.3.1. Participation in Other International Programs

The GEMOC studio has been sustained through the creation of a Research Consortium at the Eclipse Foundation.

8.3.2. 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 DIVERSE members are part of the GEMOC initiative.

8.4. International Research Visitors

8.4.1. Visits of International Scientists

Yves Le Traon, Professor at the University of Luxembourg, visited the team in June and July 2016.

Tanja Mayerhofer, Junior Researcher at the TU Wien, visited the team in September 2016.

Bernhard Rumpe, Professor at Aachen University, visited the team in May 2016.

8.4.1.1. Internships

Vikas Mishra, Master intership at the Birla Institute of Technology & Science, visited the team from June to August 2016.

Alexandre Nuttinck, Axel Halin, Master interships at the University of Namur, visited the team from September 2016 to January 2017.

8.4.2. Visits to International Teams

Manuel Leduc visited CWI for 3 weeks in December 2016

Benoit Baudry visited Professor Stephanie Forrest at the University of New Mexico for one month in April 2016.

Benoit Combemale visited Professor Jorg Kienzle at McGill University for 3 weeks in June 2016; and visited Professor Bernhard Rumpe at Aachen University in April 2016.

8.4.2.1. Research Stays Abroad

Marcelino Rodriguez-Cancio visited Vanderbildt University from November 2016 to May 2017.

KERDATA Project-Team

9. Partnerships and Cooperations

9.1. National Initiatives

9.1.1. ANR

9.1.1.1. OverFlow (2015–2019)

- Project Acronym: OverFlow.
- Project Title: Workflow Data Management as a Service for Multisite Applications.
- Coordinator: Alexandru Costan.
- Duration: Octobre 2015–October 2019.
- Other Partners: None (Young Researcher Project).
- External collaborators: Kate Keahey (University of Chicago and Argonne National Laboratory), Bogdan Nicolae (Huawei Research) and Christophe Blanchet (Institut Français de Bioinformatique).
- Abstract: This JCJC project led by Alexandru Costan investigates approaches to data management enabling an efficient execution of geographically distributed workflows running on multi-site clouds. Ultimately, OverFlow will propose a new, pioneering paradigm: Workflow Data Management as a Service — a general and easy-to-use, cloud-provided service that bridges for the first time the gap between single- and multi-site workflow data management. It aims to reap economic benefits from the geo-diversity while accelerating the scientific discovery through a democratization of access to globally distributed data.

9.1.2. Other National Projects

9.1.2.1. DISCOVERY (2015–2019)

- Project Acronym: DISCOVERY.
- Project Title: DIStributed and COoperative framework to manage Virtual EnviRonments autonomicallY.
- Coordinator: Adrien Lèbre.
- Duration: 2015–2019.
- Partners: Inria Project-Teams including ASAP, ASCOLA, Avalon, Myriads, and KerData.
- Abstract: An Inria Project Lab, led by Adrien Lèbre (ASCOLA), that aims at exploring a new way of operating Utility Computing (UC) resources by leveraging any facilities available through the Internet. The goal is to deliver widely distributed platforms that can better match the geographical dispersal of users, as well as the unending demand.

  Within DISCOVERY, S. Ibrahim (KerData Inria Team) is working with Gilles Fedak (Avalon Inria Project-Team) to address the VM images management challenge.

9.1.2.2. ADT Damaris

- Project Acronym: ADT Damaris
- Project Title: Technology development action for te Damaris environment.
- Coordinator: Alexandru Costan.
- Duration: 2016–2018.
- Abstract: This action aims to support the development of the Damaris software. Inria's *Technological Development Office* (D2T, *Direction du Développement Technologique*) provided 2 years of funding support for a senior engineer.

  Hadi Salimi is funded through this project to document, test and extend the Damaris software and make it a safely distributable product.

9.1.2.3. Grid'5000.

We are members of Grid'5000 community and run experiments on the Grid'5000 platform on a daily basis.

9.2. European Initiatives

9.2.1. FP7 and H2020 Projects

9.2.1.1. BigStorage

- Title: BigStorage: Storage-based Convergence between HPC and Cloud to handle Big Data.
- Programme: H2020.
- Duration: January 2015–December 2018.
- Coordinator: Universidad Politécnica de Madrid (UPM).
- Partners:
  - Barcelona Supercomputing Center — Centro Nacional de Supercomputacion (Spain)
  - CA Technologies Development Spain (Spain)
  - CEA — Commissariat à l'énergie atomique et aux énergies alternatives (France)
  - Deutsches Klimarechenzentrum (Germany)
  - Foundation for Research and Technology Hellas (Greece)
  - Fujitsu Technology Solutions (Germany)
  - Johannes Gutenberg Universitaet Mainz (Germany)
  - Universidad Politecnica de Madrid (Spain)
  - Seagate Systems UK (United Kingdom)
- Inria contact: G. Antoniu and Adrien Lèbre.
- URL: http://www.bigstorage-project.eu/.
- Description: BigStorage is a European Training Network (ETN) whose main goal is to train future *data scientists*. It aims at enabling them and us to apply holistic and interdisciplinary approaches to take advantage of a data-overwhelmed world. This world requires *HPC* and *Cloud* infrastructures with a redefinition of *storage* architectures underpinning them — focusing on meeting highly ambitious performance and *energy* usage objectives. The KerData team will be hosting 2 *Early Stage Researchers* in this framework.

9.3. International Initiatives

9.3.1. Inria International Labs

9.3.1.1. JLESC: Joint Laboratory on Extreme-Scale Computing

The Joint Laboratory on Extreme-Scale Computing is jointly run by Inria, UIUC, ANL, BSC, JSC and RIKEN/AICS. It has ben created in 2014 as a follow-up of the Inria-UIUC JLPC, the *Joint Laboratory for Petascale Computing*.

The KerData team is collaborating with teams from ANL and UIUC within this lab since 2009 on several topics in the areas of I/O, storage and in situ processing and cloud computing. This collaboration has been initially formalized as the *Data@Exascale* Associate Team with ANL and UIUC (2013–2015) followed by *Data@Exascale 2* Associate Team with ANL (2016–2018).

Since 2015, Gabriel Antoniu serves as a topic leader for Inria for the *I/O, Storage and In Situ Processing* topic.

9.3.1.1.1. Associate Team involved in the International Lab: Data@Exascale 2

Project Acronym: Data@Exascale 2.

Project Title: Convergent Data Storage and Processing Approaches for Exascale Computing and Big Data Analytics.

International Partner:

- Argonne National Laboratory (United States) — Mathematics and Computer Science Division (MCS) — Rob Ross.

Start year: 2013.

URL: http://www.irisa.fr/kerdata/data-at-exascale/.

Description: In the past few years, countries including United States, the European Union, Japan and China have set up aggressive plans to get closer to what appears to be the next goal in terms of high-performance computing (HPC): Exaflop computing, a target which is now considered reachable by the next-generation supercomputers in 2020-2023. While these government-led initiatives have naturally focused on the big challenges of Exascale for the development of new hardware and software architectures, the quite recent emergence of the Big Data phenomenon introduces what could be called a tectonic shift that is impacting the entire research landscape for Exascale computing. As data generation capabilities in most science domains are now growing substantially faster than computational capabilities, causing these domains to become data-intensive, new challenges appeared in terms of volumes and velocity for data to be stored, processed and analyzed on the future Exascale machines.

To face the challenges generated by the exponential data growth (a general phenomenon in many fields), a certain progress has already been made in the recent years in the rapidly-developing, industry-led field of cloud-based Big Data analytics, where advanced tools emerged, relying on machine-learning techniques and predictive analytics.

Unfortunately, these advances cannot be immediately applied to Exascale computing: the tools and cultures of the two worlds, HPC (High-Performance Computing) and BDA (Big Data Analytics) have developed in a divergent fashion (in terms of major focus and technical approaches), to the detriment of both. The two worlds share however multiple similar challenges and unification now appears as essential in order to address the future challenges of major application domains that can benefit from both.

The scientific program we propose for the Data@Exascale 2 Associate Team is defined from this new, highly-strategic perspective and builds on the idea that the design of innovative approaches to data I/O, storage and processing allowing Big Data analytics techniques and the newest HPC architectures to leverage each other clearly appears as a key catalyst factor for the convergence process.

9.3.2. Inria International Partners

9.3.2.1. DataCloud@Work

Title: DataCloud@Work.

International Partner:

- Polytechnic University of Bucharest (Romania), Computer Science Department, Nicolae Tapus and Valentin Cristea.

Duration: 4 years.

Start year: 2013. The status of IIP was established right after the end of our former *DataCloud@work* Associate Team (2010–2012).

URL: https://www.irisa.fr/kerdata/doku.php?id=cloud_at_work:start.

Description: Our research topics address the area of distributed data management for cloud services, focusing on autonomic storage. The goal is explore how to build an efficient, secure and reliable storage IaaS for data-intensive distributed applications running in cloud environments by enabling an autonomic behavior.

9.3.3. Informal International Partners

National University of Singapore (NUS): We collaborate on resource management for workflows in the cloud and optimizing graph processing in geo-distributed data-centers.

9.4. International Research Visitors

9.4.1. Visits of International Scientists

Guillaume Aupy (Vanderbilt University) visited the KerData team for one week (February 2016).

9.4.2. Visits to International Teams

9.4.2.1. Research Stays Abroad

CIC-IPN, Mexico:
Participants: Gabriel Antoniu, Alexandru Costan, Luis Eduardo Pineda Morales, Pierre Matri.

From October 31 to November 4, four members of our team visited the Informatics Research Centre of the National Polytechnic Institute (CIC-IPN for its acronym in Spanish) in Mexico City, Mexico.

The visit was a follow up to previous discussions held with the Network and Data Science Laboratory. The goal is to create a scientific collaboration on the grounds of cloud-based big data for smart cities, for which a proposal has been submitted in August to the program ECOS-NORD (Mexico-France). The visit included scientific presentations from both teams, a plenary talk from KerData to the IPN community, as well as discussions on future common research lines. Additionally, we held meetings with the partnering coordinator to talk about possible funding sources for students exchanges.

ANL, USA:
Participant: Nathanaël Cheriere.

Nathanaël Cheriere visited Matthieu Dorier and Rob Ross at ANL for 5.5 months, co-funded by the PUF NextGen project in the context of the Joint Laboratory for Extreme-Scale Computing (JLESC).

Vanderbilt University, USA:
Participant: Tien-Dat Phan.

Tien-Dat Phan visited(Guillaume Aupy, Padma Raghavan at Vanderbilt University for 2 months, funded by Vanderbilt University.

Technische Universitat Munchen and Huawei Research Center in Munich:
Participant: Ovidiu-Cristian Marcu.

Ovidiu-Cristian Marcu is doing an internship at Huawei in Munich, Germany for 4 months, starting October 2016. The goal is to create a framework to improve memory management for streaming systems.

National University of Singapore, Singapore:
Participant: Tien-Dat Phan.

Tien-Dat Phan is visiting NUS (Bingsheng He) for 3 months, co-funded by a Mobility grant from University Bretagne Loire (UBL) and NUS.

MYRIADS Project-Team

9. Partnerships and Cooperations

9.1. Regional Initiatives

9.1.1. IRT B-Com

Participants: Yvon Jégou, Edouard Outin, Jean-Louis Pazat.

Yvon Jégou and Jean-Louis Pazat are at IRT B-Com [0] one day per week. 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.

In the last period, they were involved in the elaboration of new projects in the Cloud Computing lab of B-Com.

9.1.2. CominLabs EPOC project (2013-2017)

Participants: Sabbir Hasan Rochi, 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.

9.1.3. INDIC - Cybersecurity Pole of Excellence (2014-2018)

Participants: Anna Giannakou, Christine Morin, Jean-Louis Pazat, Louis Rilling, Amir Teshome Wonjiga.

Our study carried out in the framework of a collaboration with DGA-MI aims at defining and enforcing SLA for security monitoring of virtualized information systems. To this aim we study three topics:

- defining relevant SLA terms for security monitoring,
- enforcing and evaluating SLA terms,
- making the SLA terms enforcement mechanisms self-adaptable to cope with the dynamic nature of clouds.

The considered enforcement and evaluation mechanisms should have a minimal impact on performance. The funding from DGA funds two PhD students: Anna Giannakou and Amir Teshome Wonjiga.

9.2. National Initiatives

9.2.1. Inria ADT GinFlow (2014-2016)

Participants: Christine Morin, Matthieu Simonin, Cédric Tedeschi.

[0] http://b-com.org/wp/

The GinFlow technological development action funded by INRIA targets the development of a fully-operational workflow management system based on the HOCL-TS software prototype developed during the PhD thesis of Hector Fernandez between 2009 and 2012. Also, it allows the integration of this software with the TIGRES workflow engine developed at the Lawrence Berkeley National Lab so as to make the workflows submitted using the TIGRES programming model run in a decentralized fashion. These developments led to the release of the GinFlow software and its deposit at the APP (Agence de Protection des Programmes).

9.2.2. Inria ADT SaaP (2016-2018)

Participant: Martin Quinson.

The SaaP technological development action (SimGrid As A Platform) funded by INRIA targets the refactoring of SimGrid to make it ready to use in production and teaching contexts. Our ultimate goal is to sustain the development of the framework by involving 5 to 10 companies that are using it internally. Our target of the teaching context is thus an intermediate goal, as we think that the best solution to ensure the adoption of our tool by the industrial engineers is that they discovered the tool during their studies.

The technical actions envisioned for this ADT are the complete rearchitecturation of the software (to make it easier to script a new model within the tool kernel) and a reorganization of the interfaces (for a better integration in the Java and python language). This work is lead in collaboration with the whole SimGrid community, which provide valuable feedback.

9.2.3. Inria IPL Discovery (2015-2019)

Participants: Anne-Cécile Orgerie, Matthieu Simonin, Cédric Tedeschi.

The Inria IPL Discovery officially started in September 2015. It targets the design, development and deployment of a distributed Cloud infrastructure within the network's backbone. It will be based upon a set of building blocks whose design will take locality as a primary constraint, so as to minimize distant communications and consequently achieve better network traffic, partition management and improved availability.

Its developments are planned to get integrated within the OpenStack framework. An energy/cost benefit analysis of the fully distributed Discovery architecture will also be performed to show the energy efficiency of the chosen approach.

9.2.4. Inria IPL CityLab (2015-2018)

Participant: Christine Morin.

The Inria Project Lab (IPL) CityLab@Inria (https://citylab.inria.fr) studies ICT solutions toward smart cities that promote both social and environmental sustainability. A strong emphasis of the Lab is on the undertaking of a multi-disciplinary research program through the integration of relevant scientific and technology studies, from sensing up to analytics and advanced applications, so as to actually enact the foreseen smart city Systems of Systems. City-scale experiments of the proposed platforms and services are planned in cities in California and France, thereby learning lessons from diverse setups.

Myriads investigates advanced cloud solutions for the Future Internet, which are critical for the processing of urban data. It leverages its experience in cloud computing and Internet of services while expanding its research activities to the design and implementation of cloud services to support crowd-Xing applications and mobile social applications.

In 2016, Christine Morin was involved in the MOOC entitled *Villes Intelligentes : défis technologiques et sociétaux* (Smart cities : technological and social challenges) run on the FUN platform from January to March 2016. She prepared eight sequences on urban data management in clouds. In 2016, we also conducted a comparative experimental evaluation of data stream processing environments executed on clusters and in a cloud. We compared the performance and energy consumption of Heron, Storm and SparkStreaming frameworks.

9.2.5. Inria IPL Hac Specis (2016-2020)

Participants: Anne-Cécile Orgerie, Martin Quinson.

The goal of the HAC SPECIS (High-performance Application and Computers: Studying PErformance and Correctness In Simulation) project (http://hacspecis.gforge.inria.fr/) is to answer methodological needs of HPC application and runtime developers and to allow to study real HPC systems both from the correctness and performance point of view. To this end, we gather experts from the HPC, formal verification and performance evaluation community.

The Anh Pham started a PhD thesis in November 2016, co-advised by Thierry Jéron (team SUMO, formal methods) and Martin Quinson. The envisionned work will pursue the previous efforts to formally assess distributed applications within the SimGrid framework.

9.2.6. COSMIC PRE (2016 - 2018)

Participants: Benjamin Camus, Anne-Cécile Orgerie.

The distributed nature of Cloud infrastructures involves that their components are spread across wide areas, interconnected through different networks, and powered by diverse energy sources and providers, making overall energy monitoring and optimization challenging. The COSMIC project aims at taking advantage of the opportunity brought by the Smart Grids to exploit renewable energy availability and to optimize energy management in distributed Clouds. This PRE, led by Anne-Cécile Orgerie also involves Fanny Dufossé from Dolphin team (Inria Lille) and Benjamin Camus, who has started a 18 months post-doc in October 2016 in the context of this project.

9.2.7. MIHMES ANR Investissements d'Avenir (2012 - 2018)

Participants: Yvon Jégou, Christine Morin, Manh Linh Pham, Nikos Parlavantzas.

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 provides software tools to efficiently manage and ease the use of a distributed computing infrastructure for the execution of different simulation applications.

In 2016, we further developed a distributed framework which allows to exploit multiple compute servers in parallel. Parallelism is exploited both at server level using OpenMP and at data-center level using this framework. To facilitate the deployment of the workloads on heterogeneous environments, this framework limits the requirements concerning the server configurations. They need not share any file system, the workloads can be programmed in differing programming language. These servers need only the capability to communicate through the network. The system allows to dynamically add and stop servers. To some extend, it is tolerant to server failures. The framework had being repackaged to facilitate its reuse for new workloads. We also worked on the automated deployment of the framework on top of one or multiple IaaS clouds.

9.2.8. PIA ELCI (2015-2018)

Participant: Anne-Cécile Orgerie.

The PIA ELCI project deals with software environment for computation-intensive applications. It is leaded by BULL. In the context of this project, we collaborate with ROMA and Avalon teams from Lyon: we co-supervise a PhD student (Issam Rais) funded by this project with these teams on multicriteria scheduling for large-scale HPC environments.

9.2.9. CNRS PEPS EcoSmart (2016)

Participant: Anne-Cécile Orgerie.

Smart Grids are connected to telecommunication networks and can thus optimize the production, distribution and consumption of electricity. Virtualized distributed systems (Clouds) are the major players in providing services over the Internet. The success of these on-demand services makes the energy consumption of these systems worrying. This project aims to optimize the energy consumption of these large consumers, namely virtualized distributed Clouds consisting of computing, storage and communication resources. The objective is to exploit the capabilities offered by smart grids to control the consumption of these systems and be able to influence it according to the availability or the nature of the electricity used.

9.2.10. 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.

9.3. European Initiatives

9.3.1. FP7 & H2020 Projects

9.3.1.1. PaaSage

Title: PaaSage: Model Based Cloud Platform Upperware

Programm: FP7

Duration: October 2012 - September 2016

Coordinator: ERCIM

Partners:

Akademia Gorniczo-Hutnicza Im. Stanislawa Staszica W Krakowie (Poland)

Automotive Simulation Center Stuttgart Ev (Germany)

Be.Wan Sprl (Belgium)

Centred'Excellence en Technologies de l'Information et de la Communication (Belgium)

Geie Ercim (France)

Evry As (Norway)

Flexiant (United Kingdom)

Foundation for Research and Technology Hellas (Greece)

Gesellschaft Fur Wissenschaftliche Datenverarbeitung Mbh Gottingen (Germany)

Ibsac - Intelligent Business Solutions Ltd (Cyprus)

Inria (France)

Lufthansa Systems (Germany)

Stiftelsen Sintef (Norway)

Science and Technology Facilities Council (United Kingdom)

University of Cyprus (Cyprus)

Universitaet Stuttgart (Germany)

Universitaet Ulm (Germany)

Universitetet I Oslo (Norway)

Inria contact: Christine Morin

PaaSage (2012-2016) (http://www.paasage.eu) is an FP7 collaborative project that develops an open-source cloud platform, with an accompanying methodology and language, which enables developers to access cloud services in a technology-neutral approach while guiding them to configure their applications for best performance. PaaSage facilitates application deployment on multiple clouds while enhancing the flexibility, adaptivity and scalability of applications. Myriads develops the Adapter subsystem that supports dynamic, cross-cloud application adaptation. In 2016, we improved the Adapter implementation and evaluated its use within the business scenarios of PaaSage partners.

9.3.1.2. Fed4Fire

Title: Federation for FIRE

Programm: FP7

Duration: October 2012 - September 2016

Coordinator: Interdisciplinary institute for broadband technology (iMinds, Belgium)

Partners:

University of Southampton (It Innovation, United Kingdom)

Universite Pierre et Marie Curie - paris6 (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: Walid Dabbous

Fed4FIRE is an FP7 Integrated Project project running between October 2012 and September 2016 (http://www.fed4fire.eu), extended to December 2016. 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. 2016 is the sustainability year of Fed4FIRE, and as usage from experimenters is not bringing any revenue, we closed the BonFIRE platform as it was become unmaintainable without significant effort.

9.3.2. Collaborations in European Programs, Except FP7 & H2020

9.3.2.1. NESUS

Participant: Anne-Cécile Orgerie.

Program: ICT COST

Project acronym: NESUS

Project title: Network for Sustainable Ultrascale Computing (ICT COST Action IC1305)

Duration: 2014 - 2018

Coordinator: Prof. Jesus Carretero, University Carlos III of Madrid, Spain, http://www.nesus.eu

Other partners: 33 COST countries and 11 non-COST countries

Abstract: Ultrascale systems are envisioned as large-scale complex systems joining parallel and distributed computing systems that will be two to three orders of magnitude larger that today's systems. The EU is already funding large scale computing systems research, but it is not coordinated across researchers, leading to duplications and inefficiencies. The goal of the NESUS Action is to establish an open European research network targeting sustainable solutions for ultrascale computing aiming at cross fertilization among HPC, large scale distributed systems, and big data management. The network will contribute to gluing disparate researchers working across different areas and provide a meeting ground for researchers in these separate areas to exchange ideas, to identify synergies, and to pursue common activities in research topics such as sustainable software solutions (applications and system software stack), data management, energy efficiency, and resilience. Some of the most active research groups of the world in this area are members of this proposal. This Action will increase the value of these groups at the European-level by reducing duplication of efforts and providing a more holistic view to all researchers, it will promote the leadership of Europe, and it will increase their impact on science, economy, and society. Anne-Cécile Orgerie is co-responsible of the focus group on metrics, monitoring, instrumentation and profiling in the Working Group 5 on Energy Efficiency.

9.3.3. Collaborations with Major European Organizations

Partner 1: EPFL, Network architecture lab (Switzerland)

We collaborate with Katerina Argyraki's research group on the integration of networking and cloud computing technologies in order to support placement constraints between cloud resources.

Partner 2: VU University Amsterdam, dept. of Computer Science (the Netherlands)

We collaborate with Thilo Kielmann's research group at VU University Amsterdam on research and development around the ConPaaS system.

Partner 3: University of Neuchâtel, dept. of Computer Science (Switzerland)

We collaborate with Pascal Felber's research group on energy efficiency in Clouds and in particular on the design of energy cost models for virtual machines.

9.4. International Initiatives

9.4.1. Inria International Labs

9.4.1.1. DALHIS

Title: Data Analysis on Large Heterogeneous Infrastructures for Science

International Partner (Institution - Laboratory - Researcher):

Lawrence Berkeley National Laboratory (United States) - Data Science and Technology department - Deb Agarwal

Start year: 2016

See also: https://project.inria.fr/dalhis/

Data produced by scientific instruments (large facilities like telescopes or field data), large-scale experiments, and high-fidelity simulations are increasing in magnitude and complexity. Existing data analysis methods, tools and infrastructure are often difficult to use and unable to provide the complete data management, collaboration, and curation environment needed to manage these complex, dynamic, and large-scale data analysis environments. The goal of the Inria-LBL DALHIS associate team involving the Myriads (PI) and Avalon Inria project-teams and the Data Science and Technology (DST) department at Lawrence Berkeley National Laboratory (LBL) is to create a collaborative distributed software ecosystem to manage data lifecycle and enable data analytics on distributed data sets and resources. Specifically, our goal is to build a dynamic software stack that is user-friendly, scalable, energy-efficient and fault tolerant. Our research will determine appropriate execution environments that allow users to seamlessly execute their end-to-end dynamic data analysis workflows

in various resource environments and scales while meeting energy-efficiency, performance and fault tolerance goals. We will engage in deep partnerships with scientific teams (Fluxnet in environmental science and SNFactory and LSST experiences in cosmology) and use a mix of user research with system software R&D to address specific challenges that these communities face. Our experience will in turn inform future research directions.

9.4.2. Inria International Partners

9.4.2.1. Informal International Partners

Partner: Rutgers University, dept. of Computer Science (New Jersey, United States)

We collaborate with Manish Parashar's research group on energy efficiency in edge Clouds and in particular on the design of energy cost models for such environments.

Partner: Northeastern University, dept. of Computer Science (Massachusetts, United States)

We collaborate with Gene Cooperman 's research group on virtualization technologies for the study of large-scale distributed systems.

Partner: University of Guadalajara (Mexico)

We collaborate with the team of Prof. H$\surd$©ctor Duran-Limon on application and resource management in the cloud. In 2016, we produced a joint journal publication [14]. Nikos Parlavantzas is co-advising a PhD student enrolled in the University of Guadalajara (Carlos Ruiz Diaz).

Partner: Tlemcen University (Algeria)

We collaborate with Djawida Dib on energy-efficient fault-tolerant resource and application management in containerized clouds. Christine Morin will co-advise a PhD student enrolled in the University of Tlemcen (Yasmina Bouizem) from December 2016.

9.5. International Research Visitors

9.5.1. Visits of International Scientists

Deb Agarwal, senior scientist at Lawrence Berkeley National Laboratory, who has been awarded an Inria International Chair for the 2015-2019 period, visited Myriads team during two months from May 1st to June 30th, 2016.

Christian Heinrich, PhD student in the Polaris team at Inria Grenoble, spent one month in October in the Myriads team to improve how large-scala distributed systems are declared in the SimGrid framework.

Professor Gene Cooperman, Northeastern University, Boston, USA, visited the Myriads team for one week in June to revive our collaboration on the virtualization of large-scale distributed systems.

Professor Peter Hubwieser, Technic University of Munchen, Germany, visited the Myriads team for two weeks in November to start a collaboration on the didactics of computer science with Martin Quinson.

Carlos Ruiz Diaz, PhD student in the University of Guadalajara, Mexico, spent 6 months in the Myriads team (from September 2015 to February 2016) to advance his work on adapting cloud configurations.

9.5.1.1. Internships

Benjamin Trubert

Date: May-August 2016

Institution: University of Rennes 1

Supervisor: Guillaume Pierre

Kartik Sathyanarayanan

Date: May-July 2016

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

Supervisor: Christine Morin

9.5.2. Visits to International Teams

9.5.2.1. Research Stays Abroad

- Anna Giannakou did a 3-month research internship in the Data Science and Technology department of the Lawrence Berkeley National Laboratory from August to October 2016. She worked with Sean Peisert, staff scientist, on building a workflow for anomaly Detection in HPC environments using statistical data.
- Yunbo Li did a 2 month research internship in the Computer Science department of Rutgers University from August to September 2016. He worked with Prof. Manish Parashar on building an energy cost model for edge cloud applications.

TACOMA Team

8. Partnerships and Cooperations

8.1. Regional Initiatives

Project: Modélisation des activités de site consommateur d'énergie pour favoriser l'autoconsommation d'énergies renouvelables produites localement

Partner: OKWIND

Starting: Nov 2016; ending: Nov 2019

Abstract: OKWind [0] is a company specialized in local production of renewable energy. This project, with Inria DiverSE and TACOMA teams, aims at building a system that optimizes the use of different sources of renewable energy, choosing the most suitable source for the current demand and anticipating future needs, so as to favor the consumption of locally produced electricity. The system must be able to model clients' activities. It must also trigger actions (local consumption vs. local storage). The final goal is to use " locally produced" energy in a smarter way and to tend towards a self-consumption optimum.

Project: EkoHub

Partners: Ekolis, Delaye transport

Starting: Nov 2014; ending: Nov 2017

Abtract: The EkoHub project has been architectured around hors multi-technologies gateway and leverages on the one developped in the ITSSv6 European project. In addition to the multiple interfaces of our platforms, sensor devices have been incorporated into the project and we studied different scenarios elaborated with our professional partners (Layaye Logistics). Intelligent data management schemes are being studied to adapt to the communication environment and the needs of the application consuming the data.

8.2. National Initiatives

Project: Pervasive_RFID

Partner: IETR

Starting: July 2013; ending: July 2016

Abtract: 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.

Project: GLIE - Guidage Lumineux par l'Intelligence de l'Environnement

Partner: OyaLight

Starting: December 2014; ending: April 2016

Abstract: GLIE is a collaborative projet with OYALIGT and TACOMA group. The objective of the project is to design and demonstrate a new service combining connected LEDs provided by OYALIGHT and a software tool developed by TACOMA. By integrating and analyzing data transmitted by the sensors integrated into LEDs, the service must be able to detect a given context and to react accordingly.

[0] http://www.okwind.fr/

Project: Greenfeed

http://greenfeed.org

Partner: BeNomad, Mines St Etiennes, Enedis, G2MOBILITY, GreedPocket

Starting: July 2013; ending: Nov 2016

Abstract: Greenfeed aims at improving electro-mobility, which means the ease with which users can travel using electric cars. In order to achieve its goal, the project focuses three main operators: electro-mobility service provider (EMSP), distribution service operator (DSO), and charging station operator (CSO). During the project, the role of these actors have been precisely defined, so were the role of the systems they were in charge of. A great effort has been put on interoperability, so that the developed systems could collaborate with each other. One of the key use case was to enable the smart management of available power on a 10 charging site. This led to a demonstration in which a Renault Zoé, customized by the Institut Védécom, was able to negotiate a charge planning with the electric power grid. Then a grid initiated renegotiation was demonstrated, once the initial smart charging process had began. This was the first time this behavior had been achieved with a vehicle in France.

8.3. European Initiatives

8.3.1. FP7 & H2020 Projects

Project acronym: SCOOP@F part 2

Partners: MEDE, Renault, PSA

Starting: January 2016; ending: Dec 2018

Abstract: SCOOP@F is a Cooperative ITS pilot deployment project that intends to connect approximately 3000 vehicles with 2000 kilometers of roads. It consists of 5 specific sites with different types of roads: Ile-de-France, "East Corridor" between Paris and Strasbourg, Brittany, Bordeaux and Isère. SCOOP@F is composed of SCOOP@F Part 1 from 2014 to 2015 (ongoing) and SCOOP@F Part 2 from 2016 to 2018. Its main objective is to improve the safety of road transport and of road operating staff during road works or maintenance. The project includes the validations of Cooperative ITS services in open roads, cross border tests with other EU Member States (Spain, Portugal and Austria) and development of a hybrid communication solution (3G-4G/ITS G5).

8.3.2. Collaborations in European Programs, Except FP7 & H2020

Project acronym: SEAS (ITEA3)

Partners: Telecom Paris Tech, Telecom Saint Etienne, Mines Saint Etienne, Engie, Kerlink, BeNomad, ICAM, CNR, VTT

Starting: Feb 2014; ending: Jan 2017

Abstract: The SEAS project addresses the problem of inefficient and unsustainable energy consumption, which is due to a lack of sufficient means to control, monitor, estimate and adapt the energy use of systems versus the dynamic use situations and circumstances influencing the energy use. The objective of the SEAS project is to enable energy, ICT and automation systems to collaborate at consumption sites, and to introduce dynamic and refined ICT-based solutions to control, monitor and estimate energy consumption. Proposed solution should enable energy market participants to incorporate micro-grid environments and active customers. We are involved in the project to design a distributed system architecture and to implement two proofs of concept: the first one is related to the electric vehicle charging and the other one to the prevision of solar energy production.

HYBRID Project-Team

9. Partnerships and Cooperations

9.1. Regional Initiatives

9.1.1. Labex Cominlabs SUNSET

Participants: Bruno Arnaldi, Guillaume Claude, Gautier Picard, Valérie Gouranton [contact].

SUNSET is a 4-year Labex Cominlabs project (2016-2020). SUNSET partners are MediCIS-LTSI (coordinator), Hybrid, Hycomes (IRISA/Inria), and CHU Rennes. SUNSET aims at developing an innovative training software suite based on immersive and collaborative virtual reality technology for training and evaluating non-technical skills. This approach will be implemented and evaluated in the context of training neurosurgical scrub nurses. We will notably integrate methods and systems developed in the S3PM project (see bellow). By relying on Human Factors approaches, the project also addresses training and evaluation of interpersonal skills. Whereas the developed technologies and approaches will be generic and adaptable to any surgical specialty, the project will evaluate the developed system within training sessions performed with scrub nurses. We ambition to propose novel approaches for surgical non-technical skill learning and assessment, and to install the developed training factory at the University Hospital of Rennes, and evaluate it with real-scale user studies.

9.1.2. Labex Cominlabs S3PM

Participants: Bruno Arnaldi, Guillaume Claude, Valérie Gouranton [contact].

S3PM ("Synthesis and Simulation of Surgical Process Models") is a 4-year Labex Cominlabs project (2013-2017). S3PM partners are MediCIS-LTSI (coordinator), Hybrid, Hycomes (IRISA/Inria), and CHU Rennes. The objective of S3PM is to propose a solution for the computation of surgical procedural knowledge models from recordings of individual procedures, and their execution. The goal of the Hybrid team is to propose and use new models for collaborative and interactive virtual environments for procedural training. The Hybrid team also works on the creation of a surgical training application in virtual reality, exposing the different contributions. Ar

9.1.3. Labex Cominlabs HEMISFER

Participants: Anatole Lécuyer [contact], Marsel Mano, Lorraine Perronnet.

HEMISFER is a 4-year project (2013-2017) 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).

9.1.4. Labex Cominlabs SABRE

Participants: Anatole Lécuyer [contact], Jussi Tapio Lindgren, Nataliya Kos’Myna.

SABRE is a 3-year project (2014-2017) funded by Labex CominLabs. It involves 1 Inria/IRISA team (Hybrid) and 2 groups from TELECOM BREST engineering school. The goal of SABRE is to improve computational functionnalities and power of current real-time EEG processing pipelines. The project will investigate innovative EEG solution methods empowered and speeded-up by ad-hoc, transistor-level, implementations of their key algorithmic operations. A completely new family of fully-hardware-integrated, new computational EEG imaging methods will be developed that are expected to speed up the imaging process of an EEG device of several orders of magnitude in real case scenarios.

9.1.5. IRT b<>com

Participants: Bruno Arnaldi [contact], Valérie Gouranton, Maud Marchal.

b<>com is a French Institute of Research and Technology (IRT). The main goal of this IRT is to fasten the development and marketing of tools, products and services in the field of digital technologies. Our team has collaborated with b<>com within two 3-year projects: ImData (on "Immersive Interaction") and GestChir (on "Augmented Healthcare") which both ended in 2016. A new 3-year project "NeedleWare" (on "Augmented Healthcare") has been started on October 2016.

9.1.6. CNPAO Project

Participants: Valérie Gouranton [contact], Jean-Baptiste Barreau, Ronan Gaugne.

CNPAO ("Conservatoire Numérique du Patrimoine Archéologique de l'Ouest") is an on-going research project partially funded by the Université Européenne de Bretagne (UEB) and Université de Rennes 1. 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.
This work was done in collaboration with Quentin Petit (SED Inria Rennes).

9.1.7. Imag'In CNRS IRMA

Participants: Bruno Arnaldi, Jean-Baptiste Barreau, Ronan Gaugne, Valérie Gouranton [contact].

The IRMA project is an Imag'In project funded by CNRS which aims at developping innovative methodologies for research in the field of cultural heritage based on the combination of medical imaging technologies and interactive 3D technologies (virtual reality, augmented reality, haptics, additive manufacturing). It relies on close collaborations with the National Institute of Preventive Archaeological Research (Inrap), the Research Center Archaeology, and History Archéosciences (CReAAH UMR 6566) and the company Image ET. The developed tools are intended for cultural heritage professionals such as museums, curators, restorers, and archaeologists. We focus on a large number of archeological artefacts of different nature, and various time periods (Paleolithic, Mesolithic, and Iron Age Medieval) from all over France. We can notably mention the oldest human bones found in Brittany (clavicle Beg Er Vil), a funeral urn from Trebeurden (22), or a Bronze Cauldron from a burial of the Merovingian necropolis "Crassés Saint-Dizier" (51). This project involves a strong collaboration with Théophane Nicolas (Inrap/UMR Trajectoires), Quentin Petit (SED Inria Rennes), and Grégor Marchand (CNRS/UMR CReAAH).

9.2. National Initiatives

9.2.1. ANR MANDARIN

Participants: Adrien Girard, Anatole Lécuyer, Maud Marchal [contact].

MANDARIN ("MANipulation Dextre hAptique pour opéRations INdustrielles en RV") was a 4-year ANR project (2012-2016). MANDARIN partners were CEA-List (coordinator), Inria/Hybrid, UTC, Haption and Renault. It aimed 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 was 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 dexterous manipulation. The results were evaluated with a representative industrial application: the bi-manual manipulation of complex rigid objects and cables bundles.

9.2.2. ANR HOMO-TEXTILUS

Participants: Anatole Lécuyer [contact], Maud Marchal.

HOMO-TEXTILUS was a 4-year ANR project (2012-2016). Partners of the project were : Inria/Hybrid, CHART, LIP6, TOMORROW LAND, RCP and potential end-user is Hussein Chalayan fashion designer. The objective of HOMO TEXTILUS was 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 was strongly oriented towards human science, with both user studies and sociological studies. The involvement of Hybrid team in the project consisted in studying the design of next-gen prototypes of clothes embedding novel kinds of sensors and actuators. These prototypes were used and tested in various experiments.

9.2.3. FUI Previz

Participants: Bruno Arnaldi [contact], Valérie Gouranton [contact].

Previz was a 3-year project (2013-2016) funded by the competitive cluster "Images et Réseaux". Previz involved 4 Academic partners (Hybrid/INSA Rennes, ENS Louis-Lumière, LIRIS, Gipsa-Lab) and 9 Industrial partners (Technicolor, Ubisoft, SolidAnim, loumasystem, Polymorph). Previz aimed at proposing new previsualization tools for movie directors. The goal of Hybrid in Previz was 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 ended 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.

9.2.4. Ilab CertiViBE

Participants: Anatole Lécuyer [contact], Jussi Tapio Lindgren, Charles Garraud, Jérôme Chabrol.

CertiViBE is a 2-year "Inria Innovation Lab" (2015-2017) funded by Inria for supporting the development of OpenViBE software, and notably its evolution in order to enable and fasten the medical transfer and the medical certification of products based on OpenViBE. This joint lab involves two partners: Hybrid and Mensia Technologies startup company. The project aims at setting up a quality environment, and developping a novel version of the software wich should comply with medical certification rules.

9.2.5. IPL BCI-LIFT

Participants: Anatole Lécuyer [contact], Jussi Tapio Lindgren [contact], Andéol Evain, Lorraine Perronnet, Nataliya Kos'Myna.

BCI-LIFT is a 4-year "Inria Project Lab" initiative (2015-2019) funded by Inria for supporting a national research effort on Brain-Computer Interfaces. This joint lab involves sevearl Inria teams: Hybrid, Potioc, Athena, Neurosys, Mjolnir, Demar; as well as external partners: INSERM-Lyon, and INSA Rouen. This project aims at improving several aspects of Brain-Computer Interfaces : learning and adaptation of BCI systems, user interfaces and feedback, training protocols, etc.

9.3. European Initiatives

9.3.1. FP7 & H2020 Projects

9.3.1.1. HAPPINESS

Title: HAptic Printed Patterned INtErfaces for Sensitive Surface

Programm: H2020

Duration: January 2015 - December 2017

Coordinator: CEA

Partners:

Arkema France (France)

Robert Bosch (Germany)

Commissariat A L'Energie Atomique et Aux Energies Alternatives (France)

Fundacion Gaiker (Spain)

Integrated Systems Development S.A. (Greece)

University of Glasgow (United Kingdom)

Walter Pak SL (Spain)

Inria contact: Nicolas Roussel and Anatole Lécuyer

The Automotive HMI (Human Machine Interface) will soon undergo dramatic changes, with large plastic dashboards moving from the 'push-buttons' era to the 'tactile' era. User demand for aesthetically pleasing and seamless interfaces is ever increasing, with touch sensitive interfaces now commonplace. However, these touch interfaces come at the cost of haptic feedback, which raises concerns regarding the safety of eyeless interaction during driving. The HAPPINESS project intends to address these concerns through technological solutions, introducing new capabilities for haptic feedback on these interfaces. The main goal of the HAPPINESS project is to develop a smart conformable surface able to offer different tactile sensations via the development of a Haptic Thin and Organic Large Area Electronic technology (TOLAE), integrating sensing and feedback capabilities, focusing on user requirements and ergonomic designs. To this aim, by gathering all the value chain actors (materials, technology manufacturing, OEM integrator) for application within the automotive market, the HAPPINESS project will offer a new haptic Human-Machine Interface technology, integrating touch sensing and disruptive feedback capabilities directly into an automotive dashboard. Based on the consortium skills, the HAPPINESS project will demonstrate the integration of Electro-Active Polymers (EAP) in a matrix of mechanical actuators on plastic foils. The objectives are to fabricate these actuators with large area and cost effective printing technologies and to integrate them through plastic molding injection into a small-scale dashboard prototype. We will design, implement and evaluate new approaches to Human-Computer Interaction on a fully functional prototype that combines in packaging both sensors and actuator foils, driven by custom electronics, and accessible to end-users via software libraries, allowing for the reproduction of common and accepted sensations such as Roughness, Vibration and Relief. In this project, the role of Hybrid team is to design user studies on tactile perception, and study innovative usages of the technologies developed in HAPPINESS.

9.4. International Research Visitors

9.4.1. Visits of International Scientists

Michael Pereira (EPFL, Switzerland) visited Hybrid for a collaboration on Brain-Computer Interfaces and sports in January 2016.

9.4.2. Visits to International Teams

Ferran Argelaguet visited the Virtual Reality Lab (Pr. Bernd Frohlich) at the Bauhaus University at Weimar (Germany) in October/November 2016.

LACODAM Team

9. Partnerships and Cooperations

9.1. Regional Initiatives

9.1.1. SePaDec: Declarative approaches for Sequential Pattern mining

Participants: Benjamin Negrevergne, Thomas Guyet, Ahmed Samet, Alexandre Termier.

The SEPADEC project is funded by the Region Bretagne. It aims at exploring the application of declarative pattern mining (more especially ASP) in the field of care pathway analysis. The first objective was to model knowledge from the data to enrich the raw data with medical expert knowledge and to develop a toolbox that smoothly integrates both expert knowledge and declarative pattern mining.

9.2. National Initiatives

9.2.1. ANR

9.2.1.1. #DigitAg: Digital agriculture

Participants: Alexandre Termier, Véronique Masson, Christine Largouët, Anne-Isabelle Graux.

#DigitAg is a "Convergence Institute" dedicated to the increasing importance of digital techniques in agriculture. Its goal is twofold: first, make innovative research on the use of digital techniques in agriculture in order to improve competitiveness, preserve environment, and offer correct living conditions to farmers. Second, through education prepare future farmers and agricultural policy makers to successfully exploit such technology.

While #DigitAg is based on Montpellier, Rennes is a satellite of the institute focused on cattle farming. Lacodam is involved in the "data mining" challenge of the institute, that A. Termier co-leads. He is also the representative of Inria in the steering comittee of the institute.

The interest for the team is to design novel methods to analyze and represent agricultural data, which are challenging because they are both heterogeneous and multi-scale (both spatial and temporal).

9.2.2. National Platforms

9.2.2.1. PEPS: Pharmaco-epidemiology for Health Products

Participants: Yann Dauxais, Thomas Guyet, Véronique Masson, René Quiniou, Alexandre Termier.

The PEPS project (Pharmaco-epidemiology des Produits de Santé) is funded by ANSM (national agency for health security). The project leader is E. Oger from the clinical investigation center CIC-1414 INSERM/CHU Rennes. The other partners located in Rennes are the Institute of Research and Technology (IRT) B<>Com, EHESP and the LTSI. The project started in january 2015 and is funded for 4 years.

The PEPS project has two parts: the clinical studies and a research program dedicated to the development of innovative tools for pharmaco-epidemiological studies with medico-administrative databases.

Our contribution to this project will be to propose pattern mining algorithm and reasoning techniques to analyse the typical care pathways of specific groups of insured patients.

9.3. International Initiatives

9.3.1. Inria International Partners

9.3.1.1. Informal International Partners

9.3.1.1.1. University of Calgary: Monitoring cattle in big herds with multiple sensors

Participant: René Quiniou.

The state of Alberta produces a significant part of the beef meat in Canada. Big farms feeds up around 40.000 bull calves in feedlots grouping 200-300 animals. Diseases such as Bovine Respiratory Diseases (BRD) are frequent and may propagate quickly in such conditions. So, it is important to detect as soon as possible when an animal is sick. We are collaborating with the Department of Production Animal Health, University of Calgary for designing monitoring systems able to generate early alarms when an animal is sick. Precisely, we are studying the properties of new sensors and their aptitude to provide relevant data for BRD detectors.

9.3.1.1.2. University of Potsdam: preferences in mining with ASP
Participant: Thomas Guyet.

The research group “knowledge processing and information systems" of the University of Potsdam, so called Potascco group, develops a collection of tools and programs for Answer Set Programming such as the clingo solver or the ASPRIN system, developed by J. Romero to handle preferences on ASP models. They have strong expertise in problem encoding with ASP. In addition to T. Schaub Inria position, we initiate some collaborations with other members of the Potascco group in order to strengthen our relationships.

9.4. International Research Visitors

9.4.1. Research Stays Abroad

Thomas Guyet spent a month (may 2016) in the team leaded by Prof. Torsten Schaub in the university of Potsdam.

LAGADIC Project-Team

9. Partnerships and Cooperations

9.1. Regional Initiatives

9.1.1. ARED NavRob

Participants: Suman Raj Bista, Paolo Robuffo Giordano, François Chaumette.

no Inria Rennes 8033, duration: 36 months.

This project funded by the Brittany council ended in October 2016. It supported in part Suman Raj Bista's Ph.D. about visual navigation (see Section 7.4.1).

9.1.2. ARED DeSweep

Participants: Lesley-Ann Duflot, Alexandre Krupa.

no Inria Rennes 8033, duration: 36 months.

This project funded by the Brittany council started in October 2014. It supports in part Lesley-Ann Duflot's Ph.D. about visual servoing based on the shearlet transform (see Section 7.3.3).

9.1.3. ARED Locoflot

Participants: Ide Flore Kenmogne Fokam, Vincent Drevelle, Eric Marchand.

no Inria Rennes 9944, duration: 36 months.

This project funded by the Brittany council started in October 2015. It supports in part Ide Flore Kenmogne Fokam's Ph.D. about cooperative localization in multi-robot fleets using interval analysis (see Section 7.5.3).

9.1.4. ARED Mod4Nav

Participants: Aline Baudry, Marie Babel.

no INSA Rennes 2016/01, duration: 36 months.

This project funded by the Brittany council started in October 2016. It supports in part Aline Baudry's Ph.D. about wheelchair modeling.

9.1.5. "Equipement mi-lourd Rennes Métropole"

Participant: Paolo Robuffo Giordano.

no CNRS Rennes 14C0481, duration: 36 months.

A grant from "Rennes Métropole" has been obtained in June 2014 and supports the activities related to the use of drones (quadrotor UAVs). The platform described in Section 6.9.5 has been purchased in part thanks to this grant.

9.1.6. IRT Jules Verne Mascot

Participant: François Chaumette.

no Inria Rennes 10361, duration: 36 months.

This project started in October 2015. It is managed by IRT Jules Verne in Nantes and realized in cooperation with IRCCyN, Airbus, Renault, Faurecia and Alsthom. Its goal is to perform screwing for various industrial applications.

9.1.7. IRT b<>com NeedleWare

Participants: Hadrien Gurnel, Alexandre Krupa.

no Inria Rennes 9072, duration: 36 months.

This project started in October 2016. It supports Hadrien Gurnel's Ph.D. about the study of a shared control strategy fusing haptic and ultrasound visual control for assisting manual steering of needles for biopsies or therapy purposes in a synergetic way.

9.2. National Initiatives

9.2.1. France Life Imaging WP3-FLI ANFEET

Participant: Alexandre Krupa.

duration: 24 months.

This project started in January 2016. Its objective is to initiate collaborative research with the ICube laboratory (Strasbourg) on the control and supervision of flexible endoscopes in the digestive tube using ultrasound images.

9.2.2. ANR Contint Visioland

Participants: Noël Mériaux, Patrick Rives, François Chaumette.

no Inria Rennes 8304, duration: 48 months.

This project started in November 2013. It is composed of a consortium managed by Onera in Toulouse with Airbus, Spikenet Technology, IRCCyN, and Lagadic. Its aim is to develop vision-based localization and navigation techniques for autonomous landing on a runway (see Section 7.1.3).

9.2.3. ANR Contint Entracte

Participant: Julien Pettré.

no Inria Rennes 8013, duration: 42 months.

This project started in November 2013. It is realized in collaboration with the Gepetto group at Laas, Toulouse, and the Mimetic group at Irisa and Inria Rennes Bretagne Atlantique. It addresses the problem of motion planning for anthropomorphic systems, and more generally, the problem of manipulation path planning. ENTRACTE proposes to study in parallel both the mathematical foundation of artificial motion and the neurocognitive structures used by humans to quickly solve motion problems.

9.2.4. ANR JCJC Percolation

Participant: Julien Pettré.

no Inria Rennes 7991, duration: 42 months.

The ANR "Jeune Chercheur" Percolation project started on January 2014. It aims at designing perception-based crowd simulation algorithms. We develop agents which are capable of perceiving their virtual environment through virtual sensors, and which are able to navigate in it, as well as to interact with the other agents.

9.2.5. ANR JCJC SenseFly

Participants: Thomas Bellavoir, Muhammad Usman, Riccardo Spica, Paolo Robuffo Giordano.

no Irisa CNRS 50476, duration: 36 months.

The ANR "Jeune Chercheur" SenseFly project started in August 2015. Its goal is to advance the state-of-the-art in multi-UAV in the design and implementation of fully decentralized and sensor-based group behaviors by only resorting to onboard sensing (mainly cameras and IMU) and local communication (e.g., Bluetooth communication, wireless networks). Topics such as individual flight control, formation control robust against sensor limitations (e.g., limited field of view, occlusions), distributed estimation of relative positions/bearings from local sensing, maintenance of architectural properties of a multi-UAV formation will be touched by the project. Part of the platforms described in Section 6.9.5 has been purchased thanks to this grant.

9.2.6. ANR PLaTINUM

Participants: Eduardo Fernandez Moral, Vincent Drevelle, Patrick Rives.

no Inria Sophia 10204, duration: 42 months.

This project started in November 2015. It is composed of a consortium managed by Litis in Rouen with IGN Matis (Paris), Le2i (Le Creusot) and Lagadic group. It aims at proposing novel solutions to robust long-term mapping of urban environments.

9.2.7. BPI Romeo 2

Participants: Giovanni Claudio, Nicolas Cazy, Suman Raj Bista, Fabien Spindler, François Chaumette.

no Inria Rennes 7114, duration: 60 months.

This project started in November 2012. It is composed of a large consortium managed by Softbank Robotics (ex Aldebaran Robotics) with Laas in Toulouse, Isir in Paris, Lirmm in Montpellier, Inria groups Lagadic, Bipop (Pierre-Brice Wieber), Flowers (Pierre-Yves Oudeyer), and many other partners. It aims at developing advanced control and perception functionalities to a humanoid robot. In this project, we are in charge of visual manipulation and navigation with Romeo and Pepper. It supports in part Suman Raj Bista's Ph.D. about visual navigation (see Section 7.4.1), as well as Nicolas Cazy's Ph.D. about model-based predictive control for visual servoing (see Section 7.2.4).

9.2.8. Equipex Robotex

Participants: Fabien Spindler, François Chaumette.

no Inria Rennes 6388, duration: 9 years.

Lagadic is one of the 15 French academic partners involved in the Equipex Robotex network thats started in February 2011. It is devoted to get and manage significative equipment in the main robotics labs in France. In the scope of this project, we have got the humanoid robot Romeo (see Section 6.9.4).

9.3. European Initiatives

9.3.1. FP7 & H2020 Projects

9.3.1.1. FP7 Space RemoveDEBRIS

Participants: Aurélien Yol, Eric Marchand, François Chaumette.

Instrument: Specific Targeted Research Project

Duration: October 2013 - September 2017

Coordinator: University of Surrey (United Kingdom)

Partners: Surrey Satellite Technology (United Kingdom), Airbus (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 model-based tracking algorithms on images acquired during an actual space debris removal mission (see Section 7.1.2).

9.3.1.2. H2020 Comanoid

Participants: Don Joven Agravante, Giovanni Claudio, Souriya Trinh, Fabien Spindler, François Chaumette.

Title: Multi-contact Collaborative Humanoids in Aircraft Manufacturing

Programm: H2020

Duration: January 2015 - December 2018

Coordinator: CNRS (Lirmm)

Partners: Airbus Group (France), DLR (Germany), Università Degli Studi di Roma La Sapienza (Italy), CNRS (I3S)

Inria contact: Francois Chaumette

COMANOID investigates the deployment of robotic solutions in well-identified Airbus airliner assembly operations that are laborious or tedious for human workers and for which access is impossible for wheeled or rail-ported robotic platforms. As a solution to these constraints a humanoid robot is proposed to achieve the described tasks in real-use cases provided by Airbus Group. At a first glance, a humanoid robotic solution appears extremely risky, since the operations to be conducted are in highly constrained aircraft cavities with non-uniform (cargo) structures. Furthermore, these tight spaces are to be shared with human workers. Recent developments, however, in multi-contact planning and control suggest that this is a much more plausible solution than current alternatives such as a manipulator mounted on multi-legged base. Indeed, if humanoid robots can efficiently exploit their surroundings in order to support themselves during motion and manipulation, they can ensure balance and stability, move in non-gaited (acyclic) ways through narrow passages, and also increase operational forces by creating closed-kinematic chains. Bipedal robots are well suited to narrow environments specifically because they are able to perform manipulation using only small support areas. Moreover, the stability benefits of multi-legged robots that have larger support areas are largely lost when the manipulator must be brought close, or even beyond, the support borders. COMANOID aims at assessing clearly how far the state-of-the-art stands from such novel technologies. In particular the project focuses on implementing a real-world humanoid robotics solution using the best of research and innovation. The main challenge will be to integrate current scientific and technological advances including multi-contact planning and control; advanced visual-haptic servoing; perception and localization; human-robot safety and the operational efficiency of cobotics solutions in airliner manufacturing.

9.3.1.3. H2020 Romans

Participants: Nicolò Pedemonte, Firas Abi Farraj, Fabien Spindler, François Chaumette, Paolo Robuffo Giordano.

Title: Robotic Manipulation for Nuclear Sort and Segregation

Programm: H2020

Duration: May 2015 - April 2018

Coordinator: University of Birmingham

Partners: NLL (UK), CEA (France), Univ. Darmstadt (Germany)

CNRS contact: Paolo Robuffo Giordano

The RoMaNS (Robotic Manipulation for Nuclear Sort and Segregation) project will advance the state of the art in mixed autonomy for tele-manipulation, to solve a challenging and safety-critical "sort and segregate" industrial problem, driven by urgent market and societal needs. Cleaning up the past half century of nuclear waste, in the UK alone (mostly at the Sellafield site), represents the largest environmental remediation project in the whole of Europe. Most EU countries face related challenges. Nuclear waste must be "sorted and segregated", so that low-level waste is placed in low-level storage containers, rather than occupying extremely expensive and resource intensive high-level storage containers and facilities. Many older nuclear sites (>60 years in UK) contain large

numbers of legacy storage containers, some of which have contents of mixed contamination levels, and sometimes unknown contents. Several million of these legacy waste containers must now be cut open, investigated, and their contents sorted. This can only be done remotely using robots, because of the high levels of radioactive material. Current state-of-the-art practice in the industry, consists of simple tele-operation (e.g. by joystick or teach-pendant). Such an approach is not viable in the long-term, because it is prohibitively slow for processing the vast quantity of material required. The project will: 1) Develop novel hardware and software solutions for advanced bi-lateral master-slave tele-operation. 2) Develop advanced autonomy methods for highly adaptive automatic grasping and manipulation actions. 3) Combine autonomy and tele-operation methods using state-of-the-art understanding of mixed initiative planning, variable autonomy and shared control approaches. 4) Deliver a TRL 6 demonstration in an industrial plant-representative environment at the UK National Nuclear Lab Workington test facility.

9.3.2. Collaborations with European Partners

Participants: Fabien Spindler, Alexandre Krupa, François Chaumette.

Project acronym: i-Process

Project title: Innovative and Flexible Food Processing Technology in Norway

Duration: January 2016 - December 2019

Coordinator: Sintef (Norway)

Other partners: Nofima, Univ. of Stavanger, NMBU, NTNU (Norway), DTU (Denmark), KU Leuven (Belgium), and about 10 Norwegian companies.

Abstract: This project is granted by the Norwegian Government. Its main objective is to develop novel concepts and methods for flexible and sustainable food processing in Norway. In the scope of this project, the Lagadic group is involved for visual tracking and visual servoing of generic and potentially deformable objects. Prof. Pal Johan from the Norwegian University of Life Sciences (NMBU), and Ekrem Misimi from Sintef spent a short visit in June and October respectively.

9.4. International Initiatives

9.4.1. Inria Associate Teams

9.4.1.1. SIMS

Title: Realistic and Efficient Simulation of Complex Systems

International Partners:

University of North Carolina at Chapel Hill (USA) - GAMMA Group - Ming C. Lin, Dinesh Manocha

University of Minnesota (USA) - Motion Lab - Stephen Guy

Brown University (USA) - VenLab - William Warren

Start year: 2012

See http://people.rennes.inria.fr/Julien.Pettre/EASIMS/easims.html

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 interacting 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.

9.4.1.2. ISI4NAVE

Title: Innovative Sensors and adapted Interfaces for assistive NAVigation and pathology Evaluation
International Partner:

University College London (United Kingdom) - Aspire CREATe - Tom Carlson

Start year: 2016
See http://www.irisa.fr/lagadic/team/MarieBabel/ISI4NAVE/ISI4NAVE.html
The global ageing population, along with disability compensation constitute major challenging societal and economic issues. In particular, achieving autonomy remains a fundamental need that contributes to the individual's wellness and well-being. In this context, innovative and smart technologies are designed to achieve independence while matching user's individual needs and desires.

Hence, designing a robotic assistive solution related to wheelchair navigation remains of major importance as soon as it compensates partial incapacities. This project will then address the following two issues. First, the idea is to design an indoor / outdoor efficient obstacle avoidance system that respects the user intention, and does not alter user perception. This involves embedding innovative sensors to tackle the outdoor wheelchair navigation problem. The second objective is to take advantage of the proposed assistive tool to enhance the user Quality of Experience by means of biofeedback. Indeed, adapted interfaces should improve the understanding of people that suffer from cognitive and/or visual impairments.

The originality of the project is to continuously integrate medical validation as well as clinical trials during the scientific research work in order to match user needs and acceptation.

9.4.2. Inria International Partners

9.4.2.1. Informal International Partners

- Alexandre Krupa has a collaboration with Prof. Nassir Navab from the Technical University of Munich concerning the joint supervision of Pierre Chatelain's Ph.D. (see Section 7.3.2).

9.4.3. Participation in International Programs

The Lagadic group is one of the few external partners of the Australian Center for Robotic Vision (see http://roboticvision.org). It groups QUT in Brisbane, ANU in Canberra, Monash University and Adelaide University. In the scope of this project, Peter Corke and Ben Upcroft spent a short visit in May 2016 while Jurgen Leitner spent a 1-month visit in October 2016.

9.5. International Research Visitors

9.5.1. Visits of International Scientists

- Nicolas Alt, senior researcher at Technical University of Munich (TUM) was a visiting scientist at Sophia Antipolis from Jan until Feb 2016. He worked on visuo-haptic environment perception.
- Alejandro Perez Yus, Ph.D. student at Universidad de Zaragoza, spent a 3-month visit in Sophia Antipolis from Sep until Nov 2016. He worked on the calibration of multi-camera RGB-D systems.
- Prof. Denis Wolf, associate professor at Univ. Sao Paulo, Brasil, spends a sabbatical year in Sophia Antipolis from Jul 2016 to Aug 2017. He works on semantic learning applied to intelligent vehicles.
- Nicola Battilani, Ph.D. student at University of Modena and Reggio Emilia, spent a 6-month visit in Rennes from May until Oct 2016. He worked on shared control algorithms for optimal 3D reconstruction from vision.
- Prof. Volkan Isler from University of Minnesota, Phillip Schmidt, Ph.D. student from DLR, Prof. Ivan Petrovic from Univ. of Zagreb, Prof. Purang Abolmaesumi from Univ. of British Columbia, Prof. Nassir Navab from Technical University of Munich, and Prof. Russ Taylor from John Hopkins University spent a short visit in the group in 2016.

LINKMEDIA Project-Team

9. Partnerships and Cooperations

9.1. Regional Initiatives

9.1.1. CominLabs Project Linking Media in Acceptable Hypergraphs (LIMAH)

Participants: Rémi Bois, Vincent Claveau, Guillaume Gravier, Grégoire Jadi, Pascale Sébillot, Arnaud Touboulic.

Duration: 4 years, started in April 2014
Partners: Telecom Bretagne (IODE), Univ. Rennes II (CRPCC, PREFics), Univ. Nantes (LINA/TAL)
URL: http://limah.irisa.fr

LIMAH aims at exploring hypergraph structures for multimedia collections, instantiating actual links reflecting particular content-based proximity—similar content, thematic proximity, opinion expressed, answer to a question, etc. Exploiting and developing further techniques targeting pairwise comparison of multimedia contents from an NLP perspective, LIMAH addresses two key issues: How to automatically build from a collection of documents an hypergraph, i.e., a graph combining edges of different natures, which provides exploitable links in selected use cases? How collections with explicit links modify usage of multimedia data in all aspects, from a technology point of view as well as from a user point of view? LIMAH studies hypergraph authoring and acceptability taking a multidisciplinary approach mixing ICT, law, information and communication science as well as cognitive and ergonomy psychology.

9.1.2. CominLabs Project BigCLIN

Participants: Vincent Claveau, Ewa Kijak, Clément Dalloux.

Duration: 3 years, started in September 2016
Partners: STL-CNRS, Inserm/CHU Rennes, Inria Cidre URL: http://www.bigclin.cominlabs.ueb.eu

Data collected or produced during clinical care process can be exploited at different levels and across different domains. Yet, a well-known challenge for secondary use of health big data is that much of detailed patient information is embedded in narrative text, mostly stored as unstructured data. The project proposes to address the essential needs when reusing unstructured clinical data at a large scale. We propose to develop new clinical records representation relying on fine-grained semantic annotation thanks to new NLP tools dedicated to French clinical narratives. To efficiently map this added semantic information to existing structured data for further analysis at big scale, the project also addresses distributed systems issues: scalability, management of uncertain data and privacy, stream processing at runtime, etc.

9.2. National Initiatives

9.2.1. ANR Project IDFRAud

Participant: Teddy Furon.

Duration: 3 years, started in Feb. 2015
Partners: AriadNext, IRCGN, École Nationale Supérieure de Police

The IDFRAud project consists in proposing an automatic solution for ID analysis and integrity verification. Our ID analysis goes through three processes: classification, text extraction and ID verification. The three processes rely on a set of rules that are externalized in formal manner in order to allow easy management and evolving capabilities. This leads us to the ID knowledge management module. Finally, IDFRAud addresses the forensic link detection problem and to propose an automatic analysis engine that can be continuously applied on the detected fraud ID database. Cluster analysis methods are used to discover relations between false IDs in their multidimensional feature space. This pattern extraction module will be coupled with a suitable visualization mechanism in order to facilitate the comprehension and the analysis of extracted groups of inter-linked fraud cases.

9.2.2. FUI 19 NexGenTV

Participants: Vincent Claveau, Guillaume Gravier, Ewa Kijak, Gabriel Sargent, Ronan Sicre.

Duration: 2.5 years, started in May 2015
Partners: Eurecom, Avisto Telecom, Wildmoka, Envivio-Ericsson

Television is undergoing a revolution, moving from the TV screen to multiple screens. Today's user watches TV and, at the same time, browses the web on a tablet, sends SMS, posts comments on social networks, searches for complementary information on the program, etc. Facing this situation, NexGen-TV aims at developing a generic solution for the enrichment, the linking and the retrieval of video content targeting the cost-cutting edition of second screen and multiscreen applications for broadcast TV. The main outcome of the project will be a software platform to aggregate and distribute video content via a second-screen edition interface connected to social media. The curation interface will primarily make use of multimedia and social media content segmentation, description, linking and retrieval. Multiscreen applications will be developed on various domaine, e.g., sports, news.

9.3. European Initiatives

9.3.1. Collaborations with Major European Organizations

Big Data Value Association (BDVA)

LINKMEDIA is a co-founder and co-leader of the media group (TF7) within BDVA

9.4. International Initiatives

9.4.1. Inria Associate Teams Not Involved in an Inria International Labs

9.4.1.1. MOTIF

Title: Unsupervised motif discovery in multimedia content

International Partner (Institution - Laboratory - Researcher):

Pontifícia Universidade Católica de Minas Gerais (Brazil) - Audio-Visual Information Processing Laboratory (VIPLAB) - Silvio Jamil Guimarães

Universidade Federal Minas Gerais, Brasil - NPDI - Arnaldo Albuquerque de Araújo

Duration: 2014–2016

MOTIF aims at studying various approaches to unsupervised motif discovery in multimedia sequences, i.e., to the discovery of repeated sequences with no prior knowledge on the sequences. On the one hand, we will develop symbolic approaches inspired from work on bioinformatics to motif discovery in the multimedia context, investigating symbolic representations of multimedia data and adaptation of existing symbolic motif discovery algorithms. On the other hand, we will further develop cross modal clustering approaches to repeated sequence discovery in video data, building upon previous work.

9.4.2. Inria International Partners

9.4.2.1. Informal International Partners

- National Institute for Informatics, Japan
- University of Amsterdam, The Netherlands
- Czech Technical University, Czech Republic
- Katholieke Universiteit Leuven, Belgium

9.4.3. Participation in Other International Programs

- PICS CNRS MM-Analytics
  - Title: Fouille, visualisation et exploration multidimensionnelle de contenus multimédia ; Multi-Dimensional Multimedia Browsing, Mining, Analytics (num 6382).
  - International Partner (Institution - Laboratory - Researcher):

    Reykjavík University, Iceland - Björn Þór Jónsson
  - Jan. 2014 – Dec. 2016
- CNRS – CONFAP FIGTEM
  - Title: Fine-grained text-mining for clinical trials
  - International Partner (Institution - Laboratory - Researcher): Pontifícia Universidade Católica do Paraná - Health Informatics dept, Claudia Moro

    FIGTEM aims at developing natural language processing methods, including information extraction and indexing, dedicated to the clinical trial domain. The goal is to populate a formal representation of patients (via their electronic patient records) and clinical trial data in different languages (French, English, Portuguese).
  - Jan. 2016 – Dec. 2018

9.5. International Research Visitors

9.5.1. Visits of International Scientists

Claudia Moro, Lucas Oliveira

Date: Oct. 2016 (1 week)

Institution: Pontifícia Universidade Católica do Paraná - Health Informatics dept

Giorgos Tolias

Date: Sept. 2016 (1 week)

Institution: Czech Technical University, Czech Republic

9.5.1.1. Internships

Gabriel B. de Fonseca

Date: Nov. 2016 - Jan. 2017

Institution: PUC Minas, Brazil

9.5.2. Visits to International Teams

Vincent Claveau

Date: 7-17 December 2016

Institution: Helth Informatics dept, Pontifícia Universidade Católica do Paraná, Curitiba, Brazil

Vincent Claveau

Date: 7-13 May 2016

Institution: OLST, Univ. of Montreal, Canada

Guillaume Gravier, Simon Malinowski

Date: Jul. 2016 (1 week)

Institution: PUC Minas, Brazil

Ahmet Iscen

Date: Apr. 2016 - May 2016

Institution: Czech Technical University, Czech Republic

Vedran Vukotić

Date: Sep. 2016 - Dec. 2016

Institution: TU Delft, The Netherlands

MIMETIC Project-Team

9. Partnerships and Cooperations

9.1. National Initiatives

9.1.1. ANR

9.1.1.1. Cineviz

Participants: Marc Christie [contact], Christophe Lino, Hui-Yin Wu.

Cineviz is a 3-year ANR LabCom project (2016-2019). Amount: 300kE. Parnters: SolidAnim, UR1.

The project is a bilateral collaboration with the SolidAnim company. The objective is to jointly progress on the design and implementation of novel tools for the preproduction in the film industry. The project will address the challenges related to (i) proposing expressive framing tools, (ii) integrating the technical aspects of shooting (how to place the cameras, lights, green sets) directly at the design stage), and (iii) novel interaction metaphors for designing and controlling the staging of lights in preproduction, using an example-based approach.

9.1.1.2. Cinecitta

Participants: Marc Christie [contact], Christophe Lino, Hui-Yin Wu.

Cinecitta is a 3.5 year ANR young researcher project lead by Marc Christie (ANR JCJC 2012-2016). Amount: 208kE.

The main objective of Cinecitta was 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 designed a novel cinematographic workflow that features a dynamic collaboration of a creative human filmmaker with an automated virtual camera planner. The process enhances the quality and utility of the automated planner's suggestions by adapting and reacting to the creative choices made by the filmmaker. This required 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 gathered feedback on our prototype by involving professionals (during dedicated workshops) and numerous interactions with the Louis Lumière Film School.

9.1.1.3. Entracte

Participants: Charles Pontonnier [contact], Georges Dumont, Franck Multon, Pierre Plantard, Ana Lucia Cruz Ruiz, Antoine Muller, Anthony Sorel, Nicolas Bideau, Richard Kulpa.

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, who has been recruited as a PhD student since this date, just defended her thesis on muscle-based control based on synergies.

9.1.2. National scientific collaborations

9.1.2.1. Cavaletic

Participant: Franck Multon.

The Cavaletic collaborative project is leaded by University Bretagne Sud and also involves University Rennes2 (CREAD Lab.). It has been funded by the National IFCE (Institut Français du Cheval et de l'Equitation) in order to develop and evaluate technological assistance in horse riding learning, thanks to a user-centered approach. MimeTIC is involved in measuring expert and non-expert horse riders' motions in standardized situations in order to develop metrics to measure riders' performance. It will be used to develop a technological system embedded on users to evaluate their performance and provide them with real-time feedback to correct potential errors.

9.1.2.2. FFT

Participants: Richard Kulpa, Benoit Bideau, Pierre Touzard.

An exclusive contract has been signed between the M2S laboratory and the French Federation of Tennis for three years. The goal is to perform biomechanical analyses of 3D tennis serves on a population of 40 players of the Pôle France. The objective is to determine the link between injuries and biomechanical constraints on joints and muscles depending on the age and gender of the players. At the end, the goal is to evaluate their load training.

9.1.2.3. gDGA

Participants: Antonio Mucherino, Ludovic Hoyet, Franck Multon.

gDGA (generalization of the Distance Geometry and its Applications) is a INS2I/CNRS PEPS project involving local and national partners. Distance geometry can nowadays be seen as a classical problem in operational research, having a wide range of applications. The main aim of this interdisciplinary project is to extend the definition and the range of applicability of distance geometry. In particular, our main interest is on dynamical problems, motivated by a certain number of applications of interest, including interaction motion adaptation, the simulation of crowd behaviours, and the conception of modern recommender systems. The classical application of distance geometry arising in the biological field is also taken into consideration. The necessity of a strong computational power for the considered applications motivates the need of implementing our algorithms in environments capable of exploiting the resources on GPU cards.

9.1.2.4. IRMA

Participants: Ronan Gaugne [contact], Georges Dumont.

The IRMA project is an Imag'In project funded by CNRS which aims at developping innovative methodologies for research in the field of cultural heritage based on the combination of medical imaging technologies and interactive 3D technologies (virtual reality, augmented reality, haptics, additive manufacturing). It relies on close collaborations with the National Institute of Preventive Archaeological Research (Inrap), the Research Center Archaeology, and History Archéosciences (CReAAH UMR 6566) and the company Image ET. The developed tools are intended for cultural heritage professionals such as museums, curators, restorers, and archaeologists. We focus on a large number of archeological artefacts of different nature, and various time periods (Paleolithic, Mesolithic, and Iron Age Medieval) from all over France. We can notably mention the oldest human bones found in Brittany (clavicle Beg Er Vil), a funeral urn from Trebeurden (22), or a Bronze Cauldron from a burial of the Merovingian necropolis "Crassés Saint-Dizier" (51). This project involves a strong collaboration with members of the team Hybrid (Valérie Gouranton, Bruno Arnaldi and Jean-Baptiste Barreau), Théophane Nicolas (Inrap/UMR Trajectoires), Quentin Petit (SED Inria Rennes), and Grégor Marchand (CNRS/UMR CReAAH).

9.1.3. ADT: Immerstar

Participants: Franck Multon, Georges Dumont, Ronan Gaugne.

The ADT-Immerstar is driven by the SED and aims at developing new tools and facilities for the scientific community in order to develop demos and use the two immersive rooms in Rennes: Immersia and Immermove. The engineer (Quentin Petit, SED) has the responsibility of homogenizing the software modules and development facilities in each platform, of installing new upgrades and of developping collaborative applications between the two sites.

9.1.4. PRE

Participants: Franck Multon, Ludovic Hoyet.

The Inria PRE entitled "Smart sensors and novel motion representation breakthrough for human performance analysis" aims at designing a new description for human motion in order to automatically capture, measure and transfer the intrinsic constraints of human motion. Current approaches consist in manually editing the constraints associated with a motion, to use classical skeleton representation with joint angles based on direct or indirect measurements, and then perform inverse kinematics to fulfill these constraints. We aim at designing a new representation to simplify this process pipeline and make it automatic, together with relevant motion sensors that could provide enough information to automatically extract these intrinsic constraints. To this end, this project has been jointly proposed with the Inria CAIRN team, which develops sensors based on joint orientations and distances between sensors. We aim at extending this type of device to measure new types of information that would help to simplify the above mentionned pipeline. Zhiguang Liu started to work as a research fellow on this project since November 2016, working in collaboration with CAIRN. We also involved Hubert Shum from Northumbria University to link this project with our long-term collaboration on this type of problems.

9.2. International Initiatives

9.2.1. Inria Associate Teams Not Involved in an Inria International Labs

9.2.1.1. FORMOSA

Title: Fostering Research on Models for Storytelling Applications

International Partner (Institution - Laboratory - Researcher):

NCCU (Taiwan) - Intelligent Media Lab (IML) - Tsai-Yen Li

Start year: 2016

See also: http://www.irisa.fr/mimetic/GENS/mchristi/EA-FORMOSA/

Interactive Storytelling is a new media which allows users to alter the content and outcome of narratives through role-playing and specific actions. With the quality, the availability and reasonable costs of display technologies and 3D interaction devices on one side, and the accessibility of 3D content creation tools on the other, this media is taking a significant share in entertainment (as demonstrated by the success of cinematographic games such as Heavy Rain or Beyond: two souls). These advances push us to re-think the way narratives are traditionally structured, explore new interactive modalities and provide new interactive cinematographic experiences. As a sequel of the first associate team FORMOSA 1, we propose to address new challenges pertained to interactive storytelling such as the use of temporal structures in narratives, interaction modalities and their impact in terms of immersion, and the adaptation of cinematographic real data to 3D environments. To achieve these objectives, the associate team will rely on the complementary skills of its partners and on the co-supervision of students.

9.2.1.2. RE-SIMS

Title: REal data against crowd SImulation algorithMS

International Partner (Institution - Laboratory - Researcher):

University of North Carolina at Chapel Hill (United States) - GAMMA Research Group (GAMMA) - Ming LIN

Start year: 2015

See also: http://www.irisa.fr/mimetic/GENS/jpettre/EASIMS/easims.html

RE-SIMS aims at gathering the best international research teams working on crowd simulation to allow significant progresses on the level of realism achieved by crowd simulators. To this end, RE-SIMS aims at improving methods for capturing crowd motion data that describe real crowd behaviors, as well as by improving data assimilation techniques.

In this renewal, RE-SIMS extends the previous SIMS partnership and follows a multidiciplinary direction.

9.2.2. Informal Inria International Partners

Dr. Edouard Auvinet, Imperial College London, UK (collaboration with Franck Multon, visited the team for a wekk in November)

Dr. Douglas S. Gonçalves, Federal University of Santa Catarina, Florianópolis, Brazil (collaboration with Antonio Mucherino, visited the team in December)

Prof. Carlile Lavor, UNICAMP, Campinas, São Paulo, Brazil (collaboration with Antonio Mucherino)

Dr. Rachel McDonnell, Trinity College Dublin, Ireland (collaboration with Ludovic Hoyet, joint paper submission)

Prof. Carol O'Sullivan, Trinity College Dublin, Ireland (collaboration with Ludovic Hoyet, visited the team for a week in June)

Dr. Huber Shum, Northumbria University, Newcastle, UK (collaboration with Franck Multon and Ludovic Hoyet, with joint papers and supervision, visited the team in November)

9.3. International Research Visitors

9.3.1. Visits of International Scientists

Dr. Edouard Auvinet, Imperial College London, UK (one week in November)

Dr. Douglas S. Gonçalves, Federal University of Santa Catarina, Florianópolis, Brazil (one week in December)

Prof. Carol O'Sullivan, Trinity College Dublin, Ireland (one week in June)

Dr. Hubert Shum, Northumbria University, Newcastle, UK (joint supervision, visit for two days in November)

9.3.1.1. Internships

Yihun Shen, Northumbria University, Newcastle, UK (PhD supervisor: Dr. Hubert Shum), 4-month internship on Rennes Metropole incoming mobility funding (Sept. to Dec. 2016).

PANAMA Project-Team

9. Partnerships and Cooperations

9.1. National Initiatives

9.1.1. Labex Comin Labs projects

ComInLabs is a Laboratoire d'Excellence funded by the PIA (Programme Investissements d'Avenir) in the broad area of telecommunications.

9.1.1.1. HEMISFER

Participant: Rémi Gribonval.

Acronym: HYBRID (Hybrid Eeg-MrI and Simultaneous neuro-feedback for brain Rehabilitation)

http://www.hemisfer.cominlabs.ueb.eu/

Research axis: 3.1

ComInLabs partners : EPI VISAGES; EPI HYBRID; EPI PANAMA

External partners : EA 4712 team from University of Rennes I; EPI ATHENA, Sophia-Antipolis;

Coordinator: Christian Barillot, EPI VISAGES

Description: 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. 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, Ã¢ÂÂ¦).

Contribution of PANAMA: PANAMA, in close cooperation with the VISAGES team, contributes to a coupling model between EEG and fMRI considered as a joint inverse problem addressed with sparse regularization. By combining both modalities, one expects to achieve a good reconstruction both in time and space. This new imaging technique will then be used for improving neurofeedback paradigms in the context of rehabilitation and psychiatric disorders, which is the final purpose of the HEMISFER project.

9.1.1.2. TEPN

Participant: Rémi Gribonval.

Acronym: TEPN (Toward Energy Proportional Networks)

http://www.tepn.cominlabs.ueb.eu/

Research axis: 3.1

ComInLabs partners : IRISA OCIF - Telecom Bretagne; IETR SCN; IETR SCEE; EPI PANAMA

Coordinator: Nicolas Montavont, IRISA OCIF - Telecom Bretagne

Description: As in almost all areas of engineering in the past several decades, the design of computer and network systems has been aimed at delivering maximal performance without regarding to the energy efficiency or the percentage of resource utilization. The only places where this tendency was questioned were battery-operated devices (such as laptops and smartphones) for which the users accept limited (but reasonable) performance in exchange for longer use periods. Even though the end users make such decisions on a daily basis by checking their own devices, they have no way of minimizing their energy footprint (or conversely, optimize the network resource usage) in the supporting infrastructure. Thus, the current way of dimensioning and operating the infrastructure supporting the user services, such as cellular networks and data centers, is to dimension for peak usage. The problem with this approach is that usage is rarely at its peak. The overprovisioned systems are also aimed at delivering maximal performance, with energy efficiency being considered as something desired, but non-essential. This project aims at making the network energy consumption proportional to the actual charge of this network (in terms of number of served users, or requested bandwidth). An energy proportional network can be designed by taking intelligent decisions (based on various constraints and metrics) into the network such as switching on and off network components in order to adapt the energy consumption to the user needs. This concept can be summarized under the general term of Green Cognitive Network Approach.

Contribution of PANAMA: PANAMA, in close cooperation with the SCEE team at IETR (thesis of Marwa Chafii), focuses on the design of new waveforms for multi carrier systems with reduced Peak to Average Power Ratio (PAPR).

9.1.2. ANR INVATE project with IRT b<>com France

Participants: Rémi Gribonval, Nancy Bertin, Mohamed Hafsati.

Thesis on 3D audio scene decomposition for interactive navigation

Duration: 3 years (2016-2019)

Research axis: 3.2.2

Partners: IRT b<>com, Inria-Rennes, IRISA

Funding: ANR INVATE project (PIA)

The objective of this thesis is to develop tools to analyze audio scenes in order to identify, locate, and extract the sources present in the scene to re-spatialize them according to the user head orientation and the movement of the user in the targeted virtual scene.

9.1.3. OSEO-FUI: voiceHome

Participants: Nancy Bertin, Frédéric Bimbot, Romain Lebarbenchon, Ewen Camberlein.

Duration: 3 years (2015-2017)

Research axis: 3.2

Partners: onMobile, Delta Dore, eSoftThings, Orange, Technicolor, LOUSTIC, Inria Nancy

Coordinator: onMobile

Description: The goal of the project is to design and implement a multi-channel voice interface for smart home and multimedia (set-top-box) appliances.

Contributions of PANAMA are focused on (i) audio activity monitoring and wake-up word detection and (ii) audio source localization and separation. In both cases, the issue of energy frugality is central and strongly constrains the available resources. We expect from this cooperation to make progress towards operational low-resource audio source separation schemes and we intend to investigate compressive sensing for the characterization of audio and voice activity.

9.2. European Initiatives

9.2.1. FP7 & H2020 Projects

9.2.1.1. ERC-StG: PLEASE (Projections, Learning, and Sparsity for Efficient Data Processing)

Participants: Rémi Gribonval, Srdan Kitic, Luc Le Magoarou, Nancy Bertin, Nicolas Keriven, Yann Traonmilin, Gilles Puy, Adrien Leman, Nicolas Bellot.

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/

9.3. International Initiatives

9.3.1. Inria International Partners

9.3.1.1. Informal International Partners

PANAMA has strong recurrent collaborations with the LTS2 lab at EPFL, the Center for Digital Music at Queen Mary University of London, the Institute for Digital Communications at the University of Edimburgh, and the Institute for Mathematics of the Postdam University.

9.4. International Research Visitors

9.4.1. Visits of International Scientists

- Pierre Vandergheynst, in June-July, Professor of Signal and Image Processing, EPFL (Chaire Internationale Inria)
- Gilles Blanchard, in September, Professor, University of Potsdam
- Laurent Jacques, in October, Professor, Catholic University of Louvain
- Mike Davies, in November, Professor, University of Edimburgh

SIROCCO Project-Team

9. Partnerships and Cooperations

9.1. Regional Initiatives

9.1.1. CominLabs/InterCom project

Participants: Aline Roumy, Thomas Maugey.

- Title : Interactive Communication (INTERCOM): Massive random access to subsets of compressed correlated data .
- Research axis : 7.4.1
- Partners : Inria-Rennes (Sirocco team and i4S team); LabSTICC, Telecom Bretagne, Signal & Communications Department; External partner: Kieffer L2S, CentraleSupelec, Univ. Paris Sud.
- Funding : Labex CominLabs.
- Period : Oct. 2016 - Nov. 2019.

This project aims to develop novel compression techniques allowing massive random access to large databases. Indeed, we consider a database that is so large that, to be stored on a single server, the data have to be compressed efficiently, meaning that the redundancy/correlation between the data have to be exploited. The dataset is then stored on a server and made available to users that may want to access only a subset of the data. Such a request for a subset of the data is indeed random, since the choice of the subset is user-dependent. Finally, massive requests are made, meaning that, upon request, the server can only perform low complexity operations (such as bit extraction but no decompression/compression). Algorithms for two emerging applications of this problem will be developed: Free-viewpoint Television (FTV) and massive requests to a database collecting data from a large-scale sensor network (such as Smart Cities).

9.2. European Initiatives

9.2.1. FP7 & H2020 Projects

9.2.1.1. ERC-CLIM

Participants: Pierre David, Elian Dib, Christine Guillemot, Xin Su.

Light fields yield a rich description of the scene ideally suited for advanced image creation capabilities from a single capture, such as simulating a capture with a different focus and a different depth of field, simulating lenses with different apertures, for creating images with different artistic intents or for producing 3D views. Light fields technology holds great promises for a number of application sectors, such as photography, augmented reality, light field microscopy, but also surveillance, to name only a few.

The goal of the ERC-CLIM project is to develop algorithms for the entire static and video light fields processing chain, going from compact sparse and low rank representations and compression to restoration, high quality rendering and editing.

9.3. International Initiatives

9.3.1. Informal International Partners

- Reuben Farrugia, Prof. at the University of Malta has been one sabbatical year Sept. 2015-Aug. 2016) within the team, working on inverse problems (super-resolution, inpainting) for several applications.
- The study on guided image inpainting is carried out in collaboration with Prof. Pascal Frossard from EPFL (Ecole Polytechique Federal de Lausanne).

9.4. International Research Visitors

9.4.1. Visits of International Scientists

Sheila Hemami, Prof. at Northeastern University, Boston, has visited the team during three months (May 2016-July 2016), working on the problem of demultiplexing and decoding of micro-lenses based light fields.