



RESEARCH CENTER
Grenoble - Rhône-Alpes

FIELD

Activity Report 2015

Section Partnerships and Cooperations

Edition: 2016-03-21

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ARIC Project-Team

9. Partnerships and Cooperations

9.1. Regional Initiatives

- ARC6 PhD Programme. The PhD grant of Valentina Popescu is funded since Sep. 2014 by Région Rhône-Alpes through the “ARC6” programme.
- PALSE Project. Benoît Libert was awarded a 500keur (from July 2014 to November 2016) grant for his PALSE (Programme d’Avenir Lyon Saint-Etienne) project *Towards practical enhanced asymmetric encryption schemes*.

9.2. National Initiatives

9.2.1. ANR HPAC Project

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

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

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

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

9.2.2. ANR DYNA3S Project

Participants: Guillaume Hanrot, Gilles Villard.

Dyna3s is a four year ANR project that started in October 2013. The Web page of the project is <http://www.liafa.univ-paris-diderot.fr/dyna3s/>. It is headed by Valérie Berthé (U. Paris 7) and involves also the University of Caen.

The aim is to study algorithms that compute the greatest common divisor (gcd) from the point of view of dynamical systems. A gcd algorithm is considered as a discrete dynamical system by focusing on integer input. We are mainly interested in the computation of the gcd of several integers. Another motivation comes from discrete geometry, a framework where the understanding of basic primitives, discrete lines and planes, relies on algorithm of the Euclidean type.

9.2.3. ANR FastRelax Project

Participants: Nicolas Brisebarre, Guillaume Hanrot, Vincent Lefèvre, Jean-Michel Muller, Bruno Salvy, Serge Torres, Silviu Filip, Sébastien Maulat.

FastRelax stands for “Fast and Reliable Approximation”. It is a four year ANR project started in October 2014. The web page of the project is <http://fastrelax.gforge.inria.fr/>. It is headed by B. Salvy and involves AriC as well as members of the Marelle Team (Sophia), of the Mac group (LAAS, Toulouse), of the Specfun and Toccata Teams (Saclay), as well as of the Pequan group in UVSQ and a colleague in the Plume group of LIP.

The aim of this project is to develop computer-aided proofs of numerical values, with certified and reasonably tight error bounds, without sacrificing efficiency. Applications to zero-finding, numerical quadrature or global optimization can all benefit from using our results as building blocks. We expect our work to initiate a “fast and reliable” trend in the symbolic-numeric community. This will be achieved by developing interactions between our fields, designing and implementing prototype libraries and applying our results to concrete problems originating in optimal control theory.

9.2.4. ANR MetaLibm Project

Participants: Claude-Pierre Jeannerod, Jean-Michel Muller.

MetaLibm is a four-year project (started in October 2013) focused on the design and implementation of code generators for mathematical functions and filters. The web page of the project is <http://www.metalibm.org/ANRMetaLibm/>. It is headed by Florent de Dinechin (INSA Lyon and Socrate team) and, besides Socrate and AriC, also involves teams from LIRMM (Perpignan), LIP6 (Paris), CERN (Geneva), and Kalray (Grenoble). The main goals of the project are to automate the development of mathematical libraries (libm), to extend it beyond standard functions, and to make it unified with similar approaches developed in or useful for signal processing (filter design). Within AriC, we are especially interested in studying the properties of fixed-point arithmetic and floating-point arithmetic that can help develop such a framework.

9.3. European Initiatives

9.3.1. FP7 & H2020 Projects

LATTAC ERC GRANT. Damien Stehlé was awarded an ERC Starting Grant for his project *Euclidean lattices: algorithms and cryptography* (LattAC) in 2013 (1.4Meur for 5 years from January 2014).

The LattAC project aims at studying all computational aspects of lattices, from algorithms for manipulating them to applications. The main objective is to enable the rise of lattice-based cryptography.

OPENDREAMKIT is a H2020 Infrastructure project providing substantial funding to the open source computational mathematics ecosystem. It will run for four years, starting from September 2015. Clément Pernet is a participant.

9.4. International Research Visitors

9.4.1. Visits of International Scientists

9.4.1.1. Visiting Scientists

- Jung Hee Cheon from July to August;
- Arnold Neumaier from August to December;
- Khoa Ta Toa Nguyen until October;
- Peter Tang, from June to July;
- Yong Sue Song from July to August.

9.4.1.2. Internships

Fabrice Mouhartem

Date: February 2015–July 2015

Institution: ENS de Lyon

Supervisor: Benoît Libert

Alice Pellet-Mary

Date: February 2015–July 2015

Institution: ENS de Lyon

Supervisor: Damien Stehlé

Andrada Popa

Date: July 2015–September 2015

Institution: Technical University of Cluj-Napoca (Roumanie)

Supervisor: Nicolas Brisebarre

Pablo Rotondo

Date: March 2015–June 2015

Institution: Universidad de la Republica Uruguay (Uruguay)

Supervisor: Bruno Salvy

Weiqiang Wen

Date: February 2015–July 2015

Institution: SCNU, China

Supervisor: Damien Stehlé

COMPSYS Project-Team

9. Partnerships and Cooperations

9.1. Regional Initiatives

9.1.1. *In Relation with the LYONCALCUL Initiative*

Compsys follows or participates to the activities of LyonCalcul (<http://lyoncalcul.univ-lyon1.fr/>), a network to federate activities on high-performance computing in Lyon.

In this context, and with the support of the Labex MILYON (<http://milyon.universite-lyon.fr/>), Compsys organized in 2013 a thematic quarter on compilation (<http://labexcompilation.ens-lyon.fr/>). A new thematic quarter on high performance computing (HPC) is in preparation for 2016, initiated by Violaine Louvet (Institute Camille Jordan), with the participation of the LIP teams Aric, Avalon, Compsys, and Roma. It will include, in particular, an inter-disciplinary spring school, following the polyhedral school organized in 2013, connecting mathematics (HPC numerical analysis) and computer science (polyhedral optimizations for HPC).

Alain Darté, Alexandre Isoard, and Tomofumi Yuki have also regular exchanges with Violaine Louvet and Thierry Dumont on tiling code optimizations, advising (in an informal way) some of their students during their internships, for implementations on multicore machines and GPUs.

9.1.2. *Collaboration with the Verimag lab*

Laure Gonnord, who did her PhD in abstract interpretation at Verimag, re-activated her connection with this group, in particular with N. Halbwachs and D. Monniaux. This led to several joint results, exposed in Sections 7.3 and 7.4. The theme of termination through affine ranking functions was first brought to the attention of Compsys when studying loop transformations for HLS, in the context of the S2S4HLS project with STMicroelectronics. The techniques of Compsys [15] were then extended by Laure Gonnord with D. Monniaux. Conversely, the idea of using Handelman and Schweighofer's theorems to deal with polynomial constraints, as exploited in Section 7.11, was first suggested by D. Monniaux through discussions with Paul Feautrier and some visits at ENS-Lyon.

9.1.3. *“PEPS local” with the MMI*

Alain Darté and Laure Gonnord participated to the creation of EMI (Education, Musique et Informatique), an educative inter-disciplinary project (“PEPS de site”, coordinated by Natacha Portier, from the MC2 team at LIP, and Yann Orlarey from the Grame laboratory) concerning an experience of musical programming with Faust (a functional audio stream language, with its compiler), in the context of the MMI (Maison des mathématiques et de l'informatique), a place for dissemination.

9.2. National Initiatives

9.2.1. *French Compiler Community*

In 2010, Laure Gonnord and Fabrice Rastello created the french community of compilation, which had no organized venue in the past. All groups with activities related to compilation were contacted and the first “compilation day” was organized in Lyon. This effort has been quickly a success: the community (<http://compilfr.ens-lyon.fr/>) is now well identified and 3-days workshops now occur at least once a year (the 10th event has been organized in Sep. 2015). The community is animated by Laure Gonnord and Fabrice Rastello since 2010, and now also by Florian Brandner (ex-Compsys too). Alain Darté, Alexandre Isoard, and Tomofumi Yuki participated to the 10th edition, with talks on “Static Analysis of OpenStream Programs”, “Liveness Analysis in the Polyhedral Model”, and “PolyApps: Case Study of Polyhedral Compilers using Real Applications” respectively.

Recognized as a sub-group of the CNRS GDR GPL (Software Engineering and Programming), the community is also in charge, since 2014, of organizing one day of the research school “Ecole des jeunes chercheurs en Algorithmique et Programmation” (EJCP). Tomofumi Yuki, in this context, gave a one-day lecture at the 2015 edition.

9.2.2. Collaboration with Parkas group, in Paris

Alain Darté and Paul Feautrier have regular meetings with Albert Cohen, from the Parkas team at ENS Paris. The current discussions are mostly related to the analysis and compilation of the OpenStream language developed by Parkas, a research topic that started through the ManycoreLabs project (see Section 8.1). The results of Sections 7.10 and 7.11 are related to this collaboration.

9.2.3. Collaboration with Cairn group, in Rennes

Tomofumi Yuki continues to work with the Cairn group through regular meetings and occasional visits. The topic of the collaboration is in applying compiler techniques for hardware design using high-level synthesis. Section 7.14 presents the results through this collaboration.

9.2.4. Collaboration with Camus group, in Strasbourg

Paul Feautrier and Tomofumi Yuki have an ongoing cooperation with Alain Ketterlin and Eric Violard (Camus group, Strasbourg) on several subjects connected to the analysis and transformations of X10 programs (see Section 7.8).

9.3. European Initiatives

9.3.1. FP7 & H2020 Projects

Compsys participated to a H2020 proposal (project Verde) on the convergence of compiler tools for hardware accelerators on one side (HLS tools) and programmable accelerators (multicores, GPUs) on the other side. But the project was not selected.

9.3.2. Collaborations with Major European Organizations

Compsys members participate to the European Network of Excellence on High Performance and Embedded Architecture and Compilation (HiPEAC, <http://www.hipeac.net/>), either as members or affiliate members. The International Workshop on Polyhedral Compilation Techniques (IMPACT, see Section 9.4.2.2), co-created by Christophe Alias in 2011, is now an annual event of the HIPEAC conference, as an official workshop. The 5th edition, IMPACT’15, was co-chaired by Alain Darté (see <http://impact.gforge.inria.fr/impact2015/>), while the 6th edition, IMPACT’16, was co-chaired by Tomofumi Yuki (see <http://impact.gforge.inria.fr/impact2016/>).

9.4. International Initiatives

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

Laure Gonnord and Maroua Maleej are involved in the PROSPIEL Associate Team (Inria/Brazil, <https://team.inria.fr/alf/prospiel/>), led by Sylvain Collange (Inria Alf), in a collaboration with Fernando Pereira’s group in UFMG (Brazil). The PROSPIEL project aims at optimizing parallel applications for high performance on new throughput-oriented architectures: GPUs and many-core processors. Specifically, Laure Gonnord and Maroua Maalej are in charge of designing static analyses for GPUs. Maroua Maleej visited the group of Fernando Pereira in Aug. 2015.

9.4.2. Inria International Partners

9.4.2.1. Declared Inria International Partners

- Christophe Alias is co-adviser, with Sanjay Rajopadhye from Colorado State University (USA), of the PhD thesis of Guillaume Iooss. The results described in Section 7.6 are part of this collaboration.
- Tomofumi Yuki, who did his PhD with Sanjay Rajopadhye, then a post-doc in the Cairn team in Rennes, continues his collaboration with these two groups, as the results described in Section 7.14 illustrate. He participates regularly, over the net, to the reading group “Melange” of S. Rajopadhye’s group, with CSU students.
- Laure Gonnord and Maroua Maleej have a regular collaboration with Fernando Magno Quintao Pereira from the University of Minas Gerais (Brazil). The results described in Section 7.2 are part of this collaboration. In Jan.-Feb. 2015, Compsys hosted Fernando Pereira, as a visiting professor.

9.4.2.2. Polyhedral Community

In 2011, as part of the organization of the workshops at CGO’11, Christophe Alias (with C. Bastoul) organized IMPACT’11 (international workshop on polyhedral compilation techniques, <http://impact2011.inrialpes.fr/>). This workshop in Chamonix was the very first international event on this topic, although it was introduced by Paul Feautrier in the late 80s. Alain Darté gave the introductory keynote talk. After this successful edition (more than 60 people), IMPACT continued as a satellite workshop of the HIPEAC conference, in Paris (2012), Berlin (2013), Vienna (2014). Alain Darté was program co-chair and co-organizer for the past edition, in Amsterdam (2015), while Tomofumi Yuki is program co-chair and co-organizer of the next one, in Prague (2016).

The creation of IMPACT, now the annual event of the polyhedral community, helped to identify this community and to make it more visible. This effort was complemented by the organization of the first (and for the moment unique) school on polyhedral code analysis and optimizations (<http://labexcompilation.ens-lyon.fr/polyhedral-school/>). A second polyhedral school, more open, because involving themes and researchers from numerical analysis (users of HPC), will be organized in 2016.

Alain Darté also manages two new mailing lists for news (polyhedral-news@listes.ens-lyon.fr) and discussions (polyhedral-discuss@listes.ens-lyon.fr) on polyhedral code analysis and optimizations. Tomofumi Yuki is involved in the development of PolyBench (<http://sourceforge.net/projects/polybench>), a suite of kernels used for illustrating polyhedral optimizations. He is also developing PolyApps, a set of larger applications to evaluate the gap between kernels and “real” applications, see more details in Section 7.15 .

9.5. International Research Visitors

9.5.1. Visits of International Scientists

9.5.1.1. Invited Professors

- Fernando M. Pereira was invited in Jan. 2015 to work with Maroua Maleej and Laure Gonnord on static analyses for pointers.

9.5.1.2. Internships

- Tristan Dubois, M1 student from Lyon 1 University, worked for 6 weeks in January-February 2015, on pointer arithmetic in LLVM, supervised by Laure Gonnord.
- Marc Vincenti, M1 student from Lyon 1 University, worked for 6 weeks in January-February 2015, on comparison of termination benchmarks, in the context of the Artefact Evaluation of the PLDI’15 publication [7], whose results are described in Section 7.4 .
- Adilla Susungi, a M2 student from Strasbourg University, worked, from March 2015 to July 2015, on the compilation of streaming applications on multi-GPUs, supervised by Christophe Alias. Her internship was funded by Inria.

9.5.2. Visits to International Teams

Paul Feautrier has been invited by the University of Passau (Bavaria) in the team of Prof. Christian Lengauer, where he has given a seminar “Toward a Polynomial Model” (September 2015) and held scientific discussions with Armin Groesslinger and other members of the team.

CONVECS Project-Team

8. Partnerships and Cooperations

8.1. National Initiatives

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

8.1.1.1. OpenCloudware

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

OpenCloudware⁰ is a project funded by the FSN. The project is led by France Telecom / Orange Labs (Meylan, France) and involves 18 partners (among which Bull, OW2, Thalès, Inria, etc.). OpenCloudware aims at providing an open software platform enabling the development, deployment and administration of cloud applications. The objective is to provide a set of integrated software components for: (i) modeling distributed applications to be executed on cloud computing infrastructures; (ii) developing and constructing multi-tier virtualized applications; and (iii) deploying and administrating these applications (PaaS platform) possibly on multi-IaaS infrastructures.

OpenCloudware started in January 2012 for three years and nine months. The main contributions of CONVECS to OpenCloudware (see § 6.5.2) are the formal specification of the models, architectures, and protocols (self-deployment, dynamic reconfiguration, self-repair, etc.) underlying the OpenCloudware platform, the automated generation of code from these specifications for rapid prototyping purposes, and the formal verification of the aforementioned protocols.

8.1.1.2. Connexion

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

Connexion⁰ (*Contrôle commande Nucléaire Numérique pour l'EXport et la rénoVatION*) is a project funded by the FSN, within the second call for projects “*Investissements d’Avenir — Briques génériques du logiciel embarqué*”. The project, led by EDF and supported by the *Pôles de compétitivité* Minalogic, Systematic, and *Pôle Nucléaire Bourgogne*, involves many industrial and academic partners, namely All4Tech, Alstom Power, ArevA, Atos Worldgrid, CEA-LIST, CNRS/CRAN, Corys Tess, ENS Cachan, Esterel Technologies, Inria, LIG, Predict, and Rolls-Royce. Connexion aims at proposing and validating an innovative architecture dedicated to the design and implementation of control systems for new nuclear power plants in France and abroad.

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

8.1.2. Competitvity Clusters

8.1.2.1. Bluesky for I-Automation

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

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

⁰<http://www.opencloudware.org>

⁰<http://www.cluster-connexion.fr>

Bluesky started in September 2012 for three years and was extended for nine month until June 2016. The main contributions of CONVECS to Bluesky (see § 6.1.5 and § 6.5.3) are the definition of GRL, the formal pivot language for describing the asynchronous behavior of logic controller networks, and the automated verification of the behavior using compositional model checking and equivalence checking techniques.

8.1.3. Other National Collaborations

Additionally, we collaborated in 2015 with the following Inria project-teams:

- PAREO (Inria Nancy — Grand Est): Pierre-Etienne Moreau

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

- Gaëlle Calvary and Sophie Dupuy-Chessa (LIG, Grenoble),
- Fabrice Kordon and Lom Messan Hillah (LIP6, Paris),
- Noël De Palma and Fabienne Boyer (LIG, Grenoble),
- Xavier Etchevers (Orange Labs, Meylan),
- Matthias Güdemann (Systerel, Aix-en-Provence),
- Christophe Deleuze, Ioannis Parissis, and Mouna Tka Mnad (LCIS, Valence),
- Pascal Poizat (LIP6, Paris).

8.2. European Initiatives

8.2.1. FP7 & H2020 Projects

8.2.1.1. SENSATION

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

SENSATION⁰ (*Self ENergy-Supporting Autonomous computaTION*) is a European project no. 318490 funded by the FP7-ICT-11-8 programme. It gathers 9 participants: Inria (ESTASYS and CONVECS project-teams), Aalborg University (Denmark), RWTH Aachen and Saarland University (Germany), University of Twente (The Netherlands), GomSpace (Denmark), and Recore Systems (The Netherlands). The main goal of SENSATION is to increase the scale of systems that are self-supporting by balancing energy harvesting and consumption up to the level of complete products. In order to build such Energy Centric Systems, embedded system designers face the quest for optimal performance within acceptable reliability and tight energy bounds. Programming systems that reconfigure themselves in view of changing tasks, resources, errors, and available energy is a demanding challenge.

SENSATION started on October 1st, 2012 for three years, and has been extended for five months until February 29, 2016. CONVECS contributes to the project regarding the extension of formal languages with quantitative aspects (see § 6.3.1), studying common semantic models for quantitative analysis, and applying formal modeling and analysis to the case studies provided by the industrial partners (see § 6.5.4).

8.2.2. Collaborations with Major European Organizations

The CONVECS project-team is member of the FMICS (*Formal Methods for Industrial Critical Systems*) working group of ERCIM⁰. H. Garavel and R. Mateescu are members of the FMICS board, H. Garavel being in charge of dissemination actions.

8.3. International Initiatives

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

⁰<http://sensation-project.eu/>

⁰<http://fmics.inria.fr>

8.3.1. Other International Collaborations

In 2015, we had scientific relations with several universities abroad, including:

- CWI, The Netherlands (Jurgen Vinju and Paul Klint),
- University of Málaga, Spain (F. Duran and C. Canal),
- University of Colorado, USA (Fabio Somenzi), and
- University of Utah, USA (Chris Myers and Zhen Zhang).

8.4. International Research Visitors

8.4.1. Visits of International Scientists

- The annual CONVECS seminar was held in Charavines (France) on May 27–29, 2015. The following invited scientists attended the seminar:
 - Eric Jenn (IRT Saint-Exupéry / Thales Avionics) gave on May 27, 2015 a talk entitled “*The INGEQUIP Project and the TwIRTeE demonstrator*”.
 - Alexandre Hamez (IRT Saint-Exupéry) gave on May 29, 2015 a talk entitled “*CAE-SAR.SDD*”.
- Chris Myers (University of Utah, USA) visited us from June 8–12, 2015. He gave a talk entitled “*An Integrated Verification Architecture*” on June 9, 2015.
- Hernan Ponce de Leon (Aalto University, Finland) visited us from June 29 to July 1, 2015. He gave a talk entitled “*Unfolding Based Testing for Multithreaded Programs*” on June 29, 2015.

CORSE Team

8. Partnerships and Cooperations

8.1. Regional Initiatives

8.1.1. HEAVEN Persyval Project

- Title: HEterogenous Architectures: Versatile Exploitation and programmiNg
- HEAVEN leaders: François Broquedis, Olivier Muller[TIMA lab]
- Corse participants: François Broquedis, Frédéric Desprez, Georgios Christodoulis
- Computer architectures are getting more and more complex, exposing massive parallelism, hierarchically-organized memories and heterogeneous processing units. Such architectures are extremely difficult to program as they most of the time make application programmers choose between portability and performance.

While standard programming environments like OpenMP are currently evolving to support the execution of applications on different kinds of processing units, such approaches suffer from two main issues. First, to exploit heterogeneous processing units from the application level, programmers need to explicitly deal with hardware-specific low-level mechanisms, such as the memory transfers between the host memory and private memories of a co-processor for example. Second, as the evolution of programming environments towards heterogeneous programming mainly focuses on CPU/GPU platforms, some hardware accelerators are still difficult to exploit from a general-purpose parallel application.

FPGA is one of them. Unlike CPUs and GPUs, this hardware accelerator can be configured to fit the application needs. It contains arrays of programmable logic blocks that can be wired together to build a circuit specialized for the targeted application. For example, FPGAs can be configured to accelerate portions of code that are known to perform badly on CPUs or GPUs. The energy efficiency of FPGAs is also one of the main assets of this kind of accelerators compared to GPUs, which encourages the scientific community to consider FPGAs as one of the building blocks of large scale low-power heterogeneous multicore platforms.

However, only a fraction of the community considers programming FPGAs for now, as configurations must be designed using low-level description languages such as VHDL that application programmers are not experienced with.

The main objective of this project is to improve the accessibility of heterogeneous architectures containing FPGA accelerators to parallel application programmers. The proposed project focuses on three main aspects:

- Portability: we don't want application programmers to redesign their applications completely to benefit from FPGA devices. This means extending standard parallel programming environments like OpenMP to support FPGA. Improving application portability also means leveraging most of the hardware-specific low-level mechanisms at the runtime system level ;
- Performance: we want our solution to be flexible enough to get the most out of any heterogeneous platforms containing FPGA devices depending on specific performance needs, like computation throughput or energy consumption for example ;
- Experiments: Experimenting with FPGA accelerators on real-life scientific applications is also a key element of our project proposal. In particular, the solutions developed in this project will allow comparisons between architectures on real-life applications from different domains like signal processing and computational finance.

Efficient programming and exploitation of heterogeneous architectures implies the development of methods and tools for system design, embedded or not. The HEAVEN project proposal fits in the PCS research action of the PERSYVAL-lab. The PhD of Georgios Christodoulis is funded by this project.

8.1.2. HPES Persyval Project

- Title: High Performance Embedded Systems
- HPES leader: Henri-Pierre Charles [CEA List, CRI PILSI]
- HPES participants: Suzane Lesecq [CEA Leti], Laurent Fesquet [TIMA Lab], Stéphane Mancini [TIMA Lab], Eric Ruten [Inria/CtrlA], Nicolas Marchand [Gipsa Lab], Bogdan Robu [Gipsa Lab]
- Corse participants: Naweiluo Zhou [PhD Persyval], Fabrice Rastello, Jean-François Méhaut
- The computing area has been recently deeply modified by the emergence of the so-called multicore processor. Within the same chip, several computing units are implemented. This architectural concept allows meeting the performance requirements under stringent energy consumption constraints. Multicores are used for laptops, Graphical Processor Units (GPU), High Performance Computing (HPC) platforms, but also for embedded systems such as mobile phones. Moreover, low-power high performance multicores developed for embedded systems will be soon used in data centers for HPC. This raises new scientific challenges to architecture, systems and application designers that have face massively parallel computing platforms.

The number of cores on a chip is increasing quickly. At the same time, the memory bandwidth is increasing too slowly to ensure the performance such multicore platforms should attain. This phenomenon is known as “Memory Wall” and at the moment no efficient solution to exceed this limitation exists. With the increase in the number of cores, cache coherency is becoming as well a tremendous challenge.

Power consumption is also a huge challenge as it imposes strong constraints on the computing platform, whatever the application domain. The first machine ranked in the Green500 has an energy performance ratio of 2 Gflops per watt. This ratio has to be improved by 30 when exascale computing is considered. The multi-core processor might help to improve this ratio; however, the software stack should as well evolve to boost this improvement.

8.2. National Initiatives

8.2.1. IPL Multicore

- Title: Large scale multicore virtualization for performance scaling and portability
- Multicore leader: Gilles Muller
- CORSE participants: Fabrice Rastello
- Multicore processors are becoming the norm in most computing systems. However supporting them in an efficient way is still a scientific challenge. This large-scale initiative introduces a novel approach based on virtualization and dynamicity, in order to mask hardware heterogeneity, and to let performance scale with the number and nature of cores. It aims to build collaborative virtualization mechanisms that achieve essential tasks related to parallel execution and data management. We want to unify the analysis and transformation processes of programs and accompanying data into one unique virtual machine. We hope delivering a solution for compute-intensive applications running on general-purpose standard computers. Research directions are: (1) Memory management and scheduling; (2) Garbage collection; (3) Improving data locality; (4) Dynamic parallelization; (5) Fast execution of Sequential Sections; (6) Dynamic Code Generation; (7) Dynamic Binary Rewriting for Performance Portability; (8) Virtualization of floating-point computation; (9) Convergence between VMKit and StarPU

8.2.2. IPL C2S@Exa

- Title: Computer and Computational Sciences at Exascale
- C2S@Exa leader: Stéphane Lanteri
- Corse participants: François Broquedis, Frédéric Desprez, Jean-François Méhaut
- The C2S@Exa Inria large-scale initiative 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. At the current state of the art in technologies and methodologies, a multidisciplinary approach is required to overcome the challenges raised by the development of highly scalable numerical simulation software that can exploit computing platforms offering several hundreds of thousands of cores. Hence, the main objective of the C2S@Exa Inria large-scale initiative is the establishment of a continuum of expertise in the computer science and numerical mathematics domains, by gathering researchers from Inria project-teams whose research and development activities are tightly linked to high performance computing issues in these domains. More precisely, this collaborative effort involves computer scientists that are experts of programming models, environments and tools for harnessing massively parallel systems, algorithmists that propose algorithms and contribute to generic libraries and core solvers in order to take benefit from all the parallelism levels with the main goal of optimal scaling on very large numbers of computing entities and, numerical mathematicians that are studying numerical schemes and scalable solvers for systems of partial differential equations in view of the simulation of very large-scale problems.

8.2.3. PIA ELCI

- Title: Environnement logiciel pour le calcul intensif
- ELCI leader: Corinne Marchand (BULL SAS)
- Corse participants: François Broquedis, Philippe Virouleau
- Duration: from Sept. 2014 to Sept. 2017
- The ELCI project main goal is to develop a highly-scalable new software stack to tackle high-end supercomputers, from numerical solvers to programming environments and runtime systems. In particular, the CORSE team is studying the scalability of OpenMP runtime systems on large scale shared memory machines through the PhD of Philippe Virouleau, co-advised by researchers from the CORSE and AVALON Inria teams. This work intends to propose new approaches based on a compiler/runtime cooperation to improve the execution of scientific task-based programs on NUMA platforms. The PhD of Philippe Virouleau is funded by this project.

8.3. European Initiatives

8.3.1. FP7 & H2020 Projects

8.3.1.1. Mont-Blanc

Title: Mont-Blanc (European scalable and power efficient HPC platform based on low-power embedded technology)

Program FP7

Duration: 01/10/2011 - 30/06/2015

Coordinator: Barcelona Supercomputing Center (BSC)

Mont-Blanc consortium: BSC, Arm, Bull, CNRS, CEA Leti, Juelich, LRZ, Genci, Cineca, Univ. Cantabria

Mont-Blanc website: <http://www.montblanc-project.eu/>

Corse contact: Jean-François Méhaut

Corse participants: Brice Videau, Kevin Pouget

There is a continued need for higher compute performance: scientific grand challenges, engineering, geophysics, bioinformatics, etc. However, energy is increasingly becoming one of the most expensive resources and the dominant cost item for running a large supercomputing facility. In fact the total energy cost of a few years of operation can almost equal the cost of the hardware infrastructure. Energy efficiency is already a primary concern for the design of any computer system and it is unanimously recognized that Exascale systems will be strongly constrained by power. The analysis of the performance of HPC systems since 1993 shows exponential improvements at the rate of one order of magnitude every 3 years: One petaflops was achieved in 2008, one exaflops is expected in 2020. Based on a 20 MW power budget, this requires an efficiency of 50 GFLOPS/Watt. However, the current leader in energy efficiency achieves only 1.7 GFLOPS / Watt. Thus, a 30x improvement is required. In this project, we believe that HPC systems developed from today's energy-efficient solutions used in embedded and mobile devices are the most likely to succeed. As of today, the CPUs of these devices are mostly designed by ARM. However, ARM processors have not been designed for HPC, and ARM chips have never been used in HPC systems before, leading to a number of significant challenges. The Mont-Blanc project has three objectives:

- To develop a fully functional energy-efficient HPC prototype using low-power commercially available embedded technology
- To design a next-generation HPC system together with a range of embedded technologies in order to overcome the limitations identified in the prototype system
- To develop a portfolio of exascale applications to be run on this new generation of HPC systems. This will produce a new type of computer architecture capable of setting future global HPC standards that will provide Exascale performance using 15 to 30 times less energy

8.3.1.2. Mont-Blanc2

Title: Mont-Blanc (European scalable and power efficient HPC platform based on low-power embedded technology)

Program FP7

Duration: 01/10/2013 - 30/09/2016

Coordinator: Barcelona Supercomputing Center (BSC)

Mont-Blanc consortium: BSC, Bull, Arm, Juelich, LRZ, USTUTT, Cineca, CNRS, Inria, CEA Leti, Univ. Bristol, Allinea

Corse contact: Jean-François Méhaut

Corse participants: Brice Videau, Kevin Pouget

The Mont-Blanc project aims to develop a European Exascale approach leveraging on commodity power-efficient embedded technologies. The project has developed a HPC system software stack on ARM, and is deployed the first integrated ARM-based HPC prototype by 2014, and is also working on a set of 11 scientific applications to be ported and tuned to the prototype system.

The rapid progress of Mont-Blanc towards defining a scalable power efficient Exascale platform has revealed a number of challenges and opportunities to broaden the scope of investigations and developments. Particularly, the growing interest of the HPC community in accessing the Mont-Blanc platform calls for increased efforts to setup a production-ready environment. The Mont-Blanc 2 proposal has 4 objectives:

1. To complement the effort on the Mont-Blanc system software stack, with emphasis on programmer tools (debugger, performance analysis), system resiliency (from applications to architecture support), and ARM 64-bit support
2. To produce a first definition of the Mont-Blanc Exascale architecture, exploring different alternatives for the compute node (from low-power mobile sockets to special-purpose high-end ARM chips), and its implications on the rest of the system

3. To track the evolution of ARM-based systems, deploying small cluster systems to test new processors that were not available for the original Mont-Blanc prototype (both mobile processors and ARM server chips)
4. To provide continued support for the Mont-Blanc consortium, namely operations of the original Mont-Blanc prototype, the new developer kit clusters and hands-on support for our application developers

Mont-Blanc 2 contributes to the development of extreme scale energy-efficient platforms, with potential for Exascale computing, addressing the challenges of massive parallelism, heterogeneous computing, and resiliency. Mont-Blanc 2 has great potential to create new market opportunities for successful EU technology, by placing embedded architectures in servers and HPC.

8.3.1.3. HPC4E

Title: HPC for Energy

Programm: H2020

Duration: 01/12/2015 - 30/11/2017

Coordinator: Barcelona Supercomputing Center (BSC)

European partners: Inria, Univ. Lancaster, Ciemat, Total, Repsol, Iberdrola

Brazilian partners: Coppe, LNCC, ITA, Petrobras, UFRGS, UFPE

Inria contact: Stephane Lanteri

Corse contact: Jean-François Méhaut

Corse participants: François Broquedis, Frédéric Desprez, Brice Videau

The main objective is to develop beyond-the-state-of-the-art high performance simulation tools that can help the energy industry to respond future energy demands and also to carbon-related environmental issues using the state-of-the-art HPC systems. HPC4E also aims at improving the usage of energy using HPC tools by acting at many levels of the energy chain for different energy sources. The project includes relevant energy industrial partners from Brazil and EU, which will benefit from the project's results. They guarantee that TRL of the project technologies will be very high.

8.3.1.4. EoCoE

Title: Energy oriented Centre of Excellence for computer applications

Programm: H2020

Duration: 01/10/2015 - 30/11/2018

Coordinator: Commissariat à L'Énergie Atomique et aux Énergies Alternatives (CEA)

European partners: CEA, Juelich, MPG, Enea, Cerfacs, UNITN, Fraunhofer, Univ. Bath, CNR, Univ. Brussels, BSC

Inria contact: Michel Kern

Corse contact: Jean-François Méhaut

Corse participants: François Broquedis, Frédéric Desprez, Brice Videau

This projects establishes an Energy Oriented Centre of Excellence for computing applications, (EoCoE). EoCoE (pronounce "Echo") will use the prodigious potential offered by the ever-growing computing infrastructure to foster and accelerate the European transition to a reliable and low carbon energy supply. To achieve this goal, we believe that the present revolution in hardware technology calls for a similar paradigm change in the way application codes are designed. EoCoE will assist the energy transition via targeted support to four renewable energy pillars: Meteo, Materials, Water and Fusion, each with a heavy reliance on numerical modelling. These four pillars will be anchored within a strong transversal multidisciplinary basis providing high-end expertise in applied

mathematics and HPC. EoCoE is structured around a central Franco-German hub coordinating a pan-European network, gathering a total of 8 countries and 23 teams. Its partners are strongly engaged in both the HPC and energy fields; a prerequisite for the long-term sustainability of EoCoE and also ensuring that it is deeply integrated in the overall European strategy for HPC. The primary goal of EoCoE is to create a new, long lasting and sustainable community around computational energy science. At the same time, EoCoE is committed to deliver high-impact results within the first three years. It will resolve current bottlenecks in application codes, leading to new modelling capabilities and scientific advances among the four user communities; it will develop cutting-edge mathematical and numerical methods, and tools to foster the usage of Exascale computing. Dedicated services for laboratories and industries will be established to leverage this expertise and to foster an ecosystem around HPC for energy. EoCoE will give birth to new collaborations and working methods and will encourage widely spread best practices.

8.4. International Initiatives

8.4.1. Inria International Labs

- JLESC (Joint Laboratory on Exascale Computing)
The CORSE team is involved in the JLESC with collaborations with UIUC (Sanjay Kalé) and BSC (Mont-Blanc projects). Kevin Pouget, Brice Videau and Jean-François Méhaut attended to the two JLESC workshops (Barcelona and Bonn) in 2015.
 - **Energy Efficiency and Load Balancing**
 - The power consumption of High Performance Computing (HPC) systems is an increasing concern as large-scale systems grow in size and, consequently, consume more energy. In response to this challenge, we propose new energy-aware load balancers that aim at reducing the energy consumption of parallel platforms running imbalanced scientific applications without degrading their performance. Our research explores dynamic load balancing, low power manycore platforms and DVFS techniques in order to reduce power consumption.
 - We propose the improvement of the performance and scalability of parallel seismic wave models through dynamic load balancing. These models suffer from load imbalance for two reasons. First, they add a specific numerical condition at the borders of the domain, in order to absorb the outgoing energy. The decomposition of the domain into a grid of subdomains, which are distributed among tasks, creates load differences between the tasks that simulate the borders and those responsible for the central subdomains. Second, the propagation of waves in the simulated area changes the workload on the subdomains on different time-steps. Therefore causing dynamic load imbalance. In order to evaluate the use of dynamic load balancing, we ported a seismic wave simulator to Adaptive MPI, to benefit from its load balancing framework. Our experimental results show that dynamic load balancers can adapt to load variations during the application's execution and improve performance by 36%.
 - we also focus on reducing the energy consumption of imbalanced applications through a combination of load balancing and Dynamic Voltage and Frequency Scaling (DVFS). Our strategy employs an Energy Daemon Tool to gather power information and a load balancing module that benefits from the load balancing framework available in the CHARM++ runtime system. We propose two variants of our energy-aware load balancer (ENERGYLB) to save energy on imbalanced workloads without considerably impacting the overall system performance. The first one, called Fine-Grained EnergyLB (FG-ENERGYLB), is suitable for platforms composed of few tens of cores that allow per-core DVFS. The second one, called Coarse-Grained EnergyLB (CG-ENERGLB) is suitable for current HPC platforms composed of several multi-core processors that feature per-chip DVFS.

- LIRIMA (IDASCO team)
 - The general objective of IDASCO project team is to develop models and tools that can be used to collect the huge amount of data produced by complex computational, biological, epidemiological or environmental systems, and extract knowledge from these data in order to better understand their structure and dynamics for decision making. From 2010 to 2015, the IDASCO activities were focused on the following main thematic : programming environments for parallel execution, parallel algorithms for datamining, social network analysis and trace mining. Some work on wireless sensor networks and geographic information systems with application to sustainable management of natural resources have also been developed. Ten PhD Theses were defended during this period with eight on them co-supervised. There were some industrial collaborations with a brewery company (SABC) on e-Learning platforms and with ORANGE Labs on online registration platforms. These collaborations were done in partnership of the ALOCO project team. The EPICAM project was also developed in partnership with MEDES France, Centre Pasteur Cameroun and the National Program for Fight against Tuberculosis.
 - Jean-François Méhaut is co-director with Maurice Tchuente of the IDASCO team.
 - Thomas Messi Nguelé is currently preparing a PhD with the coadvising of Maurice Tchuente. His research work is also part of the IDASCO team.
 - Ylies Falcone and Jean-François Méhaut spent two weeks in Cameroon (Yaoundé) in the context of LIRIMA and CETIC (African Center of Excellence for IT, <http://www.cetic.cm/>).

8.4.2. Inria Associate Teams not involved in an Inria International Labs

8.4.2.1. IOComplexity

Title: Automatic characterization of data movement complexity

International Partner (Institution - Laboratory - Researcher):

Ohio State University (United States) - P. Sadayappan

Start year: 2015

See also: <https://team.inria.fr/corse/iocomplexity/>

The goal of this project is to develop new techniques and tools for the automatic characterization of the data movement complexity of an application. The expected contributions are both theoretical and practical, with the ambition of providing a fully automated approach to I/O complexity characterization, in starking contrast with all known previous work that are stricly limited to pen-and-paper analysis.

I/O complexity becomes a critical factor due in large part to the increasing dominance of data movement over computation in energy consumption for current and emerging architectures. This project aims at enabling: 1. the selection of algorithms according to this new criteria (as opposed to the criteria on arithmetic complexity that has been used up to now); 2. the design of specific architectures in terms of cache size, memory bandwidth, GFlops etc. based on application-specific bounds on memory traffic; 3. higher quality feedback to the user, the compiler, or the run-time system about data traffic, a major performance and energy factor.

8.4.2.2. PROSPIEL

- Title: Profiling and specialization for locality
- International Partner (Institution - Laboratory - Researcher):
 - Universidade Federal de Minas Gerais (Brazil) - Computer Science Department - Fernando Magno Quintão Pereira
- Start year: 2015

- See also: <https://team.inria.fr/alf/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.

8.4.2.3. Exase

Title: Exascale Computing Scheduling Energy

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

Inria leader: Jean-Marc Vincent (Mescal)

Inria teams: Mescal, Moais, Corse

Corse participants: Jean-François Méhaut, François Broquedis, Frédéric Desprez

International Partner (Institution - Laboratory - Researcher):

Federal University of Rio Grande do Soul (UFRGS, Porto Alegre, Brazil) - Informatics Faculty - L. Schnoor, N. Maillard, P. Navaux

Pontifical University Minas (PUC Minas, Belo Horizonte, Brazil) - Computer Science faculty, Henrique Freitas

University of Sao Paulo (USP, Sao Paulo, Brazil), IME faculty, Alfredo Goldman

Start year: 2014

The main scientific goal of Exase for the three years is the development of state-of-the-art energy-aware scheduling algorithms for exascale systems. As previously stated, issues on energy are fundamental for next generation parallel platforms and all scheduling decisions must be aware of that. Another goal is the development of trace analysis techniques for the behavior analysis of schedulers and the applications running on exascale machines. We list below specific objectives for each development axis presented in the previous section. analysis.

- Fundamentals for the scaling of schedulers
- Design of schedulers for large-scale infrastructures
- Tools for the analysis of large scale schedulers

8.4.3. Participation In other International Programs

- LICIA
- HOSCAR
- EnergySFE (STIC Amsud)

8.5. International Research Visitors

8.5.1. Visits of International Scientists

- Thierry Jérón, Hervé Marchand, and Antoine Rollet visited Yliès Falcone during 1 week in January 2015.
- Ezio Bartocci (TU Vienna) visited Y. Falcone during two weeks in August 2015.
- Sylvain Hallé (University of Québec at Chicoutimi) visited Yliès Falcone during 1 week in December 2015.

8.5.2. Visits to International Teams

8.5.2.1. Research stays abroad

- Fabrice Rastello visited P. Sadayappan at Ohio State University two times one month (mai 2015 + September 2015) in the context of the INRIA Associate Team IOComplexity.
- Ylies Falcone visited the University of Illinois at Urbana Champaign (USA) from February to July 2015.
- Jean-François Méhaut visited M. Tchuenté at Yaoundé. (February 2015) in the context of LIRIMA (Idasco team).
- Jean-François Méhaut visited P. Navaux at UFRGS (October 2015) in the context of LICIA and the Inria associated team Exase.
- Jean-François Méhaut visited M. Castro and L. Pilla at UFSC (October 2015) in the context of the Stic Amsud EnergySFE project.

DICE Team

8. Partnerships and Cooperations

8.1. Regional Initiatives

8.1.1. *IXXI, Institute for Complex Systems*

The Dice team is hosted in the Rhône-Alpes Institute for Complex Systems, IXXI, located in Ecole Normale Supérieure de Lyon. IXXI is promoting trans-disciplinary research, in particular with social sciences, thus facilitating the establishment of connections with researchers in fields such as economics, history, law, etc.

8.1.2. *ARC6 "Innovative Services for Social Networks"*

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

8.2. National Initiatives

8.2.1. *ANR*

DICE is involved in an ANR project, which started at the end of 2013

- C3PO, on Collaborative Creation of Contents and Publishing using Opportunistic networks, with LT2C Telecom Saint-Etienne, INSA LYON, IRISA, ChronoCourse, et Ecole des Mines de Nantes.

8.3. European Initiatives

8.3.1. *FP7 & H2020 Projects*

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

8.4. International Initiatives

8.4.1. *Inria International Labs*

Dice is involved in IPL CityLab@Inria which studies ICT solutions for smart cities. Dice takes part in the *Platforms and City Governance* theme. Dice focuses on analysing and forecasting the role of intermediation platforms in the governance.

8.4.2. *Inria International Partners*

Dice is associated with the Institute of Massive Computing of ECNU, East China Normal University, in the framework of Joriss, associating ENS with ECNU. The project which focuses on "Promises of intermediation platforms for services frugal in resources" is headed by Aoying ZHOU on the ECNU side.

PRIVATICS Project-Team

8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. FUI

8.1.1.1. XDATA

Title: XDATA.

Type: FUI.

Duration: April 2013 - April 2015.

Coordinator: Data Publica

Others partners: Inria, Orange, EDF, LaPoste, Hurance, Cinequant, IMT.

See also: <http://www.xdata.fr/>.

Abstract: The X-data project is a “projet investissements d’avenir” on big data with Data Publica (leader), Orange, La Poste, EDF, Cinequant, Hurence and Inria (Indes, Privatics and Zenith) . The goal of the project is to develop a big data platform with various tools and services to integrate open data and partners’s private data for analyzing the location, density and consuming of individuals and organizations in terms of energy and services. In this project, the Zenith team leads the workpackage on data protection and anonymization.

8.1.1.2. HuMa

Title: HuMa.

Type: FUI.

Duration: Juin 2015 - Mai 2018.

Coordinator: INTRINSEC.

Others partners: Inria, SYDO, Wallix, INSA Lyon, CASSIDIAN Cybersecurity, Oberthur, INTRINSEC.

Abstract:

The goal of huMa is to improve the tools used to distinguish legitimate network flows from attacks in complex systems including IoT.

8.1.2. ANR

8.1.2.1. BIOPRIV

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

Type: ANR.

Duration: April 2013 - March 2017.

Coordinator: Morpho (France).

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

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

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

8.1.2.2. BLOC

Title: Analysis of block ciphers dedicated to constrained environments.

Type: ANR.

Duration: October 2013 - September 2015.

Coordinator: INSA-Lyon (France).

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

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

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

8.1.2.3. MOBILITICS

Title: MOBILITICS

Type: joint project.

Duration: January 2012 - Ongoing.

Coordinator: CNIL.

Others partners: CNIL.

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

8.1.2.4. CAPPRIS

Title: CAPPRIS

Type: Inria Project Lab

Duration: January 2011 - 2014.

Coordinator: PRIVATICS

Others partners: Inria (CIDRE, Comete, Secsi,Smis), Eurecom, LAAS and CRIDS

Abstract: Cappris (Collaborative Action on the Protection of Privacy Rights in the Information Society) is an Inria Project Lab initiated in 2013. The general goal of Cappris is to foster the collaboration between research groups involved in privacy in France and the interaction between the computer science, law and social sciences communities in this area.

8.2. European Initiatives

8.2.1. FP7 & H2020 Projects

8.2.1.1. PRIPARE

Title: PReparing Industry to Privacy-by-design by supporting its Application in REsearch

Programm: FP7

Duration: October 2013 - September 2015

Coordinator: France-Trialog

Inria contact: Daniel Le Métayer

The mission of PRIPARE is twofold: facilitate the application of a privacy and security-by-design methodology that will contribute to the advent of unhindered usage of Internet against disruptions, censorship and surveillance, support its practice by the ICT research community to prepare for industry practice; foster risk management culture through educational material targeted to a diversity of stakeholders. To this end PRIPARE will specify a privacy and security-by-design software and systems engineering methodology, using the combined expertise of the research community and taking into account multiple viewpoints (advocacy, legal, engineering, business), prepare best practices material (guidelines, patterns, success stories) for the development and implementation of products and services of ICT-based systems and use-cases in the area of cloud computing, mobile services and the management of cyber incidents, support FP7 and Horizon 2020 research projects through training workshops and practical support in applying PRIPARE best practices in their environment. It also provides educational material on approaches for risk management of privacy and create awareness on the need for risk management culture among users. Material consistent with PRIPARE methodology will be structured in a modular way in order to fit to different targets (policy makers, users, ICT students and professional). Identify gaps and provide recommendations on privacy and security-by-design practices, support of unhindered usage of Internet and on the creation of a risk management culture. A research agenda will be proposed. PRIPARE consists of a consortium of 11 partners with strong links with the privacy community (data protection authorities/policy makers, privacy advocacy organisations, technology, engineering). In order to prepare for the longer term adoption by the industry, a representative advisory board will be set up. The support action duration is 24 months.

8.2.2. Collaborations in European Programs, except FP7 & H2020

8.2.2.1. COPES

Title: COnsumer-centric Privacy in smart Energy gridS

Programm: CHISTERA

Duration: December 2015 - december 2018

Coordinator: KTH Royal Institute of Technology

Inria contact: Cédric Lauradoux

Smart meters have the capability to measure and record consumption data at a high time resolution and communicate such data to the energy provider. This provides the opportunity to better monitor and control the power grid and to enable demand response at the residential level. This not only improves the reliability of grid operations but also constitutes a key enabler to integrate variable renewable generation, such as wind or solar. However, the communication of high resolution consumption data also poses privacy risks as such data allows the utility, or a third party, to derive detailed information about consumer behavior. Hence, the main research objective of COPES is to develop new technologies to protect consumer privacy, while not sacrificing the "smartness", i.e., advanced control and monitoring functionalities. The core idea is to overlay the original consumption pattern with additional physical consumption or generation, thereby hiding the consumer privacy sensitive consumption. The means to achieve this include the usage of storage, small scale distributed generation and/or elastic energy consumptions. Hence, COPES proposes and develops a radically new approach to alter the physical energy flow, instead of purely relying on encryption of meter readings, which provides protection against third party intruders but does not prevent the use of this data by the energy provider.

8.3. Regional Initiatives

8.3.1. Privamov'

Title: Privamov'

Type: Labex IMU.

Duration: September 2013 - 2015.

Coordinator: LIRIS.

Others partners: EVS-ITUS, Inria Urbanets.

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

8.3.2. SCCyPhy

Title: SCCyPhy

Type: Labex Persyval.

Duration: September 2013 - 2015.

Coordinator: Institut Fourier.

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

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

8.3.3. AMNECYS

- Title: AMNECYS
- Duration: 2015 - .
- Coordinator: CESICE, UPMF.
- Others partners: Inria/Privatics and LIG/Moais, Gipsa-lab, LJK, Institut Fourier, TIMA, Vérimag, LISTIC (Pole MSTIC) .
- Abstract: Privatics participates to the creation of an Alpine Multidisciplinary Network on Cybersecurity Studies (AMNECYS). The academic teams and laboratories participating in this project have already developed great expertise on encryption technologies, vulnerabilities analysis, software engineering, protection of privacy and personal data, international & European aspects of cybersecurity. The first project proposal (ALPEPIC ALPs-Embedded security: Protecting Iot & Critical infrastructure) focuses on the protection of the Internet of Things (IoT) and Critical Infrastructure (CI).

SPADES Project-Team

8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. ANR Projects

8.1.1.1. REVER (ANR project)

Participant: Jean-Bernard Stefani.

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

The REVER work program is articulated around three major objectives:

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

The project partners are Inria (FOCUS and SPADES teams), Université de Paris VII (PPS laboratory), and CEA (List laboratory). The project ended in November 2015.

8.2. European Initiatives

8.2.1. Collaborations with Major European Organizations

We have a strong collaboration with the Technische Universität Braunschweig in Germany. In particular, Sophie Quinton actively participates in the CCC project (<http://ccc-project.org/>) to provide methods and mechanisms for the verification of software updates after deployment in safety-critical systems.

8.3. International Initiatives

8.3.1. Inria International Labs

Inria@SiliconValley

Associate Team involved in the International Lab:

8.3.1.1. RIPPES

Title: Rigorous Programming of Predictable Embedded Systems

International Partner (Institution – Laboratory – Researcher):

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

University of Auckland (New Zealand) – Electrical Computer Engineering Department (ECE) – Partha Roop

Start year: 2013

See also: <https://wiki.inria.fr/rippes>

The RIPPES associated teams gathers the SPADES team from Inria Grenoble Rhône-Alpes, the PTOLEMY group from UC Berkeley (EECS Department), and the Embedded Systems Research group from U. of Auckland (ECE Department). The planned research seeks to reconcile two contradictory objectives of embedded systems, more predictability and more adaptivity. We have addressed these issues by exploring two complementary research directions: (1) by starting from a classical concurrent C or Java programming language and enhancing it to provide more predictability (see Section 6.2.1), and (2) by starting from a very predictable model of computation (SDF) and enhancing it to provide more adaptivity (see Section 6.2.3).

8.3.2. Inria Associate Teams not involved in an Inria International Labs

8.3.2.1. Causalysis

Title: Causality Analysis for Safety-Critical Embedded Systems

International Partner (Institution – Laboratory – Researcher):

University of Pennsylvania (United States) – PRECISE center – Oleg Sokolsky

Start year: 2015

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

Today's embedded systems become more and more complex, while an increasing number of safety-critical functions rely on them. Determining the cause(s) of a system-level failure and elucidating the exact scenario that led to the failure is today a complex and tedious task that requires significant expertise. The CAUSALYSIS project will develop automated approaches to causality analysis on execution logs.

8.4. International Research Visitors

8.4.1. Visits of International Scientists

8.4.1.1. Internships

- Atena Abdi has been a visitor in the team from October 2015 to June 2016. She is doing her PhD at the Amirkabir University of Technology in Teheran, Iran. In the SPADES team, she is working on multi-criteria scheduling for real-time embedded systems, addressing the complex interplay between reliability, power consumption, temperature, and execution time (see 6.3.2).
- Ismail Assayad has been a visitor in the team in September 2015. He is assistant professor at the University of Casablanca, Morocco. In the SPADES team, he is working on adaptive scheduling methods and admission control for dynamic embedded applications (see 6.3.2).

BIPOP Project-Team

8. Partnerships and Cooperations

8.1. Regional Initiatives

- Project eBacuss from the Persyval Labex, with C. Prieur (GIPSA Lab), B. Bidegarray (LJK Grenoble), L. Fesquet (TIMA Grenoble).

8.2. National Initiatives

8.2.1. ANR

- CHASLIM Chattering Free Sliding Mode Control: ANR BLAN 2011 BS03 007 01 (octobre 2011–octobre 2015), coordinator B. Brogliato.
- SLOFADYBIO Slow-fast dynamics applied to the biosciences (january 2015 – december 2016), coordinateur: Mathieu Desroches (Inria Rocquencourt).

8.3. European Initiatives

8.3.1. FP7 & H2020 Projects

8.3.1.1. GEM

Title: from GEometry to Motion, inverse modeling of complex mechanical structures

Programm: H2020

Type: ERC

Duration: September 2015 - September 2020

Coordinator: Inria

Inria contact: Florence Bertails-Descoubes

With the considerable advance of automatic image-based capture in Computer Vision and Computer Graphics these latest years, it becomes now affordable to acquire quickly and precisely the full 3D geometry of many mechanical objects featuring intricate shapes. Yet, while more and more geometrical data get collected and shared among the communities, there is currently very little study about how to infer the underlying mechanical properties of the captured objects merely from their geometrical configurations. The GEM challenge consists in developing a non-invasive method for inferring the mechanical properties of complex objects from a minimal set of geometrical poses, in order to predict their dynamics. In contrast to classical inverse reconstruction methods, my proposal is built upon the claim that 1/ the mere geometrical shape of physical objects reveals a lot about their underlying mechanical properties and 2/ this property can be fully leveraged for a wide range of objects featuring rich geometrical configurations, such as slender structures subject to frictional contact (e.g., folded cloth or twined filaments). To achieve this goal, we shall develop an original inverse modeling strategy based upon a/ the design of reduced and high-order discrete models for slender mechanical structures including rods, plates and shells, b/ a compact and well-posed mathematical formulation of our nonsmooth inverse problems, both in the static and dynamic cases, c/ the design of robust and efficient numerical tools for solving such complex problems, and d/ a thorough experimental validation of our methods relying on the most recent capturing tools. In addition to significant advances in fast image-based measurement of diverse mechanical materials stemming from physics, biology, or manufacturing, this research is expected in the long run to ease considerably the design of physically realistic virtual worlds, as well as to boost the creation of dynamic human doubles.

8.3.1.2. *COMANOID*

Title: Multi-contact Collaborative Humanoids in Aircraft Manufacturing

Programm: H2020

Duration: January 2015 - January 2019

Coordinator: CNRS (Lirmm)

Partners:

Airbus Groups (France)

Centre national de la recherche scientifique (France)

Deutsches Zentrum für Luft - und Raumfahrt Ev (Germany)

Universita Degli Studi di Roma Lapienza (Italy)

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.

8.4. International Initiatives

8.4.1. *Inria International Labs*

Vincent Acary is on leave at Inria Chile from September 2014 to August 2016.

8.4.2. *Inria International Partners*

8.4.2.1. *Informal International Partners*

We lead collaborations with several foreign colleagues:

- Prof. Ryo Kikuuwe from Kyushu University, Japan.
- Prof. C. Liu from Peking University (PKU), Beijing, China [34].
- Prof. Thorsten Schindler from Munich Technical University.
- Prof. Nathan Krislock from North Illinois University [51].
- Prof. Yuli Starosvetsky, Technion Israel Institute of Technology.

8.4.3. Participation In other International Programs

Y. Starosvetsky (Technion, PI) and G. James (Co-PI) have been awarded a grant from the Pazi Foundation (Israel) on a 4-years project (2015-19) entitled *Experimental, computational and analytical study of wave propagation in 1D and 2D granular crystals mounted on the non-uniform elastic foundation with spatially and temporarily varying properties.*

8.5. International Research Visitors

8.5.1. Visits of International Scientists

8.5.1.1. Internships

- Professor Ryo Kikuuwe from Kyushu University (Japan) visited BIPOP from 01 September 2014 to 31 March 2016.
- Professor Nathan Krislock from North Illinois University visited BIPOP in June/July 2015.

8.5.2. Visits to International Teams

8.5.2.1. Sabbatical programme

Acary Vincent

Date: Sep 2014 - Aug 2016

Institution: **CMM** (Chile)

MISTIS Project-Team

9. Partnerships and Cooperations

9.1. Regional Initiatives

- **PERSYVACT projects.**

MISTIS is involved in the 3-year project-team Oculo Nimbus, funded (250 keuros for the whole project) by the PERSYVAL labex (<https://persyval-lab.org/en>), with other teams from local laboratories, LJK, GIPSA-Lab and LPNC. The goal of this research project is to develop tools for analyzing eye-movement data.

MISTIS is also involved in another action (2015-2018) recently granted Persyvact2 action supported by the Persyval Labex for 3.5 years. This project is a follow-up of the Persyvact Exploratory labex project. Persyvact2 consists of about 20 researchers from different laboratories, GIPSA-lab, LJK and TIMC-IMAG and different fields related to data science (statistics, machine learning, image and signal processing). Our contribution and involvement will lie essentially in a Graph signal processing work package with application in neuroscience for which we are planning to hire a PhD student with S. Achard (GIPSA-Lab). Persyvact2 also intends to organize scientific events and an international workshop during its lifetime. Persyvact2 will contribute, with other teams of Persyval, to enhance the international visibility of data science in Grenoble. The financial support for the consortium is of 250 keuros.

- **Grenoble Pole Cognition (2013-15).** We received in 2015 2.5 keuros from the Grenoble Pole Cognition, <http://www.grenoblecognition.fr/>, for collaborative projects involving the GIN and the Pixyl startup. This funding was used this year for the internship of Priscillia Previtero on brain MRI analysis.
- MISTIS participates in the weekly statistical seminar of Grenoble. Jean-Baptiste Durand is in charge of the organization and several lecturers have been invited in this context.

9.2. National Initiatives

9.2.1. *Defi Imag'IN CNRS*

Defi Imag'IN MultiPlanNet (2015-2016). This is a 2-year project to build a network for the analysis and fusion of multimodal data from planetology. There are 8 partners: IRCCYN Nantes, GIPSA-lab Grenoble, IPAG Grenoble, CEA Saclay, UPS Toulouse, LGL Lyon1, GEOPS University Orsay and Inria Mistis. F. Forbes is in charge of one work package entitled *Massive inversion of multimodal data*. Our contribution will be based on our previous work in the VAHINE project on hyperspectral images and recent developments on inverse regression methods made in the HUMAVIPS project. The CNRS support for the network is of 20 keuros.

9.2.2. *GDR Madics*

Apprentissage, optimisation à Large-échelle et calcul distribué (ATLAS). Mistis is participating to this action supported by the GDR in 2016 (3 keuros).

9.2.3. *Networks*

MSTGA and AIGM INRA (French National Institute for Agricultural Research) networks: F. Forbes is a member of the INRA network called AIGM (ex MSTGA) network since 2006, <http://carlit.toulouse.inra.fr/AIGM>, on Algorithmic issues for Inference in Graphical Models. It is funded by INRA MIA and RNSC/ISC Paris. This network gathers researchers from different disciplines. F. Forbes co-organized and hosted 2 of the network meetings in 2008 and 2015 in Grenoble.

9.3. European Initiatives

9.3.1. FP7 & H2020 Projects

European H2020 RESSTORE (2015-2018). F. Forbes is involved in this multi-center Stroke European H2020 project including 20 partners. F. Forbes will contribute through the Pixyl startup which will receive 70 keuros as a subcontractor. RESSTORE stands for REgenerative Stem cell therapy for STroke in Europe. It is part of the Clinical research on regenerative medicine program. It will involve a phase 2 trial with 300 patients imaged at 4 time points over a 3 year timeframe. Pixyl will provide automatic stroke lesion segmentations.

9.4. International Initiatives

9.4.1. Inria International Labs

LIRIMA

Associate Team involved in the International Lab:

9.4.1.1. SIMERGE

Title: Statistical Inference for the Management of Extreme Risks and Global Epidemiology

International Partner (Institution - Laboratory - Researcher):

UGB (Senegal) - LERSTAD - Abdou Kâ Diongue

Start year: 2015

See also: <http://mistis.inrialpes.fr/simerge>

The objective of the associate team is to federate some researchers from LERSTAD (Laboratoire d'Etudes et de Recherches en Statistiques et Développement, Université Gaston Berger) and Mistis (Inria Grenoble Rhône-Alpes). The associate team will consolidate the existing collaborations between these two laboratories. Since 2010, the collaborations have been achieved through the co-advising of two PhD theses. They have led to three publications in international journals. The associate team will also involve statisticians from EQUIPPE laboratory (Economie QUantitative Intégration Politiques Publiques Econométrie, Université de Lille) and associated members of Modal (Inria Lille Nord-Europe) as well as an epidemiologist from IRD (Institut de Recherche pour le Développement) at Dakar. We aim at developing two research themes: 1) Spatial extremes with application to management of extreme risks and 2) Classification with application to global epidemiology.

9.4.2. Inria International Partners

9.4.2.1. Informal International Partners

The context of our research is also the collaboration between MISTIS and a number of international partners such as the Statistics Department of University of Washington in Seattle, the Russian Academy of Science in Moscow, and more recent partners like IDIAP involved in the past HUMAVIPS project, Université Gaston Berger in Senegal and Universities of Melbourne and Brisbane in Australia. We also work at turning other current European contacts, *e.g.* at EPFL (A. Roche at University Hospital Lausanne and Siemens Healthcare), into more formal partnerships.

The main international collaborations that we are currently trying to develop are with:

- Fabrizio Durante, Free University of Bozen-Bolzano, Italy.
- K. Qin and D. Wraith from RMIT in Melbourne, Australia and Queensland University of Technology in Brisbane, Australia.
- E. Deme and S. Sylla from Gaston Berger university and IRD in Senegal.
- Alexandre Nazin and Russian Academy of Science in Moscow, Russia.
- Alexis Roche and University Hospital Lausanne/Siemens Healthcare, Advanced Clinical Imaging Technology group, Lausanne, Switzerland.

9.5. International Research Visitors

9.5.1. Visits of International Scientists

9.5.1.1. Researchers

- Seydou Nourou Sylla (Université Gaston Berger, Sénégal) has been hosted by the MISTIS team for four months.
- El Hadji Deme has been hosted by the MISTIS team for 3 weeks.
- Abdelhakim Necir (University Biskra, Algeria) has been hosted for 2 weeks.

9.5.1.2. Internships

Sebastian Torres Leiva (Master, from Feb 2015 until June 2015)

Subject: Extreme value modelling of some glacial processes in Chilean Andes.

Institution: UTFSM - Universidad Tecnica Federico Santa Maria, Valparaiso, Chile

NANO-D Project-Team

8. Partnerships and Cooperations

8.1. Regional Initiatives

We have funding from the Rhone-Alpes region through an ARC6 grant for the development of parallel algorithms for adaptively restrained particle simulations. This grant is funding Krishna Kant Singh's PhD project.

8.2. National Initiatives

8.2.1. ANR

In 2015, NANO-D had funding from one ANR program:

- **ANR Modeles Numeriques (MN)**: 180,000 Euros over four years (2011-2015). This project, coordinated by NANO-D (S. Grudinin), gathers biologists and computer scientists from three research groups: Dave Ritchie at LORIA, Valentin Gordeliy at IBS (total grant: 360,000 Euros).

8.3. European Initiatives

8.3.1. FP7 & H2020 Projects

8.3.1.1. ADAPT

Type: ERC Starting Grant

Title: Theory and Algorithms for Adaptive Particle Simulation

Programm: FP7

Duration: September 2012 - August 2017

Coordinator: Inria

Inria contact: Stephane Redon

8.4. International Initiatives

8.4.1. Inria Associate Teams not involved in an Inria International Labs

8.4.1.1. PPI-3D

Title: Structure Meets Genomics

International Partner (Institution - Laboratory - Researcher):

Boston University (United States) - Dima Kozakov

Start year: 2015

See also: <https://team.inria.fr/nano-d/research/ppi-3d-structure-meets-genomics/>

Protein–protein interactions are integral to many mechanisms of cellular control, and therefore their characterization has become an important task for both experimental and computational approaches in systems biology. Genome-wide proteomics studies provide a growing list of putative protein-protein interactions, and demonstrate that most if not all proteins have interacting partners in the cell. A fraction of these interaction has been reliably established, however, one can only identify whether two proteins interact and, in the best cases, which are the individual domains mediating the interaction. A full comprehension of how proteins bind and form complexes can only come from high-resolution three-dimensional structures. While the most complete structural characterization of a complex is provided by X-ray crystallography, protein-protein hetero-complexes constitute less than 6% of protein structures in the Protein Data Bank. Thus, it is important to develop computational methods that, starting from the structures of component proteins, can determine the structure of their complexes.

The basic problem of predictive protein docking is to start with the structures (or sequences) of unbound component proteins A and B, and to obtain computationally a model of the bound complex AB, as detailed structural knowledge of the interactions facilitates understanding of protein function and mechanism. Our current docking approaches performs ab initio docking of the two structures without the use of any additional information. The goal of this proposal is to speed up docking approaches to tackle genome-scale problems, and utilize additional information on interactions, sequences, and structures that is available for virtually any protein.

This project includes several methodological and application research directions: 1) Developing fast sampling approaches; 2) Development of new scoring functions; 3) Integrative approaches for structure determination.

Overall, during the course of the project we will (i) jointly develop new methodology and algorithms in the field of genomic-scale protein complex prediction; (ii) provide server-based applications built upon services of the Boston team; (iii) and finally develop modular applications coded inside the SAMSON software platform created by the Inria team.

8.4.2. Inria International Partners

8.4.2.1. Informal International Partners

- The Reihher group at ETH Zurich
- The Cherezov Lab, UCS USA
- The Katritch Lab, UCS USA
- ICS-5 FZJ Juelich, Juelich, Germany
- Laboratory for Advanced Studies of Membrane Proteins, MIPT, Moscow, Russia Laboratory of Structural Biology of G-protein Coupled Receptors, MIPT Moscow, Russia

8.5. International Research Visitors

8.5.1. Visits of International Scientists

8.5.1.1. Internships

Aleksandr Katrutsa.

Subject: Convex relaxation for non-convex quadratic optimization problems with applications to side-chain prediction in protein structures.

Institution: MIPT Moscow, Russia.

8.5.2. Visits to International Teams

8.5.2.1. Research stays abroad

- Emilie Neveu visited the Kozakov group at Stony Brook University, NY, USA for three weeks in November 2015.
- Alexandre Hoffmann visited the Kozakov group at Stony Brook University, NY, USA for two weeks in November 2015.

NECS Project-Team

9. Partnerships and Cooperations

9.1. National Initiatives

9.1.1. PEPS META-TRAM

META-TRAM is a PEPS-CNRS project funded for two years (2013-2015). It aims at studying tensor methods for analyzing traffic data. Indeed, for a better management of mobility in modern cities (avoid or better control episodes of congestion, accurately predict traffic trends, finely analyze urban and suburban trips via multimodal networks), it is necessary to develop appropriate analytic tools that integrate multimodality and heterogeneity of networks from inherently multidimensional measures. Three areas are studied: tensor modeling for estimating origin-destination matrices, dynamic clustering flow and synthesis of distributed algorithms adapted to large volume of data, diversity of sensors, and their spatial dispersion. This project involves also I3S Lab (Sophia Antipolis) and CRAN (Nancy).

9.1.2. *Projet exploratoire Persyval LOCATE-ME*

LOCATE-ME (LOcalization teChniques for pedestriAn navigaTion based on inErtial MEasurements in indoor environments) is a Persyval project funded from April 2014 to August 2015. It aims at proposing a new and fresh look on innovative technologies for localization. It constructs the scientific foundations for development of a prototype of a pedestrian indoor localization system, which has the ability to monitor and track the positions of pedestrians in an indoor environment, where GPS is not available. LOCATE-ME brings some answers on how to advance the current pedestrian navigation solutions for the critical domains, using robust software. The specific contribution of LOCATE-ME is the development of a novel fusion algorithm merging two different methods of localization (INS and SHS) to obtain a concrete improvement on tracking position. This project involves also Tyrex team (LIG, Inria Grenoble). The collaboration has also included a visit to Grenoble of Valérie Renaudin (IFSTTAR, Nantes), in March 2015.

9.2. European Initiatives

9.2.1. FP7 & H2020 Projects

9.2.1.1. *SPEEDD (Scalable Proactive Event-Driven Decision making)*

Type: STREP

Objective: ICT-2013.4.2a – Scalable data analytics – Scalable Algorithms, software frameworks and viualisation

Duration: Feb. 2014 to Jan. 2017.

Coordinator: National Centre of Scientific Research ‘Demokritos’ (Greece)

Partners: IBM Israel, ETH Zurich (CH), Technion (Israel), Univ. of Birmingham (UK), NECS CNRS (France), FeedZai (Portugal)

Inria contact: C. Canudas de Wit

Abstract: SPEEDD is developing a prototype for robust forecasting and proactive event-driven decision-making, with on-the-fly processing of Big Data, and resilient to the inherent data uncertainties. NECS leads the intelligent traffic-management use and show case.

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

9.3. International Initiatives

9.3.1. *Inria International Labs*

Inria@SiliconValley

Associate Team involved in the International Lab:

9.3.1.1. COMFORT

Title: Control and Forecasting in Transportation networks

International Partner (Institution - Laboratory - Researcher):

University of California Berkeley (United States) - Mechanical Engineering - Roberto Horowitz

Start year: 2014

See also: http://necs.inrialpes.fr/v2/pages/comfort/EA_homepage_COMFORT.html

COMFORT addresses open issues for Intelligent Transportation Systems (ITS). The goal of these systems is to use information technologies (sensing, signal processing, machine learning, communications, and control) to improve traffic flow, as well as enhance the safety and comfort of drivers. It has been established over the past several decades, through field studies and many scholarly publications, that the tools of ITS can significantly improve the flow of traffic on congested freeways and streets. Traffic operators can manage the system in a top-down fashion, for example, by changing the speed limit on a freeway, or by controlling the flow on the onramps (ramp metering). Individual drivers can also affect traffic conditions from the bottom up, by making decisions based on reliable predictions. These predictions must be provided by a centralized system that can evaluate the decisions based on global information and sophisticated modeling techniques. It is now crucial to develop efficient algorithms for control and prediction that are well adapted to current and emerging sensing and communication technologies. The areas of traffic modeling and calibration, state estimation, and traffic control remain central to this effort. Specifically, COMFORT addresses issues related to model validation and development of new traffic forecasting and distributed control algorithms. The efficiency of the derived methods will be assessed using large networks simulators and real data obtained from the Californian and the Grenoble's testbed.

9.3.2. Participation In other International Programs

9.3.2.1. TICO-MED

TicoMed (Traitement du signal Traitement numérique multidimensionnel de l'Information avec applications aux Télécommunications et au génie Biomédical) is a French-Brazilian project funded by CAPES-COFECUB. It started in February 2015 with University of Nice Sophia Antipolis (I3S Laboratory), CNAM, SUPELEC, University of Grenoble Alpes (Gipsa-Lab), Universidade Federal do Ceara, Universidade Federal do Rio de Janeiro, and Universidade Federal do Santa Catarina as partners.

9.4. International Research Visitors

9.4.1. Visits of International Scientists

- Prof. Subrahkany Dey (University of Uppsala, Sweden) visited the team from June 6th to July 7th, for research discussions, in particular with F. Garin and A. Kibangou on privacy issues in cyber-physical systems.
- Prof. Gerhard Hancke (Dept of Electrical, Electronic and Computer Engineering, University of Pretoria, South Africa) visited the team and the Doctoral college of UGA in order to set up student exchange program in July 2015.
- Prof. Paolo Frasca (University of Twente, Enschede, The Netherlands) visited the team for two weeks in October, for research discussions with team members, and in particular with C. Canudas de Wit on open problems in social dynamics related to traffic drivers.
- Prof. Joao Cesar Moura Mota (Universidade Federal do Ceara, Brazil) visited the team in December 2015 within the framework of the French-Brazilian CAPES-COFECUB project TICO-MED.

9.4.1.1. Internships

- Tomas Manuel Pippia from University of Pavia, Italy, made his research internship for his master thesis in the team, from March to July.

9.4.2. Visits to International Teams

9.4.2.1. Research stays abroad

- A. Kibangou visited UC Berkeley during the BIS workshop (Berkeley-Inria-Stanford, May 12-15). During this stay, A. Kibangou participated as a member for the panel dedicated to Urban mobility. He had discussions with G. GOMES (UC Berkeley) on different topics about traffic including flow prediction and interfacing traffic micro-simulator such as AIMSUM with Matlab.
- C. Canudas de Wit visited UC Berkeley for a week in October. He had research meetings with faculty and students at ITS and PATH, and in particular with prof. Horowitz and dr. Gomes. On Oct 23rd he gave an invited lecture at Institute of Transportation Studies (ITS) and the Transportation Program of the Civil and Environmental Engineering Department at the University of California, Berkeley, in the ITS transportation seminar program.
- Various team members attended the IPAM Long Program New Directions in Mathematical Approaches for Traffic Flow Management (<http://www.ipam.ucla.edu/programs/long-programs/new-directions-in-mathematical-approaches-for-traffic-flow-management>), at UCLA, Los Angeles. IPAM long programs are a collection of one-week workshops, intertwined with study periods, where participants are encouraged to pursue their own research while interacting with other participants.
 - A. Ladino, 26 Sept. to 24 Oct. (Workshops I Mathematical Foundations of Traffic and II Traffic Estimation, and a study period)
 - P. Grandinetti, 25 Oct. to 20 Nov. (Workshops III Traffic Control and IV Decision Support for Traffic, and a study period)
 - C. Canudas de Wit, Oct. 10-16 and 25-31 (Workshops II Traffic Estimation and III Traffic Control)
 - F. Garin, Oct. 25-30 (Workshop III Traffic Control)

AIRSEA Team

9. Partnerships and Cooperations

9.1. Regional Initiatives

- Clémentine Prieur is a member of the project "Soutien à l'Excellence et à l'Innovation Grenoble INP MEPIERA (METHodologies innovantes Pour l'Ingénierie de l'Eau et des Risques Associés) led by A.- C. Favre (LTHE).
- N. Feyeux PhD is sponsored by the action ARC3 Environment of the Region Rhone-Alpes.

9.2. National Initiatives

9.2.1. ANR

- A 3.5 year ANR contract: ANR CITiES (numerical models project selected in 2012). <https://team.inria.fr/steep/projects/>
- A 4-year ANR contract: ANR TOMMI (Transport Optimal et Modèles Multiphysiques de l'Image), see paragraphs 7.4.2 ,7.4 .
- A 5 year ANR contract (2011-2016): ANR COMODO (Communauté de Modélisation Océanographique) on the thematic "Numerical Methods in Ocean Modelling". (coordinator L. Debreu) 7.1.2

9.2.2. Other Initiatives

- A. Vidard leads a group of projects gathering multiple partners in France and UK on the topic "Variational Data Assimilation for the NEMO/OPA9 Ocean Model", see 6.3 .
- C. Prieur chairs GdR MASCOT NUM, in which are also involved M. Nodet, E. Blayo, C. Helbert, E. Arnaud, L. Viry, S. Nanty, L. Gilquin. <http://www.gdr-mascotnum.fr/doku.php>
- C. Prieur is the leader of the LEFE/MANU project MULTIRISK (2014-2016) on multivariate risk analysis, which gathers experts from Lyon 1 University, CNAM, LSCE and Grenoble University mainly.
- E.Kazantsev, E.Blayo, F. Lemarié participate in the project "PACO - Vers une meilleure paramétrisation de la côte et des conditions limites dans les modèles d'océan" supported by LEFE-GMMC and LEFE-MANU .

9.3. European Initiatives

9.3.1. FP7 & H2020 Projects

9.3.1.1. ERA-CLIM2

Type: COOPERATION

Instrument: Specific Targeted Research Project

Program: Collaborative project FP7-SPACE-2013-1

Project acronym: ERA-CLIM2

Project title: European Reanalysis of the Global Climate System

Duration: 01/2014 - 12/2016

Coordinator: Dick Dee (ECMWF, Europe)

Other partners: Met Office (UK), EUMETSAT (Europe), Univ Bern (CH), Univ. Vienne (AT), FFCUL (PT), RIHMI-WDC (RU), Mercator-Océan (FR), Météo-France (FR), DWD (DE), CER-FACS (FR), CMCC (IT), FMI (FI), Univ. Pacifico (CL), Univ. Reading (UK), Univ. Versailles St Quentin en Yvelines (FR)

Inria contact: Arthur Vidard

9.3.2. Collaborations with Major European Organizations

Partner: European Centre for Medium Range Weather Forecast. Reading (UK)

World leading Numerical Weather Center, that include an ocean analysis section in order to provide ocean initial condition for the coupled ocean atmosphere forecast. They play a significant role in the NEMOVAR project in which we are also partner.

Partner: Met Office (U.K) National British Numerical Weather and Oceanographic service. Exeter (UK).

We do have a strong collaboration with their ocean initialization team through both our NEMO, NEMO-ASSIM and NEMOVAR activities. They also are our partner in the NEMOVAR consortium.

Partner: University of Reading, Department of Meteorology, Department of Mathematics

Subject: Data assimilation for geophysical systems.

9.4. International Initiatives

C. Prieur collaborates with Jose R. Leon (UCV, Central University of Caracas).

C. Prieur is leader of a project ECOS Nord with Venezuela (2012-2015).

9.5. International Research Visitors

9.5.1. Visits of International Scientists

Jose-Raphael Leon-Ramos, Caracas University, has been granted by the Inria international chair.

Victor Shutyaev, Russian Academy of Sciences, 2 weeks.

Pierre Ngnepieba, Florida Agricultural & Mechanical University, 2 weeks.

9.5.2. Visits to International Teams

F-X Le Dimet has been invited two times by the Department of Mathematics at Florida State University (one week in April and 2 weeks in october). In USA he was also invited at NASA Stennis Space center (Mississippi) by NRL (Navy Resarch lab) He delivered seminars in this place.

F-X Le Dimet has been invited by Nanjing University (Department of Meteoroly) , one week in May 2015 to give a 6 -hours tutorial on Variational Data Assimilation.

F-X. Le Dimet and E.Kazantsev were invited by the Institute of Numerical Mathematics of the Russian Academy of Sciences to present a communication at the G.Marchuk's memorial jubilee [34].

F-X. Le Dimet has presented a communication at the SIAM meetng on Scientific Computing held in Salt Lake city in April 2015

BEAGLE Project-Team

8. Partnerships and Cooperations

8.1. Regional Initiatives

- Intracell X Evo, projet LABEX ECOFECT. Leaders: Thomas Henry, CIRI, Lyon, and Eric Tannier, Beagle. Other partner : Dominique Schneider, laboratoire Adaptation et pathogénie des Microorganismes, Grenoble. Duration: 3 years The objective of the project is to understand the host-pathogen interactions in the cytosol by an experimental evolution approach. Funding: 120 000 Euros.

8.2. National Initiatives

8.2.1. ANR

- Ancestrome: phylogenetic reconstruction of ancestral "-omes", a five-year project (2012-2017), call "Bioinformatics" of the "Investissements d'avenir". Supervisor: V Daubin (CNRS, LBBE, Lyon) ; with Institut Pasteur, ENS Paris, ISEM (Univ Montpellier 2) Participant: E Tannier.
- Aucomsi (2013-2016) (Models of the vocal tract to study auditory circuits): a 4-year project (2013-2016) funded by a grant from the ANR-NSF-NIH Call for French-US Projects in Computational Neuroscience. With F. Theunissen, UC Berkeley, CA, USA. Supervisor: H. Soula (for France) and F. Theunissen (for US). Participants: H. Soula, M. Fernandez.
- Dopaciumcity: Dopamine modulation of calcium influx underlying synaptic plasticity, a 4-year project (2014-2017) funded by a grant from the ANR-NSF-NIH Call for French-US Projects in Computational Neuroscience. With L. Venance, College de France, CIRB, CNRS/UMR 7241 - INSERM U1050, Paris, France and K Blackwell, Krasnow Institute of Advanced Studies, George Mason University, Fairfax, VA, USA. Supervisor: L Venance (for France) and K.L. Blackwell (for US). Participants: H Berry, I Prokin, A Foncelle

8.3. European Initiatives

8.3.1. FP7 & H2020 Projects

8.3.1.1. *EvoEvo*

Title: Evolution of Evolution

Programm: FP7

Duration: November 2013 - October 2016

Coordinator: Inria

Partners:

Agencia Estatal Consejo Superior de Investigaciones Cientificas (Spain)

Institut National des Sciences Appliquees de Lyon (France)

Universite Lyon 1 Claude Bernard (France)

Universite Joseph Fourier Grenoble 1 (France)

Universiteit Utrecht (Netherlands)

University of York (United Kingdom)

Inria contact: Guillaume Beslon

Evolution is the major source of complexity on Earth, at the origin of all the species we can observe, interact with or breed. On a smaller scale, evolution is at the heart of the adaptation process for many species, in particular micro-organisms (e.g. bacteria, viruses...). Microbial evolution results in the emergence of the species itself, and it also contributes to the organisms' adaptation to perturbations or environmental changes. These organisms are not only organised by evolution, they are also organised to evolve. The EvoEvo project will develop new evolutionary approaches in information science and will produce algorithms based on the latest understanding of molecular and evolutionary biology. Our ultimate goal is to address open-ended problems, where the specifications are either unknown or too complicated to express, and to produce software able to operate in unpredictable, varying conditions. We will start from experimental observations of micro-organism evolution, and abstract this to reproduce EvoEvo, in biological models, in computational models, and in application software. Our aim is to observe EvoEvo in action, to model EvoEvo, to understand EvoEvo and, ultimately, to implement and exploit EvoEvo in software and computational systems. The EvoEvo project will have impact in ICT, through the development of new technologies. It will also have impact in biology and public health, by providing a better understanding of micro-organism adaptation (such as the emergence of new pathogens or the development of antibiotic resistances).

8.3.1.2. *Neuron-Astro-Nets*

Title: Neuron-Astro-Nets

Programm: Marie-Curie International Outgoing Fellowship (IOF) grant FP7

Duration: 2013 - October 2017

Coordinator: Inria

Partners:

Inria (France)

Dept Statistics and Neurobiology, University of Chicago (USA)

Inria contact: Hugues Berry

This project aims at developing a new model of synaptic plasticity that takes into account astrocyte signaling, its extension to astrocytes-synapse biochemical interactions in ensembles of synapses enwrapped by the same astrocyte and, eventually, to the firing of a single neuron or networks. The project funds Maurizio De Pitta's postdoc for 4 years (June 2013- May 2017). M. De Pitta has first spent one year in Beagle, Lyon funded by an EU ERCIM grant (06/2013-05/2014) then two years in N. Brunel's Lab in Chicago (06/2014-05/2016) and one year back in Beagle in Lyon (06/2016-05/2017). The IOF grant funds the last three years.

8.4. International Initiatives

8.4.1. *Inria International Partners*

8.4.1.1. *Informal International Partners*

Beagle collaborates with two american laboratories: the Theunissen Lab (UC Berkeley, CA, <http://theunissen.berkeley.edu/publications.html>) and the Blackwell lab (George Mason Univ., VA, <http://krasnow1.gmu.edu/CENlab/index.html>). Those labs are the partners of the two ANR-NSF-NIH grants we were awarded (cf "ANR" section above).

8.4.2. *Participation In other International Programs*

The Beagle team is part of the LIA (Laboratoire International Associé) EvoAct (Evolution in action with living and artificial organisms). EvoAct is a joint laboratory gathering researchers from Dominique Schneider team (UJF, LAPM, UMR CNRS 5163, France), Rich Lenski team (Michigan State University, Beacon center, US) and the Beagle team.

8.5. International Research Visitors

8.5.1. Visits of International Scientists

8.5.1.1. Internships

- Priscila Biller did a one year doctoral internship in Beagle, ending in April 2015
- Jaap Rutten started his internship in the Beagle team in December 2015. Jaap Rutten is a M2 student from the Utrecht University (NL).

8.5.2. Visits to International Teams

8.5.2.1. Research stays abroad

Eric Tannier has spent one month in July 2015 at Simon Fraser University in Vancouver, Canada.

DRACULA Project-Team

8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. ANR

Projects coordination by a member of Dracula

- ANR STOCHAGENE "Role of the chromatin dynamics on the stochasticity in gene expression in higher eukaryotic cells", 2011-2015.
Participant: Olivier Gandrillon [Coordinator].

Collaboration in other projects

- ANR RPIB PrediVac "Innovative modeling tools for the prediction of CD8 T cell based vaccine efficacy", 2013-2016. Partners: U1111 Inserm (J. Marvel, coordinator), Dracula, Altrabio (small company), CoSMo (small company). For Dracula, the budget from 2013 to 2016 is 198 keuros, including three one-year post-doc positions (one post-doc has been recruited in April 2014 (Xuefeng Gao)), and the members are Fabien Crauste and Olivier Gandrillon.
- Thomas Lepoutre participates in the ANR (jeunes chercheurs) MODPOL (head Vincent Calvez (ENS Lyon)) "Cell polarization modeling", 2011-2015.
- Thomas Lepoutre is a member of the ANR KIBORD (head L. Desvillettes) dedicated to "kinetic and related models in biology". 2012-2016.
- Thomas Lepoutre is a member of the ERC MESOPROBIO (head V. Calvez) dedicated to "Mesoscopic models for propagation in biology". 2015-2020.
- Olivier Gandrillon participates in the ANR (Investissement d'Avenir) Iceberg (head Gregory Batt (Inria)) "From population models to model populations: single cell observation, modeling, and control of gene expression".

8.1.2. Other projects

- Inria ADT : SiMuScale "Simulations Multi-Échelles de Populations Cellulaires", 2014-2016.
Participants: Samuel Bernard [Coordinator], Fabien Crauste, David Parsons.
- Association France Alzheimer Sciences Médicales 2014-2015 : PAMELA "Prion et Alzheimer : Modélisation et Expérimentation d'une Liaison Agressive", 2014-2015. Partners: UR0892 VIM (Virologie et Immunologie Moléculaires), INRA Domaine de Vilvert, Jouy-en-Josas.
Participants: Mostafa Adimy, Samuel Bernard, Thomas Lepoutre, Laurent Pujo-Menjouet [Coordinator], Léon Tine.

8.2. European Initiatives

8.2.1. Collaborations in European Programs, except FP7 & H2020

- Research program PHC POLONIUM (2014-2015) "Applications of reaction-diffusion equations in biology and medicine". Partners: Warsaw, Poland (Slawomir Bialecki, Jolanta Ciesielska, Bogdan Kazmierczak (coordinator), Marek Kochanczyk, Tomasz Lipniacki).
Participants: Mostafa Adimy, Abdennasser Chekroun, Laurent Pujo-Menjouet [Coordinator], Alen Tosenberger, Vitaly Volpert.

8.2.2. Collaborations with Major European Organizations

- University of Valladolid (Spain). Collaboration with Oscar Angulo, Juan Carlos Lopez-Marcos and Miguel Ange Lopez-Marcos, on the analysis of an age-structured model describing erythropoiesis, and its numerical resolution.
- Karolinska University Hospital of Stockholm (Sweden). Collaboration with Peter Arner, Mats Eriksson, Erik Arner, Mikael Rydén and Kirsty L. Spalding, on the study of dynamics of human adipose lipid turnover in health and metabolic disease.

8.3. International Initiatives

8.3.1. Inria Associate Teams not involved in an Inria International Labs

8.3.1.1. Modelling leukemia

Title: Modeling quiescence and drug resistance in Chronic Myeloid Leukemia

International Partner (Institution - Laboratory - Researcher):

Center for Scientific Computation And Mathematical Modelling, University of Maryland (United States).

Duration: 2013 - 2015.

See also: http://dracula.univ-lyon1.fr/modelling_leukemia.php

Leukemia is the most famous disease of the blood cell formation process (hematopoiesis). Chronic myeloid leukemia results in an uncontrolled proliferation of abnormal blood cells. As the hematopoiesis involves stem cells (not accessible to observations), mathematical modeling is here a great tool to test hypothesis. We will join the expertise of Inria team DRACULA specialized on the modeling of blood cell formation and the Center for Scientific Computation and Applied Mathematical Modeling (CSCAMM, University of Maryland, College Park). The theoretical and modeling experience of team DRACULA and the numerical expertise combined with the links with experimentalists of members of CSCAMM will allow us to study deeply evolution of leukemia. We will especially focus on the behavior of leukemic stem cells and their possibility of becoming quiescent (dormant). Then we will study (using the knowledge obtained on leukemic stem cells) the phenomenon of drug resistance and its propagation over time and finally the mechanisms of multidrug resistance.

8.3.2. Participation In other International Programs

8.3.2.1. M3CD

Program: [Euromediterranean 3+3](#)

Title: Mathematical Models and Methods in Cell Dynamics

Inria principal investigator: Mostafa Adimy

International Partners (Institution - Laboratory - Researcher):

Institut Pasteur de Tunis (Tunisia) - Slimane Ben Miled

Consiglio Nazionale delle Ricerche- Istituto per le Applicazioni del Calcolo Mauro Picone (Italy) - Istituto per le Applicazioni del Calcolo Mauro Picone - Roberto Natalini

Cadi Ayyad University (Morocco) - Populations Dynamics Laboratory - Moulay Lhassan Hbid

Duration: Jan 2012 - Dec 2015

The aim of this project is to establish a network working on mathematical and computational models in cell dynamics. This network consists of five groups which have already established close bilateral relations. Those are the Inria teams Bang and Dracula in Paris and Lyon, France, the team IAC-CNR in Rome, Italy, the laboratory of Mathematical Population Dynamics (LMDP) from the university of Marrakech in Morocco, and the team of Mathematical Modelling and Computing in Biology (MoMinBi) from the Pasteur Institute in Tunis. Modelling cell dynamics and related processes is one of the main subjects of interest for the partners for many years. The issues addressed in the present project can be divided into five parts:

- 1) Analysis of structured models in cell population dynamics ;
- 2) Dynamics of normal and pathological haematopoiesis ;
- 3) Dynamics of Darwinian adaptation, in particular by drug resistance in competing cell or parasite populations, healthy and pathological / pathogenic (cancer, bacteria, parasites) ;
- 4) Dynamics of chemical and physical determinants of filament formation and intracellular spatial organisation of the cytoskeleton conformation ;
- 5) Coupling of the molecular mechanisms of control of the cell division cycle and cell proliferation.

The first part has been developed for many years by all the partners in this project. It tackles issues related to cell dynamics and biological mechanisms, physiological and chemical properties of cells and cell populations. The other four aspects of the project have been studied in the past by the Inria teams "Bang" and "Dracula" (2, 4, 5) and the IAC-CNR team (Rome), or are a rapidly emergent theme in Bang (3, cell Darwinism) with possible and natural connections with the other teams, in particular IAC-CNR and MoMinBi in Tunisia. Themes (2, 4, 5) have also been initiated (for their fundamental part) in a recent collaboration between Dracula and the teams from Morocco and Tunisia. The objectives of the present project are to pursue and deepen the study of cell proliferation dynamics and cellular mechanisms using structured models that take into account some new structure variables. The development of computer models will also be investigated in this project. Training and research activities related to these topics are currently underway between the Inria teams and the teams from Marrakech and Tunis, and between the Italian team and Bang. Two co-supervised theses are currently in progress, a Spring school on this subject will be organised by the partners in 2012. This program comes at the right time to give a new impetus to this collaboration. It will lead to the establishment of a multi-site laboratory expertise in population dynamics modelling, especially in cellular dynamics. This project will also allow the teams from Morocco and Tunisia to use their knowledge on mathematics applied to cell dynamics.

8.3.2.2. FCRF

Program: Fonds France Canada pour la recherche (FFCR)- France Canada research fund (FCRF)
"New research collaboration" 2014-2015.

Title: Mathematical modelling of megakaryopoiesis and applications to platelet related diseases

Participants: Mostafa Adimy, Fabien Crauste, Laurent Pujo-Menjouet [Coordinator].

International Partners : Canada (Jiguo Cao, Nemanja Kosovalic, Jianhong Wu).

ERABLE Project-Team

8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. ANR

8.1.1.1. ABS4NGS

- Title: Solutions Algorithmiques, Bioinformatiques et Logicielles pour le Séquençage Haut Débit
- Coordinator: E. Barillot
- ERABLE participant(s): V. Lacroix
- Type: ANR (2012-2016)
- Web page: <https://sites.google.com/site/abs4ngs/>

8.1.1.2. Colib' read

- Title: Methods for efficient detection and visualization of biological information from non assembled NGS data
- Coordinator: P. Peterlongo
- ERABLE participant(s): V. Lacroix, L. I. S. de Lima, A. Julien-Lafférière, H. Lopez-Maestre, C. Marchet, G. Sacomoto, M.-F. Sagot, B. Sinimeri
- Type: ANR (2013-2016)
- Web page: <http://colibread.inria.fr/>

8.1.1.3. ExHyb

- Title: Exploring genomic stability in hybrids
- Coordinator: C. Vieira
- ERABLE participant(s): C. Vieira
- Type: ANR (2014-2018)
- Web page: Not available

8.1.1.4. IMetSym

- Title: Immune and Metabolic Control in Intracellular Symbiosis of Insects
- Coordinator: A Heddi
- ERABLE participant(s): H. Charles, S. Colella
- Type: ANR Blanc (2014-2017)
- Web page: Not available

8.1.2. Others

Notice that were included here regional projects of our members from Italy when these have no other partners than researchers from the same country.

8.1.2.1. Exomic

- Title: Functional annotation of the transcriptome at the exon level
- Coordinator: D. Auboeuf (Inserm, Lyon)
- ERABLE participant(s): V. Lacroix, M.-F. Sagot
- Type: INSERM Systems Biology Call (2012-2015)
- Web page: Not available

8.1.2.2. Amanda

- Title: Algorithmics for MAssive and Networked DAta
- Coordinator: G. Di Battista (University of Roma 3)
- ERABLE participant(s): R. Grossi, N. Pisanti
- Type: MIUR PRIN, Italian Ministry of Research National Projects (2014-2017)
- Web page: <http://www.dia.uniroma3.it/~amanda/research-units.php>

8.1.2.3. Effets de l'environnement sur la stabilité des éléments transposables

- Title: Effets de l'environnement sur la stabilité des éléments transposables
- Coordinator: C. Vieira
- ERABLE participant(s): C. Vieira
- Type: Fondation pour la Recherche Médicale (FRM) (2014-2016)
- Web page: Not available

8.2. European Initiatives

8.2.1. FP7 & H2020 Projects

8.2.1.1. BacHBerry

- Title: BACterial Hosts for production of Bioactive phenolics from bERRY fruits
- Duration: November 2013 - October 2016
- Coordinator: Jochen Förster, DTU Denmark
- ERABLE participant(s): R. Andrade, L. Bulteau, A. Julien-Laferrière, V. Lacroix, A. Marchetti-Spaccamela, A. Mary, D. Parrot, M.-F. Sagot, L. Stougie, A. Viari, M. Wannagat
- Type: FP7 - KBBE
- Web page: <http://www.bachberry.eu/>

8.2.1.2. MicroWine

- Title: Microbial metagenomics and the modern wine industry
- Duration: January 2015 - January 2019
- Coordinator: Lars Hestbjerg Hansen, University of Copenhagen
- ERABLE participant(s): A. Marchetti-Spaccamela, A. Mary, H. T. Pusa, M.-F. Sagot, L. Stougie
- Type: H2020-MSCA-ETN-2014
- Web page: <http://www.microwine.eu/>

8.2.1.3. SWIPE

- Title: Predicting whitefly population outbreaks in changing environments
- Duration: 2012 - 2015
- Coordinator: E. Zchori-Fein
- ERABLE participant(s): F. Vavre
- Web page: Not available

8.2.1.4. SISYPHE

- Title: Species Identity and SYmbiosis Formally and Experimentally explored
- Duration: 2010-2015 (ended March 31st)
- Coordinator: M.-F. Sagot
- BAMBOO participant(s): Whole BAMBOO team
- Type: ERC Advanced Grant
- Web page: <http://team.inria.fr/erable/en/older-projects/erc-sisyphe/>

8.2.2. Collaborations with Major European Organisations

By itself, ERABLE is built from what initially were collaborations with some major European Organisations (CWI, Sapienza University of Rome, Universities of Florence and Pisa, Free University of Amsterdam) and now has become a European Inria Team.

8.3. International Initiatives

8.3.1. Inria International Labs

ERABLE participates in a project within the Inria-Chile CIRIC (Communication and Information Research and Innovation Center) titled “Omics Integrative Sciences”. The main objectives of the project are the development and implementation of mathematical and computational methods and the associated computational platforms for the exploration and integration of large sets of heterogeneous omics data and their application to the production of biomarkers and bioidentification systems for important Chilean productive sectors. The project started in 2011 and is coordinated in Chile by Alejandro Maass, Mathomics, University of Chile, Santiago. It is in the context of this project that we are currently hosting the presence of Alex di Genova in ERABLE as a PhD sandwich student (for 18 to 24 months). Alex is co-supervised by Alejandro Maass and by Eric Goles from the University Adolfo Ibañez, Santiago, Chile.

8.3.2. Inria Associate Teams not involved in an Inria International Labs

ALEGRIA

- Title: ALgorithms for ExplorinG the inteRactions Involving Apicomplexa and kinetoplastida
- Duration: 2015 - 2017
- Coordinator: On the Brazilian side, Andréa Rodrigues Ávila; on the French side, Marie-France Sagot
- ERABLE participant(s): M. Ferrarini, L. Ishi Soares de Lima, A. Mary, H. T. Pusa, M.-F. Sagot, M. Wannagat
- Web page: <http://team.inria.fr/erable/en/alegria/>

8.3.3. Participation in other International Programs

ERABLE is coordinator of a CNRS-UCBL-Inria Laboratoire International Associé (LIA) with the Laboratório Nacional de Computação Científica (LNCC), Petrópolis, Brazil. The LIA has for acronym LIRIO (“Laboratoire International de Recherche en bIOinformatique”) and is coordinated by Ana Tereza Vasconcelos from the LNCC and Marie-France Sagot from BAMBOO. The LIA was created in January 2012 for 4 years, renewable once. A web page for the LIA LIRIO is available at this address: <http://team.inria.fr/bamboo/en/cnrs-lia-laboratoire-international-associe-lirio/>.

ERABLE coordinates another project with Brazil. This is a CAPES-COFECUB project titled: “Multidisciplinary Approach to the Study of the Biodiversity, Interactions and Metabolism of the Microbial Ecosystem of Swines”. The coordinators are M.-F. Sagot (France) and A. T. Vasconcelos (LNCC, Brazil) with also the participation of Arnaldo Zaha (Federal University of Rio Grande do Sul). The project started in 2013 for 2 years, and then was renewed for 2 more years starting from 2015. The main objective of this project is to experimentally and mathematically explore the biodiversity of the bacterial organisms living in the respiratory tract of swines, many of which are pathogenic. This project is strongly linked to the LIA LIRIO. More information on it may be found at this address: http://team.inria.fr/erable/en/cnrs-lia-laboratoire-international-associe-lirio/associated-projects/#CAPES-COFECUB_Microbial_Ecosystem_of_Swines.

ERABLE had a Stic AmSud project accepted in 2015 that will start in 2016 for 2 years. The title of the project is “Methodological Approaches Investigated as Accurately as possible for applications to biology”, and its acronym MAIA. This project involves the following partners: (France) Marie-France Sagot, ERABLE Team, Inria; (Brazil) Roberto Marcondes César Jr, Instituto de Matemática e Estatística, Universidade de São Paulo; and Paulo Vieira Milreu, TecSinapse; (Chile) Vicente Acuña, Centro de Modelamiento Matemático, Santiago; and Gonzalo Ruz, University Adolfo Ibañez, Santiago. One of them, TecSinapse, is an industrial partner. MAIA has two main goals: one methodological that aims to explore how accurately hard problems can be solved theoretically by different approaches – exact, approximate, randomised, heuristic – and combinations thereof, and a second that aims to better understand the extent and the role of interspecific interactions in all main life processes by using the methodological insights gained in the first goal and the algorithms developed as a consequence. A preliminary web page for MAIA is available at this address: <http://team.inria.fr/erable/en/projects/maia/>.

Finally, we would like to mention the participation of one member of ERABLE (Alain Viari) in the Breast Cancer French Working Group of the International Cancer Genome Consortium (ICGC, <https://icgc.org>) led by the Institut National du Cancer (INCa, <http://www.e-cancer.fr/Professionnels-de-la-recherche/Innovations/Les-progres-de-la-genomique/ICGC-France>). This project was initiated by Pr. Gilles Thomas who passed away in 2014. Alain took the head of the bioinformatics platform located at the Centre Léon Bérard. The project aims at the genomic characterisation of 75 HER2-amplified breast cancers by using high-throughput sequencing (whole genome of paired tumor/normal samples and RNAseq of tumor samples). One of the scientific goals is to decipher whether the HER2/ERBB2 amplification is a driver or passenger event in the course of tumor development.

8.4. International Research Visitors

8.4.1. Visits of International Scientists

In 2015, ERABLE greeted the following International scientists:

- In France: Katharina Huber (University of Warwick, UK), Giuseppe Italiano (Tor Vergata University of Rome, Italy, various visits), Ana Rute Neves and Zeidan (ChR Hansen, Oslo, Danemark), three members of the LIA LIRIO (Arnaldo Zaha from the Federal University of Rio Grande do Sul, Maria Cristina Motta from the Federal University of Rio Grande do Sul, and Ana Tereza Vasconcelos from the LNCC, all in Brazil), Susana Vinga and various members of her team (IDMEC-IST Portugal), Tiziana Calamoneri (Sapienza University of Rome).
- In Italy: David Coudert (Inria Sophia Antipolis, France, to Florence), Alberto Policriti (University of Udine, Italy, to Pisa), Fabio Vandin (University of Southern Danemark to Pisa), Solon Pissis (King’s College London UK to Pisa), Costas Iliopoulos (King’s College London UK to Pisa), Grzegorz Rozenberg (Leiden University, The Netherlands, and Boulder University of Colorado, USA, to Pisa).
- In The Netherlands: Kirk Pruhs (University of Pittsburgh, USA), Kevin Schewior (Technical University of Berlin, Germany), Paola Bonizzoni, Yuri Pirola and Simone Zaccharia (all from the University of Milano-Bicocca, Italy).

8.4.2. Internships

In 2015, ERABLE greeted on average the following internship students:

- In France: Bastien Sylvere, Master 1 (2 months); Audric Cologne, Master 1 (3 months); Henri Dupoy, Master 1 (2 months); Virginie Jouffret, Master 1 (2 months); Caroline Michaud, Master 2 (6 months); Hong-Phong Pham, Master 2 (5 months); Nabel Sersoub, Master 1 (2 months); Manon Villa, Master 1 (2 months).
- In Italy: Anna Tarsia, Master 2 (Pisa).
- In The Netherlands: Gunnar Klau supervised a couple of MSc and BSc theses.

8.4.3. Visits to International Teams

8.4.3.1. Visits

In 2015, members of ERABLE visited the following International teams:

- In France: Giuseppe Italiano (Tor Vergata University of Rome), visit to members of the LIA LIRIO at the LNCC in Brazil, visit to the Departement of Computer Science of the University of São Paulo and to members of the TecSinapse company in Brazil, Tiziana Calamoneri (La Sapienza University of Rome), Susana Vinga and the members of her team (IDMEC-IST Portugal).
- In Italy: visit to Pierre Fraigniaud and Michel Habib at LIAFA, Paris, visit to Solon Pissis and Costas Iliopoulos at King's College London UK.
- In The Netherlands: visit to the Technical University of Berlin, visit to Paola Bonizzoni and her group at the University of Milano-Bicocca.

8.4.3.2. Research stays abroad

Gunnar Klau will be spending 9 months starting from November 2015 at the Center for Computational Molecular Biology at Brown University, USA, visiting notably Benjamin Raphael, Director of the Center.

IBIS Project-Team

8. Partnerships and Cooperations

8.1. Regional Initiatives

Project name	Séminaire grenoblois des systèmes complexes
Coordinators	S. Achard, O. François, A. Maignan, E. Prados, S. Rafai, D. Ropers
IBIS participants	D. Ropers
Type	Funding by Institut des Systèmes Complexes de Lyon (IXXI)
Web page	http://www.ixxi.fr/?page_id=114&lang=fr

8.2. National Initiatives

Project name	AlgeaInSilico: Prédire et optimiser la productivité des microalgues en fonction de leur milieu de croissance
Coordinator	O. Bernard
IBIS participants	H. de Jong, N. Giordano
Type	Inria Project Lab (2015-)
Web page	https://project.inria.fr/iplalgaesilico/

Project name	RESET – Arrest and restart of the gene expression machinery in bacteria: from mathematical models to biotechnological applications
Coordinator	H. de Jong
IBIS participants	E. Cinquemani, J. Geiselmann, C. Gomez Balderas, H. de Jong, S. Lacour, Y. Markowicz, C. Pinel, D. Ropers
Type	Bioinformatics call, Investissements d’Avenir program (2012-2017)
Web page	https://project.inria.fr/reset/

Project name	Fonction du système de régulation post-transcriptionnel CSR dans la dynamique de l’adaptation métabolique chez la bactérie modèle Escherichia coli
Coordinators	M. Coccagn-Bousquet (Inra, LISBP), B. Enjalbert (INSA, LISBP), D. Ropers
IBIS participants	M. Morin, D. Ropers
Type	Contrat Jeune Scientifique Inra-Inria (2012-2015)
Web page	http://www.inra.fr/les_hommes_et_les_femmes/rejoignez_nous/compléter_sa_formation/le_recrutement_de_doctorants/cjs__1/inra_inria

Project name	A web application for the analysis of time-series fluorescent reporter gene data
Coordinator IBIS participants	H. de Jong E. Cinquemani, J. Geiselmann, M. Page, D. Ropers, V. Zulkower (University of Edinburgh)
Type	IFB call for development of innovative bioinformatics services for life sciences (2016-2017)

8.3. European Initiatives

8.3.1. Collaborations with Major European Organizations

Computer Engineering & Systems Science Department of University of Pavia (Italy), Giancarlo Ferrari-Trecate

Control theory and systems identification with applications to systems biology

Automatic Control Lab at ETH Zürich (Switzerland), John Lygeros

Control theory and systems identification with applications to systems biology

Computational Microbiology research group, Institute of Food Research, Norwich (United Kingdom), Aline Métris and József Baranyi

Mathematical modelling of survival and growth of bacteria

8.4. International Research Visitors

8.4.1. Visits of International Scientists

Invited professor Subject	Alberto Soria-López (Centro de Investigación y de Estudios Avanzados (Cinestav) of Instituto Politécnico Nacional (IPN), Mexico) Development of an automatically-controlled system of multiplexed mini-bioreactors
Visiting scientist Subject	Aline Métris (Institute of Food Research (IFR), Norwich, UK) Comparative analysis of metabolic networks of Escherichia coli and Salmonella

NUMED Project-Team

6. Partnerships and Cooperations

6.1. Regional Initiatives

- Paul Vigneaux: collaborative project of the Fédération Mathématique Rhone-Alpes-Auvergne, on the growth of biological tissue.
- Emmanuel Grenier and Paul Vigneaux: Member of a collaborative project of the Fédération Mathématique Rhone-Alpes-Auvergne headed by Adeline Samson, on PDE and Statistics.

6.2. National Initiatives

6.2.1. ANR.

Thibault Bourgeron is part of "Keyboard" (head: Laurent Desvillettes)

6.3. European Initiatives

6.3.1. FP7 & H2020 Projects

Vincent Calvez: ERC starting grant Mesoprobio "Mesoscopic models for propagation in biology". 2015-2020

6.3.1.1. DDMoRE

Title: DDMORE

Programm: FP7

Duration: February 2011 - January 2016

Coordinator: Pfizer

Inria contact: Marc Lavielle

6.4. International Research Visitors

6.4.1. Visits to International Teams

6.4.1.1. Explorer programme

Bouin Emeric

Date: Jan 2015 - Apr 2015

Institution: **Stanford** (United States)

6.4.1.2. Research stays abroad

Thibault Bourgeron visited Granada University in october 2015.

STEPP Project-Team

8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. ANR

CITiES (*Calibrage et validation de modèles Transport - usagE des Sols*)

Program: “Modèles Numériques” 2012, ANR

Duration: 2013 – 2016

Coordinator: Emmanuel Prados (STEPP)

Other partners: LET, IDDRI, IRTES-SET (“Systemes and Transports” lab of Univ. of Tech. of Belfort-Montbéliard), IFSTTAR-DEST Paris (formerly INRETS), LVMT (“Laboratoire Ville Mobilité Transport”, Marne la Vallée), VINCI (Pirandello Ingenierie, Paris), IAU Île-De-France (Urban Agency of Paris), AURG (Urban Agency of Grenoble), MOISE (Inria project-team)

Abstract: Calibration and validation of transport and land use models.

8.1.2. FRB (*Fondation pour la Recherche sur la Biodiversité*)

ESNET (Futures of ecosystem services networks for the Grenoble region)

Program: “Modeling and Scenarios of Biodiversity” flagship program, Fondation pour la Recherche sur la Biodiversité (FRB). This project is funded by ONEMA (*Office National de l’Eau et des Milieux Aquatiques*).

Duration: 2013 – 2016

Coordinator: Sandra Lavorel (LECA)

Other partners: EDDEN (UPMF/CNRS), IRSTEA Grenoble (formerly CEMAGREF), PACTE (UJF/CNRS), ERIC (Lyon 2/CNRS)

Abstract: This project explores alternative futures of ecosystem services under combined scenarios of land-use and climate change for the Grenoble urban area in the French Alps. In this project, STEPP works in particular on the modeling of the land use and land cover changes, and to a smaller extent on the interaction of these changes with some specific services.

AVALON Project-Team

9. Partnerships and Cooperations

9.1. National Initiatives

9.1.1. PIA

9.1.1.1. PIA ELCI, Environnement Logiciel pour le Calcul Intensif, 2014-2017

Participants: H el ene Coullon, Thierry Gautier, Laurent Lef evre, Christian Perez, Issam Rais, J er ome Richard.

The ELCI PIA project is coordinated by BULL with several partners: CEA, Inria, SAFRAB, UVSQ.

This project aims to improve the support for numerical simulations and High Performance Computing (HPC) by providing a new generation software stack to control supercomputers, to improve numerical solvers, and pre- and post computing software, as well programming and execution environment. It also aims to validate the relevance of these development by demonstrating their capacity to deliver better scalability, resilience, modularity, abstraction, and interaction on some application use-cases. Avalon is involved in WP1 and WP3 ELCI Work Packages through the PhD of Issam Rais and the postdoc of H el ene Coullon. Laurent Lefevre is the Inria representative in the ELCI technical committee.

9.1.2. French National Research Agency Projects (ANR)

9.1.2.1. ANR EMERGENCE CloudPower, Cloud Service providing HPC on-demand to innovative SME's, 35 months, ANR-12-EMMA-0038

Participant: Gilles Fedak.

High performance computing (HPC) allows scientists and industries to run large numerical application on huge data volumes. The HPC is a key factor in knowledge and innovation in many fields of industry and service, with high economic and social issues: aerospace, finance and business intelligence, energy and environment, chemicals and materials, medicine and biology , digital art and games, Web and social networks, ... Today, acquiring HPC supercomputer is very expensive, making HPC unreachable to SMIs / SMEs for their research and development. The CloudPower project results from the XtremWeb research and development project. Its goal is to offer a low cost Cloud HPC service for small and medium-sized innovative companies. With CloudPower, companies and scientists will run their simulations to design and develop new products on a powerful, scalable, economical, reliable and secure infrastructure.

The project will lead the creation of a new and innovative company operating the platform implemented in the framework of the ANR Emergence. CloudPower will implement SaaS / PaaS portal for customers and develop extensions to allow commercial exploitation of unused resources. Building on the network of SMIs from the competitiveness clusters System@tic and LyonBiopole, we will implement scenarios and/or demonstrators which illustrate the ability of CloudPower to increase competitiveness, research and marketing of innovative SMEs.

9.1.2.2. ANR INFRA MOEBUS, Multi-objective scheduling for large computing platforms, 4 years, ANR-13-INFR-000, 2013-2016

Participants: Christian Perez, Laurent Lef evre, Fr ed eric Suter.

The ever growing evolution of computing platforms leads to a highly diversified and dynamic landscape. The most significant classes of parallel and distributed systems are supercomputers, grids, clouds and large hierarchical multi-core machines. They are all characterized by an increasing complexity for managing the jobs and the resources. Such complexity stems from the various hardware characteristics and from the applications characteristics. The MOEBUS project focuses on the efficient execution of parallel applications submitted by various users and sharing resources in large-scale high-performance computing environments.

We propose to investigate new functionalities to add at low cost in actual large scale schedulers and programming standards, for a better use of the resources according to various objectives and criteria. We propose to revisit the principles of existing schedulers after studying the main factors impacted by job submissions. Then, we will propose novel efficient algorithms for optimizing the schedule for unconventional objectives like energy consumption and to design provable approximation multi-objective optimization algorithms for some relevant combinations of objectives. An important characteristic of the project is its right balance between theoretical analysis and practical implementation. The most promising ideas will lead to integration in reference systems such as SLURM and OAR as well as new features in programming standards implementations such as MPI or OpenMP.

9.1.2.3. ANR INFRA SONGS, *Simulation Of Next Generation Systems*, 4 years, ANR-12-INFRA-11, 2012-2016

Participant: Frédéric Suter.

The last decade has brought tremendous changes to the characteristics of large scale distributed computing platforms. Large grids processing terabytes of information a day and the peer-to-peer technology have become common even though understanding how to efficiently such platforms still raises many challenges. As demonstrated by the USS SIMGRID project, simulation has proved to be a very effective approach for studying such platforms. Although even more challenging, we think the issues raised by petaflop/exaflop computers and emerging cloud infrastructures can be addressed using similar simulation methodology.

The goal of the SONGS project is to extend the applicability of the SIMGRID simulation framework from Grids and Peer-to-Peer systems to Clouds and High Performance Computation systems. Each type of large-scale computing system will be addressed through a set of use cases and lead by researchers recognized as experts in this area.

Any sound study of such systems through simulations relies on the following pillars of simulation methodology: Efficient simulation kernel; Sound and validated models; Simulation analysis tools; Campaign simulation management.

9.1.3. Inria Large Scale Initiative

9.1.3.1. C2S@Exa, *Computer and Computational Sciences at Exascale*, 4 years, 2013-2017

Participants: Hélène Coullon, Christian Perez, Laurent Lefèvre, Jérôme Richard, Thierry Gautier.

Since January 2013, the team is participating to the C2S@Exa Inria Project Lab (IPL). This national initiative aims at the development of numerical modeling methodologies that fully exploit the processing capabilities of modern massively parallel architectures in the context of a number of selected applications related to important scientific and technological challenges for the quality and the security of life in our society. At the current state of the art in technologies and methodologies, a multidisciplinary approach is required to overcome the challenges raised by the development of highly scalable numerical simulation software that can exploit computing platforms offering several hundreds of thousands of cores. Hence, the main objective of C2S@Exa is the establishment of a continuum of expertise in the computer science and numerical mathematics domains, by gathering researchers from Inria project-teams whose research and development activities are tightly linked to high performance computing issues in these domains. More precisely, this collaborative effort involves computer scientists that are experts of programming models, environments and tools for harnessing massively parallel systems, algorithmists that propose algorithms and contribute to generic libraries and core solvers in order to take benefit from all the parallelism levels with the main goal of optimal scaling on very large numbers of computing entities and, numerical mathematicians that are studying numerical schemes and scalable solvers for systems of partial differential equations in view of the simulation of very large-scale problems.

9.1.3.2. DISCOVERY, *Distributed and COoperative management of Virtual Environments autonomousLY*, 4 years, 2015-2019

Participants: Christian Perez, Gilles Fedak.

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 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 (LUC) platforms is the availability of appropriate operating mechanisms. The main objective of DISCOVERY is to design, implement, demonstrate and promote the LUC Operating System (OS), a unified system in charge of turning a complex, extremely large-scale and widely distributed infrastructure into a collection of abstracted computing resources which is efficient, reliable, secure and at the same time friendly to operate and use.

To achieve this, the consortium is composed of experts in research areas such as large-scale infrastructure management systems, network and P2P algorithms. Moreover two key network operators, namely Orange and RENATER, are involved in the project.

By deploying and using such a LUC Operating System on backbones, our ultimate vision is to make possible to host/operate a large part of the Internet 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, government and academic institutions, to any idle resources that may be provided by end-users.

9.2. European Initiatives

9.2.1. FP7 & H2020 Projects

9.2.1.1. PaaSage

Participants: Christian Perez, Laurent Pouilloux.

Title: PaaSage: Model-based Cloud Platform Upperware

Type: Seventh Framework Programme

Instrument: Collaborative project

Duration: October 2012 - September 2016 (48 months)

Coordinator: Pierre Guisset (GEIE ERCIM)

Others partners: SINTEF, STFC, HLRS, University of Stuttgart, Inria, CETIC, FORTH, be.wan, EVRY, SysFera, Flexiant, Lufthansa Systems, AG GWDG, Automotive Simulation Center Stuttgart e.V.

See also: <http://paasage.eu>

Abstract: PaaSage will deliver an open and integrated platform, to support both deployment and design of Cloud applications, together with an accompanying methodology that allows model-based development, configuration, optimization, and deployment of existing and new applications independently of the existing underlying Cloud infrastructures. Specifically it will deliver an IDE (Integrated Development Environment) incorporating modules for design time and execution time optimizations of applications specified in the CLOUD Modeling Language (CLOUD ML), execution-level mappers and interfaces and a metadata database.

9.2.2. Collaborations in European Programs, except FP7 & H2020

9.2.2.1. CHIST-ERA STAR

Participants: Marcos Dias de Assunção, Radu Carpa, Laurent Lefèvre, Olivier Glück.

Title: SwiTching And tRansmission project

Type: CHIST-ERA (European Coordinated Research on Long-term Challenges in Information and Communication Sciences & Technologies ERA-Net)

Duration: 2013-2015

Coordinator: Jaafar Elmighani (University of Leeds - UK)

Others partners: Inria ,University of Cambridge (UK), University of Leeds (UK), AGH University of Science and Technology Department of Telecommunications (Poland)

See also: <http://www.chistera.eu/projects/star>

Abstract: The Internet power consumption has continued to increase over the last decade as a result of a bandwidth growth of at least 50 to 100 times. Further bandwidth growth between 40% and 300% is predicted in the next 3 years as a result of the growing popularity of bandwidth intensive applications. Energy efficiency is therefore increasingly becoming a key priority for ICT organizations given the obvious ecological and economic drivers. In this project we adopt the GreenTouch energy saving target of a factor of a 100 for Core Switching and Routing and believe this ambitious target is achievable should the research in this proposal prove successful. A key observation in core networks is that most of the power is consumed in the IP layer while optical transmission and optical switching are power efficient in comparison, hence the inspiration for this project. Initial studies by the applicants show that physical topology choices in networks have the potential to significantly reduce the power consumption, however network optimization and the consideration of traffic and the opportunities afforded by large, low power photonic switch architectures will lead to further power savings. Networks are typically over provisioned at present to maintain quality of service. We will study optimum resource allocation to reduce the overprovisioning factor while maintaining the quality of service. Protection is currently provided in networks through the allocation of redundant paths and resources, and for full protection there is a protection route for every working route. Avalon is contributing to STAR in terms of software network protocols and services optimizations which will be combined with more efficient photonic switches in order to obtain a factor of 100 power saving in core networks can be realised through this project with significant potential for resulting impact on how core photonic networks are designed and implemented.

9.2.2.2. COST IC1305 : Nesus

Participants: Laurent Lefèvre, Marcos Dias de Assunção, Violaine Villebonnet.

Program: COST

Project acronym: IC1305

Project title: Network for Sustainable Ultrascale Computing (NESUS)

Duration: 2014-2019

Coordinator: Jesus Carretero (Univ. Madrid)

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 than 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 glue 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. In Nesus, Laurent Lefevre is co-chairing the Working on Energy Efficiency (WG5). In 2015, Violaine Villebonnet has been involved in a short term scientific mission with University of La Lagune (Spain) on the topic of energy proportionality and profiling of HPC systems (May 18-29, 2015).

9.2.2.3. SEED4C

Program: Celtic-Plus

Project acronym: SEED4C

Project title: Security Embedded Element and Data privacy for the Cloud.

Duration: 2012-2015

Coordinator: Stéphane Betge-Brezetz (Alcatel-Lucent lab)

Other partners: Gemalto, ENSI Bourges, Inria, Wallix, VTT Technical Research centre of Finland, Mikkelin Puhelin Oyj, Cygate, Nokia Siemens Networks, Finceptum OY (Novell), Solacia, Innovalia Association, Nextel, Software Quality Systems, Ikusi, Vicomtech, Biscaytik

Abstract: SEED4C is a Celtic-Plus project: an industry-driven European research initiative to define, perform and finance through public and private funding common research projects in the area of telecommunications, new media, future Internet, and applications and services focusing on a new "Smart Connected World" paradigm. Celtic-Plus is a EUREKA ICT cluster and is part of the inter-governmental EUREKA network.

The cloud security challenge not only reflects on the secure running of software on one single machine, but rather on managing and guaranteeing security of a computer group or cluster seen as a single entity. Seed4C focus is to evolve from cloud security with an isolated point or centralized points of enforcement for security to cloud security with cooperative points of enforcement for security.

9.3. International Initiatives

9.3.1. Inria International Labs

9.3.1.1. Inria-UIUC-NCSA Joint Laboratory for Petascale Computing

Participants: Eddy Caron, Hélène Coullon, Olivier Glück, Vincent Lanore, Laurent Lefèvre, Christian Perez.

The University of Illinois at Urbana-Champaign, Inria, the French national computer science institute, Argonne National Laboratory, Barcelona Supercomputing Center, Jülich Supercomputing Centre and the Riken Advanced Institute for Computational Science formed the Joint Laboratory on Extreme Scale Computing, a follow-up of the Inria-Illinois Joint Laboratory for Petascale Computing. The Joint Laboratory is based at Illinois and includes researchers from Inria, and the National Center for Supercomputing Applications, ANL, BSC and JSC. It focuses on software challenges found in extreme scale high-performance computers.

9.3.1.2. Informal International Partners

- Université Gaston Berger, Saint Louis, Sénégal. Contact: Pr. Ousmane Thiaré.
- École Centrale Mahindra, Hyderabad, India. Contact: Dr. Arya Kumar Bhattacharya.

9.3.2. Participation In other International Programs

9.3.2.1. GreenTouch

Participants: Jean-Patrick Gelas, Laurent Lefèvre.

GreenTouch is a consortium of leading Information and Communications Technology (ICT) industry, academic and non-governmental research experts dedicated to fundamentally transforming communications and data networks, including the Internet, and significantly reducing the carbon footprint of ICT devices, platforms and networks. The GreenTouch project has ended in June 2015 through the dissemination and demonstration of main results during a final celebration in New York. Our activities on designing virtual home gateway at large scale have been demonstrated.

9.4. International Research Visitors

9.4.1. Visits of International Scientists

Dr Dan Emanoil Grigoras. University College Cork (UK). September 16-18 2015.

9.4.2. Visits to International Teams

9.4.2.1. Research stays abroad

9.4.2.1.1. Gilles Fedak visited CAS, Beijing, China

Dates: 15/8/15 - 15/9/15

Local contact: Pr Haiwu He

Gilles Fedak has been awarded the President's International Fellowship Initiative (PIFI) from the Chinese Academy of Sciences. He visited the CSNET institute in Beijing for one month, working with Pr. Haiwu He on D³ MapReduce.

9.4.2.1.2. Daniel Balouek Thomert visited Mahindra Ecole Centrale, India

Dates: 10/5/15 - 12/19/15

Local contact: Dr Arya K. Bhattacharya (Arya.Bhattacharya@mechyd.ac.in)

Other avalon researcher involved: Eddy Caron and Laurent Lefevre.

Abstract: Our work synergizes two state-of-the-art technologies by combining Multi-Objective Evolutionary Algorithms (MOEA) with trade-off mechanisms using the DIET toolkit, in a context of cloud computing workflow placement. Evaluation of the proposed solution under different scheduling policies shows significant gains of energy consumption with some improvement on the overall workflow completion time. Following this work, a paper has been submitted.

CTRL-A Team

9. Partnerships and Cooperations

9.1. Regional Initiatives

The Labex Persyval-lab is a large regional initiative, supported by ANR, where we are contributing through two projects:

9.1.1. *Equipe-action HPES*

This project (2013-17) groups members from Inria, LIG, Gipsa-lab, TIMA and Gipsa-lab, around the topic of High-Performance Computing benefitting from technologies originally developed for Embedded Systems. Ctrl-A is directly involved in the co-advising of the PhD of Naweiluo Zhou, with J.F. Méhaut (LIG), on the topic of autonomic management of software transactional memory mechanisms: <https://persyval-lab.org/en/sites/hpes>

9.1.2. *Projet Exploratoire CASE*

This project (2015-16) grouped members from Inria, LIG, Gipsa-lab and CEA LETI/DACLE and concerned the general topic of Control techniques for Autonomic Smart Environments, with a special emphasis on relating discrete and stochastic control models with middleware platforms applied to smart environments. It enables us to hire two Masters students for 2016.

9.2. National Initiatives

9.2.1. *ANR*

HPeC is an ANR project on Self-Adaptive, Energy Efficient High Performance Embedded Computing, with a UAV case study. The Coordinator is Lab-STICC / MOCS (Lorient / Brest), and the duration: 42 month from october 2015. Others Partners are: Inria Rennes, IRIT, Eolas.

In Ctrl-A, it is funding a PhD thesis or a post-doc position, to be hired in Grenoble and co-advised with Lorient. Another PhD based in Brest is co-advised by Stéphane Mocanu.

9.2.2. *Informal National Partners*

We have contacts with colleagues in France, in addition to the cooperation mentioned before, and with whom we are submitting collaboration projects, co-organizing events and workshops, etc. They feature : Avalon Inria team in Lyon (F. Desprez), LIP6 (J. Malenfant), Scales Inria team in Sophia-Antipolis (L. Henrio), LIRRM in Montpellier (A. Gamatié, K. Godary, D. Simon), IRISA/Inria Rennes (J. Buisson, J.L. Pazat, ...), Telecom Paris-Tech (A. Diaconescu, E. Najm), LAAS (Thierry Monteil), LURPA ENS Cachan (J.M. Faure, J.J. Lesage), ...

9.2.3. *Informal National Industrial Partners*

We have ongoing discussions with several industrial actors in our application domains, some of them in the framework of cooperation contracts, other more informal: Eolas/Business decision (G. Dulac), ST Microelectronics (V. Bertin), Schneider Electric (C. El-Kaed, P. Nappey, M. Pitel), Orange labs (J. Pulou, G. Privat).

9.3. International Initiatives

9.3.1. Inria International Partners

9.3.1.1. Informal International Partners

We have ongoing relations with international colleagues in the emerging community on our topic of control for computing e.g., in Sweden at Lund (K.E. Arzen, M. Maggio) and Linnaeus Universities (D. Weyns, N. Khakpour), in the Netherlands at CWI/leiden University (F. Arbab), in China at Heifei University (Xin An), in Italy at University Milano (C. Ghezzi, A. Leva), in the USA at Ann Arbor University (S. Lafortune) and UMass (P. Shenoy, E. Cecchet).

9.3.2. Participation In other International Programs

Eric Rutten is a member of the IFAC Technical Committee 1.3 on Discrete Event and Hybrid Systems, for the 2011-2014 triennium, and for the 2014-2017 triennium <http://tc.ifac-control.org/1/3> ; and of the IEEE Control Systems Society Discrete Event Systems Technical Committee <http://discrete-event-systems.ieeecss.org>.

DANTE Project-Team

9. Partnerships and Cooperations

9.1. National Initiatives

9.1.1. ANR

9.1.1.1. Equipex FIT (*Futur Internet of Things*)

Participant: Éric Fleury.

FIT is one of 52 winning projects in the Equipex research grant program. It will set up a competitive and innovative experimental facility that brings France to the forefront of Future Internet research. FIT benefits from 5.8 million grant from the French government Running from 22.02.11 – 31.12.2019. The main ambition is to create a first-class facility to promote experimentally driven research and to facilitate the emergence of the Internet of the future.

9.1.1.2. ANR GRAPHSIP

Participants: Paulo Gonçalves Andrade, Éric Fleury, Thomas Begin, Sarra Ben Alaya, Hadrien Hours.

An increasing number of application areas require the processing of massive datasets. These data can often be represented by graphs in order to encode complex interactions. When data vectors are associated with graph vertices, a so-called graph signal is obtained. The processing of such graph signals includes several open challenges because of the nature of the involved information. Indeed graph theory and signal and image processing methodologies do not combine readily. In particular, such a combination requires new developments, allowing classical signal processing methods to work on irregular grids and non Euclidean spaces. Considering the significant success of classical signal processing tools, it appears essential to generalise their use to graph signals. The GRAPHSIP project aims at developing a set of advanced methods and algorithms for the processing of graph signals: multi-scale transforms and solutions of variational problems on graphs. The major outcomes of this project are expected to lead to significant breakthroughs for graph data processing. The project will also focus on two novel applications on instances of graph signals: brain networks and 3D colour point clouds. They will exemplify and illustrate the proposed methodological advances on emerging applications.

9.1.1.3. ANR INFRA DISCO (*DIstributed SDN COntrollers for rich and elastic network services*)

Participants: Thomas Begin [correspondant], Anthony Busson, Isabelle Guérin Lassous, Huu Nghi Nguyen.

The DANTE team will explore the way SDN (Software Designed Network) can change network monitoring, control, urbanisation and abstract description of network resources for the optimisation of services. More specifically, the team will address the issues regarding the positioning of SDN controllers within the network, and the implementation of an admission control that can manage IP traffic prioritization.

9.1.1.4. ANR REFLEXION (*REsilient and FLEXible Infrastructure for Open Networking*)

Participants: Thomas Begin [correspondant], Anthony Busson, Isabelle Guérin Lassous, Guillaume Artero Gallardo.

The DANTE team will work on the monitoring of NFV proposing passive and light-weight metrology tools. They will then investigate the modeling of low-level resources consumptions and finally propose methods to dynamically allocate these resources taking into account performance constraints.

9.1.1.5. ANR CONTINT CODDDE

Participants: Éric Fleury [correspondant], Christophe Crespelle, Márton Karsai, Hadrien Hours.

It is a collaborative project between the ComplexNetwork team at LIP6/UPMC; Linkfluence and Inria Dante. The CODDDE project aims at studying critical research issues in the field of real-world complex networks study:

- How do these networks evolve over time?
- How does information spread on these networks?
- How can we detect and predict anomalies in these networks?

In order to answer these questions, an essential feature of complex networks will be exploited: the existence of a community structure among nodes of these networks. Complex networks are indeed composed of densely connected groups of that are loosely connected between themselves.

The CODDDE project will therefore propose new community detection algorithms to reflect complex networks evolution, in particular with regards to diffusion phenomena and anomaly detection.

These algorithms and methodology will be applied and validated on a real-world online social network consisting of more than 10 000 blogs and French media collected since 2009 on a daily basis (the dataset comprises all published articles and the links between these articles).

9.1.1.6. ANR RESCUE

Participants: Thomas Begin, Isabelle Guérin Lassous [correspondant].

In the RESCUE project, we investigate both the underlying mechanisms and the deployment of a substitution network composed of a fleet of dirigible wireless mobile routers. Unlike many projects and other scientific works that consider mobility as a drawback, in RESCUE we use the controlled mobility of the substitution network to help the base network reduce contention or to create an alternative network in case of failure. The advantages of an on-the-fly substitution network are manifold: Reusability and cost reduction; Deployability; Adaptability.

The RESCUE project addresses both the theoretical and the practical aspects of the deployment of a substitution network. From a theoretical point of view, we will propose a two-tiered architecture including the base network and the substitution network. This architecture will describe the deployment procedures of the mobile routing devices, the communication stack, the protocols, and the services. The design of this architecture will take into account some constraints such as quality of service and energy consumption (since mobile devices are autonomous), as we want the substitution network to provide more than a best effort service. From a practical point of view, we will provide a proof of concept, the architecture linked to this concept, and the necessary tools (*e.g.*, traffic monitoring, protocols) to validate the concept and mechanisms of on-the-fly substitution networks. At last but not least, we will validate the proposed system both in laboratory testbeds and in a real-usage scenario.

9.1.1.7. ANR FETUSES

Participant: Paulo Gonçalves Andrade.

The goals of this ANR project consist in the development of statistical signal processing tools dedicated to per partum fetal heart rate characterization and acidosis detection, and are organized as follows: *(i)* construction of a large dataset of per partum fetal heart rate recordings, which is well documented and of significant clinical value; *(ii)* Developments of adaptive (*e.g.* data driven) algorithms to separate data into trend (deceleration induced by contractions) and fluctuation (cardiac variability) components; *(iii)* Developments of algorithms to characterize the non stationary and multifractal properties of per partum fetal heart rate ; *(iv)* Acidosis detection and assessment using the large datasets; *(v)* Algorithm implementation for performing tests in real clinical situations. ANR is a joint project between DANTE, the Physics Lab of ENS de Lyon (SiSyPhe team) and the *Hôpital Femme-Mère-Enfant* of Bron (Lyon). Fetuses started in january 2012 and ended in june 2015.

9.1.1.8. ANR SoSweet

Participants: Éric Fleury, Márton Karsai.

The SoSweet project focuses on the synchronic variation and the diachronic evolution of the variety of French used on Twitter. The recent rise of novel digital services opens up new areas of expression which support new linguistics behaviors. In particular, social medias such as Twitter provide channels of communication through which speakers/writers use their language in ways that differ from standard written and oral forms. The result is the emergence of new varieties of languages. The main goal of SoSweet is to provide a detailed account of the links between linguistic variation and social structure in Twitter, both synchronically and diachronically. Through this specific example, and aware of its bias, we aim at providing a more detailed understanding of the dynamic links between individuals, social structure and language variation and change.

9.2. European Initiatives

9.2.1. FP7 & H2020 Projects

9.2.1.1. EMBERS

Title: Enabling a Mobility Back-End as a Robust Service

Programm: H2020

Duration: 2015, Dec to 2019

Coordinator: UPMC

Partners: UPMC, LIP6, France; UBIWHERE Lda, Portugal; Fraunhofer Gesellschaft Zur Forderung Der Angewandten Forschung, Germany; Technische Universitaet Berlin, Germany; Inria, France

Inria contact: Eric Fleury

EMBERS will bring to market a back-end for smart city mobility that is developed by a European small enterprise based upon its smart parking and smart traffic management products that two municipalities in Portugal currently deploy. The Mobility Back-end as a Service (MBaaS) replaces such all-in-one systems, in which a municipality purchases the full set of components from a single vendor. Instead, the city manager can purchase best-of-breed devices and apps developed by third parties, with the only constraint being that they interoperate with the back-end via a free, open, smart city mobility API. This domain-specific API lowers barriers to entry for app and device developers, making it easier for innovative SMEs to enter the market. Furthermore, the API is offered via a variety of generic interfaces, including oneM2M, ETSI M2M, OMA LWM2M, and FIWARE NGSI. EMBERS thus clears the way for developers and to municipalities that have adopted any one of these potential emerging machine-to-machine (M2M) communication standards.

9.2.1.2. ARMOUR

Title: Large-Scale Experiments of IoT Security & Trust (Project n°688237)

Programm: H2020

Duration: 2015 Dec to 2018

Coordinator: UPMC

Partners: UPMC, LIP6, France; Synelixis Lyseis Pliroforikis Automatismou & Tilepikoinonion Monoprosopi EPE, Greece; Smartesting Solutions & Services, France; Unparallel Innovation, Lda, Portugal; Easy Global Market, France; ODIN Solutions, Spain;

Inria contact: Eric Fleury

Provide duly tested, benchmarked and certified Security & Trust solutions for large-scale IoT using upgraded FIRE large-scale IoT/Cloud testbeds properly-equipped for Security & Trust experimentations. ARMOUR takes the top large-scale FIT IoT-LAB testbed – a FIRE OpenLAB / FIT IoT LAB facility – and enhances it as to enable experimentally-driven research on a key research dimension: large-scale IoT Security & Trust. Presently, no proper installations exist to experiment IoT Security & Trust on large-scale conditions; ARMOUR will develop and install such capability.

9.3. International Initiatives

9.3.1. Inria International Partners

University of Namur: Department of Mathematics/Naxys (Belgium). Collaboration with Renaud Lambiotte on dynamical processes on dynamical networks and communities detections.

Aalto University: Department of Biomedical Engineering and Computational Science (Finland). Collaboration with Jari Saramaki on modeling temporal networks and community like modular structure

Central European University (Hungary). Collaboration with János Kertész on modeling complex contagion phenomena.

ISI Foundation (Italy). Collaboration with Laetitia Gauvin on multiplex networks and transportation systems

UPC (Spain): Department of Telematic Engineering. Collaboration with Monica Aguilar Igartua and Luis J. de la Cruz Llopis on vehicular and community networks.

University of Bergen: Institute of Computer Science (Norway). Collaboration with Pinar Heggernes on graph editing problems for analysis and modeling of complex networks.

Ecole Polytechnique Fédérale de Lausanne (Switzerland). Collaboration with Pierre Vandergheynst on Graph Signal Processing

LNCC, Petropolis (Brazil). Collaboration with Arthur Ziviani on Temporal Graph modeling and algorithms.

Algorithms group: University of Bergen, Institute of Computer Science (Norway).

Collaboration with Pinar Heggernes on graph editing problems for analysis and modeling of complex networks.

Algorithmics group: University of Konstanz, Department of Computer and Information Science (Germany).

Collaboration with Ulrik Brandes on graph editing problems for analysis and modeling of complex networks.

9.3.1.1. Declared Inria International Partners

Taiwan, ACADEMIA SINICA & IIIS. Signature of a MoU in the framework of IoT-LAB.

9.3.2. Participation In other International Programs

9.3.2.1. PHC Peridot

Participants: Mohammed Amer, Thomas Begin, Anthony Busson, Isabelle Guérin Lassous.

Framework for Control and Monitoring of Wireless Mesh Networks (WMN) using Software-Defined Networking (SDN). The main objective of this project is propose mechanisms and modifications in the SDN architecture, specifically in the OpenFlow, which allow SDN mechanisms to operate over WMN considering the dynamic network topology that WMN may experience and some other relevant characteristics. The project will involve devising mechanisms for controlling mesh switches through controllers in a wireless environment, which will require developing novel and WMN-specific rules, actions and commands. The project will involve proposing mechanism that consider dynamic environment of WMN along with providing redundancy in the network. Besides, there is a requirement to have an adaptive measurement API for WMN. This is the second objective of our research project. The proposed measurement API will enable the network operators to monitor network traffic over WMN which may be content-specific or host-specific. This is a joint project between DANTE and M. A. Jinnah University, Islamabad. It started in June 2015 and will end in June 2018.

9.3.2.2. STIC AMSUD UCOOL: Understanding and predictin human demanded COntent and mObiLity

Participants: Éric Fleury, Márton Karsai, Christophe Crespelle.

Finding new ways to manage the increased data usage and to improve the level of service required by the new wave of applications for smartphones is an essential issue nowadays. The improved understanding of user mobility (i.e. the context they experience) and the content they demand is of fundamental importance when looking for solutions for this problem in the modern communication landscape. The resulting knowledge can help at the design of more adaptable networking protocols or services as well as can help determining, for instance, where to deploy networking infrastructure, how to reduce traffic congestion, or how to fill the gap between the capacity granted by the infrastructure technology and the traffic load generated by mobile users.

9.4. International Research Visitors

9.4.1. Visits of International Scientists

Sahoo Prasan Kumar

Date: July 2015

Institution: Chang Gung University (Taiwan)

9.4.2. Visits to International Teams

9.4.2.1. Sabbatical programme

Begin Thomas

Date: Sep 2015 - Aug 2016

Institution: **University of Ottawa** (Canada)

Thomas Begin is on a research leave at DIVA lab - University of Ottawa - Canada for the 2015 - 2016 academic year. This leave is funded through a CNRS grant (délégation CNRS) & Inria grant (Sabatic grant).

Christophe Crespelle

Date: Sep 2015 - Aug 2016

Institution: **Institute of Mathematics, Vietnam Academy of Science and Technology** (Vietnam)

Christophe Crespelle is in CNRS delegation for academic year 2015-2016 at the Institute of Mathematics, Vietnam Academy of Science and Technology, Hanoi

MESCAL Project-Team

8. Partnerships and Cooperations

8.1. Regional Initiatives

8.1.1. CIMENT

The CIMENT project (Intensive Computing, Numerical Modeling and Technical Experiments, <http://ciment.ujf-grenoble.fr/>) gathers a wide scientific community involved in numerical modeling and computing (from numerical physics and chemistry to astrophysics, mechanics, bio-modeling and imaging) and the distributed computer science teams from Grenoble. Several heterogeneous distributed computing platforms were set up (from PC clusters to IBM SP or alpha workstations) each being originally dedicated to a scientific domain. More than 600 processors are available for scientific computation. The MESCAL project-team provides expert skills in high performance computing infrastructures. The members of MESCAL involved in this project are Pierre Neyron and Olivier Richard.

8.1.2. Cluster Région

Partners: the Inria GRAAL project-team, the LSR-IMAG and IN2P3-LAPP laboratories.

The MESCAL project-team is a member of the regional "cluster" project on computer science and applied mathematics, the focus of its participation is on handling large amount of data large scale architecture.

8.2. National Initiatives

8.2.1. Inria Large Scale Initiative

- *HEMERA, 2010-2014* Leading action "Completing challenging experiments on Grid'5000 (Methodology)" (see <https://www.grid5000.fr/Hemera>).

Experimental platforms like Grid'5000 or PlanetLab provide an invaluable help to the scientific community, by making it possible to run very large-scale experiments in controlled environment. However, while performing relatively simple experiments is generally easy, it has been shown that the complexity of completing more challenging experiments (involving a large number of nodes, changes to the environment to introduce heterogeneity or faults, or instrumentation of the platform to extract data during the experiment) is often underestimated.

This working group explores different complementary approaches, that are the basic building blocks for building the next level of experimentation on large scale experimental platforms.

8.2.2. ANR

- *ANR GAGA (2014-2017)*

GAGA is a "Young Researchers" project funded by the French National Research Agency (ANR) to explore the Geometric Aspects of GAMES. The GAGA team is spread over three different locations in France (Paris, Toulouse and Grenoble), and is coordinated by Vianney Perchet, assistant professor (Maître de Conférences) in the Probabilities and Random Models laboratory in Université Paris VII.

As the name suggests, our project's focus is game theory, a rapidly developing subject with growing applications in economics, social sciences, computer science, engineering, evolutionary biology, etc. As it turns out, many game theoretical topics and tools have a strong geometrical or topological flavor: the structure of a game's equilibrium set, the design of equilibrium-computing algorithms, Blackwell approachability, the geometric character of the replicator dynamics, the use of semi-algebraicity concepts in stochastic games, and many others. Accordingly, our objective is to perform a systematic study of these geometric aspects of game theory and, by so doing, to establish new links between areas that so far appeared unrelated (such as Hessian-Riemannian geometry and discrete choice theory).

- *ANR MARMOTE, 2013-2016.* Partners: Inria Sophia (MAESTRO), Inria Rocquencourt (DIOGEN), PRiSM laboratory from University of Versailles-Saint-Quentin, Telecom SudParis (SAMOVAR), University Paris-Est Créteil (*Spécification et vérification de systèmes*), Université Pierre-et-Marie-Curie/LIP6.

The project aims at realizing a software prototype dedicated to Markov chain modeling. It gathers seven teams that will develop advanced resolution algorithms and apply them to various domains (reliability, distributed systems, biology, physics, economy).

- *ANR NETLEARN, 2013-2015.* Partners: PRiSM laboratory from University of Versailles-Saint-Quentin, Telecom ParisTech, Orange Labs, LAMSADE/University Paris Dauphine, Alcatel-Lucent, Inria (MESCAL).

The main objective of the project is to propose a novel approach of distributed, scalable, dynamic and energy efficient algorithms for managing resources in a mobile network. This new approach relies on the design of an orchestration mechanism of a portfolio of algorithms. The ultimate goal of the proposed mechanism is to enhance the user experience, while at the same time to better utilize the operator resources. User mobility and new services are key elements to take into account if the operator wants to improve the user quality of experience. Future autonomous network management and control algorithms will thus have to deal with a real-time dynamicity due to user mobility and to traffic variations resulting from various usages. To achieve this goal, we focus on two central aspects of mobile networks (the management of radio resources at the Radio Access Network level and the management of the popular contents users want to get access to) and intend to design distributed learning mechanisms in non-stationary environments, as well as an orchestration mechanism that applies the best algorithms depending on the situation.

- *ANR SONGS, 2012-2015.* Partners: Inria Nancy (Algorille), Inria Sophia (MASCOTTE), Inria Bordeaux (CEPAGE, HiePACS, RunTime), Inria Lyon (AVALON), University of Strasbourg, University of Nantes.

The last decade has brought tremendous changes to the characteristics of large scale distributed computing platforms. Large grids processing terabytes of information a day and the peer-to-peer technology have become common even though understanding how to efficiently exploit such platforms still raises many challenges. As demonstrated by the USS SimGrid project funded by the ANR in 2008, simulation has proved to be a very effective approach for studying such platforms. Although even more challenging, we think the issues raised by petaflop/exaflop computers and emerging cloud infrastructures can be addressed using similar simulation methodology.

The goal of the SONGS project (Simulation of Next Generation Systems) is to extend the applicability of the SimGrid simulation framework from grids and peer-to-peer systems to clouds and high performance computation systems. Each type of large-scale computing system will be addressed through a set of use cases and led by researchers recognized as experts in this area.

Any sound study of such systems through simulations relies on the following pillars of simulation methodology: Efficient simulation kernel; Sound and validated models; Simulation analysis tools; Campaign simulation management.

8.2.3. National Organizations

Jean-Marc Vincent is member of the scientific committees of the CIST (Centre International des Sciences du Territoire).

8.3. European Initiatives

8.3.1. FP7 & H2020 Projects

8.3.1.1. Mont-Blanc 2

Program: FP7 Programme

Project acronym: Mont-Blanc 2

Project title: Mont-Blanc: European scalable and power efficient HPC platform based on low-power embedded technology

Duration: October 2013 - September 2016

Coordinator: BSC (Barcelone)

Other partners: BULL - Bull SAS (France), STMicroelectronics - (GNB SAS) (France), ARM - (United Kingdom), JUELICH - (Germany), BADW-LRZ - (Germany), USTUTT - (Germany), CINECA - (Italy), CNRS - (France), Inria - (France), CEA - (France), UNIVERSITY OF BRISTOL - (United Kingdom), ALLINEA SW LIM - (United Kingdom)

Abstract: Energy efficiency is already a primary concern for the design of any computer system and it is unanimously recognized that future Exascale systems will be strongly constrained by their power consumption. This is why the Mont-Blanc project has set itself the following objective: to design a new type of computer architecture capable of setting future global High Performance Computing (HPC) standards that will deliver Exascale performance while using 15 to 30 times less energy. Mont-Blanc 2 contributes to the development of extreme scale energy-efficient platforms, with potential for Exascale computing, addressing the challenges of massive parallelism, heterogeneous computing, and resiliency. Mont-Blanc 2 has great potential to create new market opportunities for successful EU technology, by placing embedded architectures in servers and HPC.

The Mont-Blanc 2 proposal has 4 objectives:

1. To complement the effort on the Mont-Blanc system software stack, with emphasis on programmer tools (debugger, performance analysis), system resiliency (from applications to architecture support), and ARM 64-bit support.
2. To produce a first definition of the Mont-Blanc Exascale architecture, exploring different alternatives for the compute node (from low-power mobile sockets to special-purpose high-end ARM chips), and its implications on the rest of the system.
3. To track the evolution of ARM-based systems, deploying small cluster systems to test new processors that were not available for the original Mont-Blanc prototype (both mobile processors and ARM server chips).
4. To provide continued support for the Mont-Blanc consortium, namely operations of the Mont-Blanc prototype, and hands-on support for our application developers

8.3.1.2. *QUANTICOL*

Program: The project is a member of Fundamentals of Collective Adaptive Systems (FOCAS), a FET-Proactive Initiative funded by the European Commission under FP7.

Project acronym: QUANTICOL

Project title: A Quantitative Approach to Management and Design of Collective and Adaptive Behaviours

Duration: 04 2013 – 03 2017

Coordinator: Jane Hillston (University of Edinburgh, Scotland)

Other partners: University of Edinburgh (Scotland); Istituto di Scienza e Tecnologie della Informazione (Italy); IMT Lucca (Italy) and University of Southampton (England).

Abstract: The main objective of the QUANTICOL project is the development of an innovative formal design framework that provides a specification language for collective adaptive systems (CAS) and a large variety of tool-supported, scalable analysis and verification techniques. These techniques will be based on the original combination of recent breakthroughs in stochastic process algebras and associated verification techniques, and mean field/continuous approximation and control theory. Such a design framework will provide scalable extensive support for the verification of developed models, and also enable and facilitate experimentation and discovery of new design patterns for emergent behaviour and control over spatially distributed CAS.

8.3.1.3. NEWCOM#

Program: FP7-ICT-318306

Project acronym: NEWCOM#

Project title: Network of Excellence in Wireless Communications

Duration: 11 2012 – 10 2015

Coordinator: Consorzio Nazionale Interuniversitario per le Telecomunicazioni (Italy)

Other partners: Aalborg Universitet (AAU). Denmark; Bilkent Üniversitesi (Bilkent). Turkey; Centre National de la Recherche Scientifique (CNRS). France; Centre Tecnològic de Telecomunicacions de Catalunya (CTTC). Spain; Institute of Accelerating Systems and Applications (IASA). Greece; Inesc Inovacao; Instituto de Novas Tecnologias (INOV). Portugal; Poznan University of Technology (PUT). Poland; Technion - Israel Institute of Technology (TECHNION). Israel; Technische Universität Dresden (TUD). Germany; University of Cambridge (UCAM). United Kingdom; Université Catholique de Louvain (UCL). Belgium; Oulun Yliopisto (UOULU). Finland

Abstract: NEWCOM# is a project funded under the umbrella of the 7th Framework Program of the European Commission (FP7-ICT-318306). NEWCOM# pursues long-term, interdisciplinary research on the most advanced aspects of wireless communications like Finding the Ultimate Limits of Communication Networks, Opportunistic and Cooperative Communications, or Energy- and Bandwidth-Efficient Communications and Networking.

8.3.1.4. HPC4E

Title: HPC for Energy

Program: H2020

Duration: 01 2016 – 01 2018

Coordinator: Barcelona Supercomputing Center

Inria contact: Stephane Lanteri

Other partners:

- Europe: Lancaster University (ULANC), Centro de Investigaciones Energéticas Medioambientales y Tecnológicas (CIEMAT), Repsol S.A. (REPSOL), Iberdrola Renovables Energía S.A. (IBR), Total S.A. (TOTAL).
- Brazil: Fundação Coordenação de Projetos, Pesquisas e Estudos Tecnológicos (COPPE), National Laboratory for Scientific Computation (LNCC), Instituto Tecnológico de Aeronáutica (ITA), Petróleo Brasileiro S. A. (PETROBRAS), Universidade Federal do Rio Grande do Sul (INF-UFRGS), Universidade Federal de Pernambuco (CER-UFPE)

Abstract: The main objective of the HPC4E project is to develop beyond-the-state-of-the-art high performance simulation tools that can help the energy industry to respond future energy demands and also to carbon-related environmental issues using the state-of-the-art HPC systems. The other objective is to improve the cooperation between energy industries from EU and Brazil and the cooperation between the leading research centres in EU and Brazil in HPC applied to energy industry. The project includes relevant energy industrial partners from Brazil and EU, which will benefit from the project's results. They guarantee that TRL of the project technologies will be very high. This includes sharing supercomputing infrastructures between Brazil and EU. The cross-fertilization between energy-related problems and other scientific fields will be beneficial at both sides of the Atlantic.

8.3.2. Collaborations in European Programs, except FP7 & H2020

8.3.2.1. CROWN

Program: European Community and Greek General Secretariat for Research and Technology

Project acronym: CROWN

Project title: Optimal Control of Self Organized Wireless Networks

Duration: 2012-2015

Coordinator: Tassiulas Leandros

Other partners: Thales, University of Thessaly, National and Kapodistrian University of Athens, Athens University of Economics and Business

Abstract: Wireless networks are rapidly becoming highly complex systems with large numbers of heterogeneous devices interacting with each other, often in a harsh environment. In the absence of central control, network entities need to self-organize to reach an efficient operating state, while operating in a distributed fashion. Depending on whether the operating criteria are individual or global, nodes interact in an autonomic or coordinated way. Despite recent progress in autonomic networks, the fundamental understanding of the operational behaviour of large-scale networks is still lacking. This project will address these emergent network properties, by introducing new tools and concepts from other disciplines.

We will first analyze how imperfect network state information can be harvested and distributed efficiently through the network using machine learning techniques. We will design flexible methodologies to shape the competition between autonomous nodes for resources, with aim to maintain robust social optimality. Both cooperating and non-cooperating game-theoretic models will be used. We also consider networks with nodes coordinating to achieve a joint task, e.g., global optimization. Using algorithms inspired from statistical physics, we will address two representative paradigms in the context of wireless ad hoc networks, namely connectivity optimization and the localization of a network of primary sources from a sensor network.

Finally, we will explore delay tolerant networks as a case study of an emerging class of networks that, while sharing most of the characteristics of traditional autonomic or coordinated networks, they present unique challenges, due to the intermittency and constant fluctuations of the connectivity. We will study tradeoffs involving delay, the impact of mobility on information transfer, and the optimal usage of resources by using tools from information theory and stochastic evolution theory.

8.3.3. Collaborations with Major European Organizations

University of Athens: Panayotis Mertikopoulos was an invited professor for 3 months.

EPFL: Laboratoire pour les communications informatiques et leurs applications 2, Institut de systèmes de communication ISC, Ecole polytechnique fédérale de Lausanne (Switzerland). We collaborate with Jean-Yves Leboudec (EPFL) and Pierre Pinson (DTU) on electricity markets.

University of Edinburgh and Istituto di Scienza e Tecnologia della Informazione: we strongly collaborate through the Quanticol European project.

University of Antwerp: we collaborate with Benny Van Houdt on caching problems.

TU Wien: Research Group Parallel Computing, Technische Universität Wien (Austria). We collaborate with Sascha Hunold on experimental methodology and reproducibility of experiments in HPC.

8.4. International Initiatives

8.4.1. Inria International Labs

8.4.1.1. North America

- JLESC (former JLPC) (Joint Laboratory for Extreme-Scale Computing) with University of Illinois Urbana Champaign, Argonne Nat. Lab and BSC. Several members of MESCAL are partners of this laboratory, and have done several visits to Urbana-Champaign or NCSA.

8.4.2. Inria Associate Teams not involved in an Inria International Labs

8.4.2.1. EXASE

Title: Exascale Computing Scheduling and Energy

International Partner (Institution - Laboratory - Researcher):

Universidade Federal do Rio Grande do Sul (Brazil) - INF (INF) - Nicolas MAILLARD

Start year: 2014

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

The main scientific goal of this collaboration for the three years is the development of state-of-the-art energy-aware scheduling algorithms for exascale systems. Three complementary research directions have been identified : (1) Fundamentals for the scaling of schedulers: develop new scheduling algorithms for extreme exascale machines and use existing workloads to validate the proposed scheduling algorithms (2) Design of schedulers for large-scale infrastructures : propose energy-aware schedulers in large-scale infrastructures and develop adaptive scheduling algorithms for exascale machines (3) Tools for the analysis of large scale schedulers : develop aggregation methodologies for scheduler analysis to propose synthesized visualizations for large traces analysis and then analyze schedulers and energy traces for correlation analysis

8.4.3. Inria International Partners

8.4.3.1. Declared Inria International Partners

- MESCAL has strong connections with both UFRGS (Porto Alegre, Brazil) and USP (Sao Paulo, Brazil). The creation of the LICIA common laboratory (see next section) has made this collaboration even tighter.
- MESCAL has strong bounds with the University of Illinois Urbana Champaign, within the (Joint Laboratory on Petascale Computing, see previous section).

8.4.4. Participation In other International Programs

8.4.4.1. South America

- LICIA. The CNRS, Inria, the Universities of Grenoble, Grenoble INP and Universidade Federal do Rio Grande do Sul have created the LICIA (*Laboratoire International de Calcul intensif et d'Informatique Ambiante*). Jean-Marc Vincent is the director of the laboratory, on the French side.

The main themes are high performance computing, language processing, information representation, interfaces and visualization as well as distributed systems.

More information can be found at <http://www.inf.ufrgs.br/licia/>.

8.5. International Research Visitors

8.5.1. Visits of International Scientists

Stan Zachary and James Cruise, from Heriot-Watt University at Edinburgh, came for a week in the context of the European Quanticol project. Lucas Schnorr and Philippe Navaux from UFRGS (Porto Alegre, Brazil) both came for a week in the context of the EXASE associated team.

MOAIS Project-Team

7. Partnerships and Cooperations

7.1. Regional Initiatives

- MOAIS participates to the creation of an Alpine Multidisciplinary Network on CYbersecurity Studies (AMNECYs). The academic teams and laboratories participating in this project have already developed great expertise on encryption technologies, vulnerabilities analysis, software engineering, protection of privacy and personal data, international & European aspects of cybersecurity. The first project proposal (ALPEPIC ALPs-Embedded security: Protecting IoT & Critical infrastructure) focuses on the protection of the Internet of Things (IoT) and Critical Infrastructure (CI).
Leader: CESICE, UPMF (Théodore Cristakis). Partners: Inria/Privatics and LIG/Moais, Gipsa-lab, LJK, Institut Fourier, TIMA, Verimag, LISTIC (Pole MSTIC)

7.2. National Initiatives

7.2.1. ANR

- **ANR grant MOEBIUS (2013-2015)**. Multi-objective scheduling for large computing platforms. Coordinator: Grenoble-INP (Moais team). Partners: Grenoble-INP, Inria, BULL.
- **ANR grant EXAVIZ (2011-2015)**. Large Scale Interactive Visual Analysis for Life Science. Partners: Inria Rhône-Alpes, Université d'Orléans, the LBT lab from IBPC, the LIMSI from Université d'Orsay, and the CEMHTI labs from CNRS.
- **ANR HPAC (2012-2015)**. High Performance Algebraic Computing. Coordinator: UJF (LJK/CASYS team). Partners: project-team MOAIS (Grenoble), project-team ARENAIRE (LIP, Lyon), project-team SALSA (LIP6, Paris), the ARITH group (LIRMM lab, Montpellier).
- **Equipex Kinovis (2012-2017)**. 2.6 Meuros. Large scale multi-camera platform (extension of the Grimage platform to 60 cameras, depth and X-ray cameras). Coordinator E Boyer, LJK Inria MORPHEO team. Partners: Inria Rhône-Alpes and the LJK, LIG, LADAF and GIPSA labs.
- **ANR-11-LABX-0025 PERSYVAL-Lab** funds the following PhD in collaboration with other labs:
 - in collaboration with Verimag: Multi-objective optimization for resource management on multicore systems, (PhD Abhinav Srivastav, since 9/2012)
 - In collaboration with Gipsa-lab and Inria BiBop: Simulations of Fibrous Materials. (PhD Gilles Daviet, since 9/2013)
 - in collaboration with Inria Privatics and Verimag: Secure Outsourcing (PhD Amrit Kumar, since 11/2013)

7.2.2. Competitivity Clusters

- **SoC-Trace**, Minalogic 2011-2015 contract. This project aims the development of tools for the monitoring and debug of multicore systems on chip. Leader: ST-Microelectronic. Partners: Inria (Mescal, Moais); UJF (TIMA, LIG/Hadas); Magilem, ProBayes. Moais contributes with technics and tools for visual aggregation of application traces. The contract funds 1 PhD thesis (Damien Dosimont) and 1 year engineer.
- **ARAMIS, PIA contract n°P3342-146798 (2014-2017)**: Architecture Robuste pour les Automates et Matériels des Infrastructures Sensibles. Coordinator: ATOS-WorldGrid; Partners: CEA, SecLab, UJF. The UJF gathers the following teams: LIG (Moais, Drakkar, Vasco); LJK (Casys); IF; Verimag (DCS). BPI funds UJF with 775 ke (funds 4 PhDs and 5 years engineers), among which 410ke for LIG. Moais co-advises two PhD Thesis: Nicolas Kox with LIG-VASCO team (Protocol firewall with security guarantees for control-command systems); Maxime Puy with VERIMAG-DCS (Generation of certified filters for control-command systems).

- **PIA ELCI (2014-2017)**. Environnement Logiciel pour le Calcul Intensif. Coordinator BULL. Partners: BULL, CEA, Inria, SAFRAB, UVSQ.

7.2.3. National ADT

- ADT K'STAR with cooperation between EPIs MOAIS and RUNTIME (Bordeaux). Coordinator: T. Gautier. <https://gforge.inria.fr/projects/kstar>. The main objective is to provide OpenMP-3.1 with some extension from OpenMP-4.0 standard to perform OpenMP programs on multi-CPU multi-GPU by using XKaapi and StarPU runtimes.

7.2.4. Inria Project Lab

7.2.4.1. C2S@Exa - Computer and Computational Sciences at Exascale

Participants: Olivier Aumage [RUNTIME project-team, Inria Bordeaux - Sud-Ouest], Jocelyne Erhel [SAGE project-team, Inria Rennes - Bretagne Atlantique], Philippe Helluy [TONUS project-team, Inria Nancy - Grand-Est], Laura Grigori [ALPINE project-team, Inria Saclay - Île-de-France], Jean-Yves L'Excellent [ROMA project-team, Inria Grenoble - Rhône-Alpes], Thierry Gautier [MOAIS project-team, Inria Grenoble - Rhône-Alpes], Luc Giraud [HIEPACS project-team, Inria Bordeaux - Sud-Ouest], Michel Kern [POMDAPI project-team, Inria Paris - Rocquencourt], Stéphane Lanteri [Coordinator of the project], François Pellegrini [BACCHUS project-team, Inria Bordeaux - Sud-Ouest], Christian Perez [AVALON project-team, Inria Grenoble - Rhône-Alpes], Frédéric Vivien [ROMA project-team, Inria Grenoble - Rhône-Alpes].

Since January 2013, the team is participating to the C2S@Exa http://www-sop.inria.fr/c2s_at_exa Inria Project Lab (IPL). This national initiative aims at the development of numerical modeling methodologies that fully exploit the processing capabilities of modern massively parallel architectures in the context of a number of selected applications related to important scientific and technological challenges for the quality and the security of life in our society. At the current state of the art in technologies and methodologies, a multidisciplinary approach is required to overcome the challenges raised by the development of highly scalable numerical simulation software that can exploit computing platforms offering several hundreds of thousands of cores. Hence, the main objective of C2S@Exa is the establishment of a continuum of expertise in the computer science and numerical mathematics domains, by gathering researchers from Inria project-teams whose research and development activities are tightly linked to high performance computing issues in these domains. More precisely, this collaborative effort involves computer scientists that are experts of programming models, environments and tools for harnessing massively parallel systems, algorithmists that propose algorithms and contribute to generic libraries and core solvers in order to take benefit from all the parallelism levels with the main goal of optimal scaling on very large numbers of computing entities and, numerical mathematicians that are studying numerical schemes and scalable solvers for systems of partial differential equations in view of the simulation of very large-scale problems.

T. Gautier is coordinator of the Pole 4: Programming Models.

7.3. European Initiatives

7.3.1. FP7 & H2020 Projects

7.3.1.1. HPC4E

Title: HPC for Energy

Programm: H2020

Duration: 2015-2020

Coordinator: Barcelona Supercomputing Center

Inria contact: Stephane Lanteri

The main objective is to develop beyond-the-state-of-the-art high performance simulation tools that can help the energy industry to respond future energy demands and also to carbon-related environmental issues using the state-of-the-art HPC systems. The project also aims at improving the usage of energy using HPC tools by acting at many levels of the energy chain for different energy sources: Exploitation: In wind energy (respond to demand peaks, output prediction) Efficiency: In biomass-derived fuels (develop more efficient and renewable fuels, reduce green-house gas emissions, reduce hydrocarbon dependency and fuel cost) Exploration: In wind energy (resource assessment) and in hydrocarbons (improve available reserves, explore with less financial and environmental risk). Another objective is to improve the cooperation between energy industries from EU and Brazil. The project includes relevant energy industrial partners from Brazil (PETROBRAS) and EU (REPSOL and TOTAL as O&G industries), which will benefit from the project's results. They guarantee that TRL of the project technologies will be very high. A last objective is to improve the cooperation between the leading research centres in EU and Brazil in HPC applied to energy industry. This includes sharing supercomputing infrastructures between Brazil and EU. The cross-fertilization between energy-related problems and other scientific fields will be beneficial at both sides of the Atlantic.

7.3.1.2. VISIONAIR

Title: VISION ADVANCED INFRASTRUCTURE FOR RESEARCH

Programm: FP7

Duration: February 2011 - January 2015

Coordinator: Grenoble-INP

Partners:

- Ecole Nationale Supérieure d'arts et Métiers (France)
- Université d'Aix Marseille (France)
- Consiglio Nazionale Delle Ricerche (Italy)
- Cranfield University (United Kingdom)
- Ecole Centrale de Nantes (France)
- "European Manufacturing and Innovation Research Association, A Cluster Leading Excellence" (Belgium)
- Fraunhofer-Gesellschaft zur Förderung der Angewandten Forschung e.V (Germany)
- Institut Polytechnique de Grenoble (France)
- Inpg Entreprise (France)
- Kungliga Tekniska Högskolan (Sweden)
- Politecnico di Milano (Italy)
- Instytut Chemii Bioorganicznej Polskiej Akademii Nauk (Poland)
- Poznan University of Technology (Poland)
- Rheinisch-Westfälische Technische Hochschule Aachen (Germany)
- Magyar Tudományos Akadémia Számítástechnikai és Automatizálási Kutató Intézet (Hungary)
- Technion - Israel Institute of Technology. (Israel)
- University College London (United Kingdom)
- University of Essex (United Kingdom)
- Technische Universität Kaiserslautern (Germany)
- University of Patras (Greece)
- Universität Stuttgart (Germany)

University of Bristol (United Kingdom)
 The University Offord (United Kingdom)
 Universite de la Mediterranee' aix-Marseille Ii (France)
 Universiteit Twente (Netherlands)
 "fundacio Privada I2cat, Internet I Innovacio Digital A Catalunya" (Spain)

Inria contact: G. Dumont

VISIONAIR is a project of creation of a European infrastructure that should be a unique, visible and attractive entry towards high level visualisation facilities. These facilities must be open to the access of a wide set of research communities. By integrating existing facilities, it will create a world-class research infrastructure enabling to conduct frontier research. This integration will provide a significant attractiveness and visibility of the European Research Area. Current scientific challenges concern climate evolution, environmental risks, health, energy, etc. and require the management of more and more complex information. The development of information technologies, the increasing complexity of the information to be handled and analysed, along with the increasing capacities in scientific and engineering simulations, call for the development of increasingly powerful visualisation tools and methods. The Europe Research Area must be able to compete with other big Research Areas when addressing the previously defined challenges. By integrating visualisation facilities with the VISIONAIR project, ERA will be able to answer integrated challenges out of the scope of usually disseminated research teams. Both, physical access and virtual services, will be provided by the infrastructure. A full access to visualisation dedicated software will be organised, while physical access on high level platforms, will be partially (about 20% of global usage) open for other scientists for free on behalf of excellence of submitted projects. The partners of this project propose to build a common infrastructure that would grant access to high level visualisation facilities and resources to researchers. Indeed, researchers from Europe and from around the world will be welcome to carry out research projects using the visualisation facilities provided by the infrastructure. Visibility and attractiveness of ERA will be increased by the invitation of external projects.

7.3.1.3. VELA^{SSCo}

Title: Visualization For Extremely Large-Scale Scientific Computing
 Program: STREP (Specific Targeted Research Project)
 Duration: January 2014 - December 2016
 Coordinator: Centre Internacional de Metodes Numerics en Enginyeria (Spain)
 Partners: JOTNE (No.), SINTEF (No.), Fraunhofer IGD (D), ATOS (SP), Univ. Edinburgh (UK)
 Inria contact: Toan Nguyen, Bruno Raffin

Abstract: VELA^{SSCo} aims at developing a new concept of integrated end-user visual analysis methods with advanced management and post-processing algorithms for engineering modelling applications, scalable for real-time petabyte level simulations [59]. The interface will enable real-time interrogation of simulation data, generating key information for analysis. Main concerns have to do with handling of large amounts of data of a very specific kind intrinsically linked to geometrical properties; how to store, access, simplify and manipulate billion of records to extract the relevant information; how to represent information in a feasible and flexible way; and how to visualise and interactively inspect the huge quantity of information they produce taking into account end-user's needs. VELA^{SSCo} achieves this by putting together experts with relevant background in Big Data handling, advanced visualisation, engineering simulations, and a User Panel including research centres, SMEs and companies from key European industrial sectors such as aerospace, household products, chemical, pharmaceutical and civil engineering.

7.3.1.4. GRAIN 2

Type: Cooperation

Defi: Transport (incl. Aeronautics)

Instrument: Coordination and Support Action (CSA)

Duration: October 2013 - June 2016

Coordinator: Centre Internacional de Metodes Numerics en Enginyeria, Barcelone (Spain)

Partner: Airbus (Sp), Alenia (I), EADS-IW (F), Rolls-Royce (UK), Ingenia (Sp.), Numeca (B), U. Sheffield (UK), U. Birmingham (UK), CIRA (I), VKI (B), Airbone (NL), Leitao (Sp), Cerfacs (F), U. Cranfield (UK), CAE (CN), GTE (CN), ARI (CN), FAI (CN), ASRI (CN), SAERI (CN), BIAM (CN), ACTRI (CN), BUAA (CN), NPU (CN), PKU (CN), NUAU (CN), ZIU (CN)

Inria contact: Toan Nguyen

Abstract: The main objective of GRAIN2 is to focus its greening activities following the Flight Path 2050 Vision for Aircraft. GRAIN2 will in particular identify innovative R&D methods, tools and HPC environments (supercomputers and GPGPUs) according to the needs of major aeronautical industries to deeper understand the mechanism of engine exhaust emissions, to improve fuel efficiency and environmental performance.

7.4. International Initiatives

7.4.1. Inria International Labs

JLESC

Associate Team involved in the International Lab:

7.4.1.1. ANOMALIES@EXASCALE

Title: Anomalies Detection and Handling towards Exascale Platforms

International Partner (Institution - Laboratory - Researcher):

University of Chicago (United States) - Argonne National Laboratory (ANL) - Franck Cappello

Start year: 2014

See also: <http://anomalies.imag.fr>

The Anomalies@exascale project intends to prospect new scheduling solutions for very large parallel computing platforms. In particular, we consider the new problems related to fault tolerance raising with the developments of exascale platforms. We expect to define new ways to detect both execution failures and more transient performance anomalies. Information gathered from the detectors will then be taken into account by schedulers to implement corrective measures.

7.4.2. Inria Associate Teams not involved in an Inria International Labs

7.4.2.1. ExaSE

Title: Exascale Computing Scheduling and Energy

International Partner (Institution - Laboratory - Researcher):

UFRGS, PUC Minas and UPS (Brazil)

Duration: 2014 - 2016

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

The main scientific context of this project is high performance computing on Exascale systems: large-scale machines with billions of processing cores and complex hierarchical structures. This project intends to explore the relationship between scheduling algorithms and techniques and the energy constraints present on such exascale systems.

7.4.3. Participation In other International Programs

7.4.3.1. LICIA

Title: International Laboratory in High Performance and Ubiquitous Computing

International Partner (Institution - Laboratory - Researcher):

UFRGS (Brazil)

Duration: 2011 - 2018

See also: <http://licia-lab.org/>

The LICIA is an International Laboratory and High Performance and Ubiquitous Computing born in 2011 from the common desire of members of Informatics Institute of the Federal University of Rio Grande do Sul and of Laboratoire d'Informatique de Grenoble to enhance and develop their scientific partnership that started by the end of the 1970. LICIA is an International Associated Lab of the CNRS, a public french research institution. It has support from several brazilian and french research funding agencies, such as CNRS, Inria, ANR, European Union (from the french side) and CAPES, CNPq, FAPERGS (from the Brazilian side). Moais is deeply involved in the creation and animation of LICIA. Bruno Raffin is LICIA associate director.

7.4.3.2. CAPES/COFECUB StarShip

Title: Scalable Tools and Algorithms para Resilient, Scalable, Hybrid Interactive Processing

International Partner (Institution - Laboratory - Researcher):

UFRGS (Brazil)

Duration: 2013 - 2016

7.5. International Research Visitors

7.5.1. Visits of International Scientists

- Daouda Traore, Director of Informatics Dept at Seguou Univ., Mali (oct-nov. 2015)

7.5.1.1. Internships

KHATIRI Mohammed

Date: Sep 2015 - Dec 2015

Institution: UMP (Morocco)

Supervisor: Denis Trystram

7.5.2. Visits to International Teams

7.5.2.1. Research stays abroad

- B. Raffin visited the Universidad A Coruña, Spain, from Sept 2015 to Dec 2015.

ROMA Project-Team

9. Partnerships and Cooperations

9.1. Regional Initiatives

9.1.1. PhD grant laboratoire d'excellence MILYON-Mumps consortium

Thanks to the doctoral program from the MILYON labex dedicated to applied research in collaboration with industrial partners, we obtained 50% of a PhD grant, the other 50% being funded by the MUMPS consortium. The PhD student will focus on improvements of the solution phase of the MUMPS solver, in accordance to requirements from industrial members of the consortium.

9.1.2. Cooperation with ECNU

ENS Lyon has launched a partnership with ECNU, the East China Normal University in Shanghai, China. This partnership includes both teaching and research cooperation.

As for teaching, the PROSFER program includes a joint Master of Computer Science between ENS Rennes, ENS Lyon and ECNU. In addition, PhD students from ECNU are selected to conduct a PhD in one of these ENS. Yves Robert is responsible for this cooperation. He has already given two classes at ECNU, on Algorithm Design and Complexity, and on Parallel Algorithms, together with Patrice Quinton (from ENS Rennes).

As for research, the JORISS program funds collaborative research projects between ENS Lyon and ECNU. Yves Robert and Changbo Wang (ECNU) are leading a JORISS project on resilience in cloud and HPC computing.

9.2. National Initiatives

9.2.1. ANR

ANR White Project RESCUE (2010-2015), 4 years. The ANR White Project RESCUE was launched in November 2010, for a duration of 48 months (and was later extended for 6 additional months, up to June 2015). It gathers three Inria partners (ROMA, Grand-Large and Hiepac) and is led by ROMA. The main objective of the project is to develop new algorithmic techniques and software tools to solve the *exascale resilience problem*. Solving this problem implies a departure from current approaches, and calls for yet-to-be-discovered algorithms, protocols and software tools.

This proposed research follows three main research thrusts. The first thrust deals with novel *checkpoint protocols*. The second thrust entails the development of novel *execution models*, i.e., accurate stochastic models to predict (and, in turn, optimize) the expected performance (execution time or throughput) of large-scale parallel scientific applications. In the third thrust, we will develop novel *parallel algorithms* for scientific numerical kernels.

ANR Project SOLHAR (2013-2017), 4 years. The ANR Project SOLHAR was launched in November 2013, for a duration of 48 months. It gathers five academic partners (the HiePACS, Cepage, ROMA and Runtime Inria project-teams, and CNRS-IRIT) and two industrial partners (CEA/CESTA and EADS-IW). This project aims at studying and designing algorithms and parallel programming models for implementing direct methods for the solution of sparse linear systems on emerging computers equipped with accelerators.

The proposed research is organized along three distinct research thrusts. The first objective deals with linear algebra kernels suitable for heterogeneous computing platforms. The second one focuses on runtime systems to provide efficient and robust implementation of dense linear algebra algorithms. The third one is concerned with scheduling this particular application on a heterogeneous and dynamic environment.

9.2.2. Inria Project Lab C2S@Exa - Computer and Computational Sciences at Exascale

Participants: Olivier Aumage [RUNTIME project-team, Inria Bordeaux - Sud-Ouest], Jocelyne Erhel [SAGE project-team, Inria Rennes - Bretagne Atlantique], Philippe Helluy [TONUS project-team, Inria Nancy - Grand-Est], Laura Grigori [ALPINE project-team, Inria Saclay - Île-de-France], Jean-Yves L'Excellent [ROMA project-team, Inria Grenoble - Rhône-Alpes], Thierry Gautier [MOAIS project-team, Inria Grenoble - Rhône-Alpes], Luc Giraud [HIEPACS project-team, Inria Bordeaux - Sud-Ouest], Michel Kern [POMDAPI project-team, Inria Paris - Rocquencourt], Stéphane Lanteri [Coordinator of the project], François Pellegrini [BACCHUS project-team, Inria Bordeaux - Sud-Ouest], Christian Perez [AVALON project-team, Inria Grenoble - Rhône-Alpes], Frédéric Vivien [ROMA project-team, Inria Grenoble - Rhône-Alpes].

Since January 2013, the team is participating to the C2S@Exa http://www-sop.inria.fr/c2s_at_exa Inria Project Lab (IPL). This national initiative aims at the development of numerical modeling methodologies that fully exploit the processing capabilities of modern massively parallel architectures in the context of a number of selected applications related to important scientific and technological challenges for the quality and the security of life in our society. At the current state of the art in technologies and methodologies, a multidisciplinary approach is required to overcome the challenges raised by the development of highly scalable numerical simulation software that can exploit computing platforms offering several hundreds of thousands of cores. Hence, the main objective of C2S@Exa is the establishment of a continuum of expertise in the computer science and numerical mathematics domains, by gathering researchers from Inria project-teams whose research and development activities are tightly linked to high performance computing issues in these domains. More precisely, this collaborative effort involves computer scientists that are experts of programming models, environments and tools for harnessing massively parallel systems, algorithmists that propose algorithms and contribute to generic libraries and core solvers in order to take benefit from all the parallelism levels with the main goal of optimal scaling on very large numbers of computing entities and, numerical mathematicians that are studying numerical schemes and scalable solvers for systems of partial differential equations in view of the simulation of very large-scale problems.

9.3. European Initiatives

9.3.1. FP7 & H2020 Projects

9.3.1.1. SCORPIO

Title: Significance-Based Computing for Reliability and Power Optimization

Programm: FP7

Duration: June 2013 - May 2016

Coordinator: Nikolaos Bellas

Partners: CERTH, Greece; EPFL, Switzerland; RWTH Aachen University, Germany; The Queen's University of Belfast, UK; IMEC, Belgium

Inria contact: Frédéric Vivien

Manufacturing process variability at low geometries and power dissipation are the most challenging problems in the design of future computing systems. Currently manufacturers go to great lengths to guarantee fault-free operation of their products by introducing redundancy in voltage margins, conservative layout rules, and extra protection circuitry. However, such design redundancy may result into energy overheads. Energy overheads cannot be alleviated by lowering supply voltage below a nominal value without hardware components experiencing faulty operation due to timing errors. On the other hand, many modern workloads, such as multimedia, machine learning, visualization, etc. are designed to tolerate a degree of imprecision in computations and data. SCORPiO seeks to exploit this observation and to relax reliability requirements for the hardware layer by allowing a controlled degree of imprecision to be introduced to computations and data. It proposes to introduce methodologies that allow the system- and application-software layers to synergistically characterize the significance of various parts of the program for the quality of the end result, and their tolerance

to faults. Based on this information, extracted automatically or semi-automatically, the system software will steer computations and data to either low-power, yet unreliable or higher-power and reliable functional and storage units. In addition, the system will be able to aggressively reduce its power footprint by opportunistically powering hardware modules below nominal values. Significance-based computing lays the foundations for not only approaching the theoretical limits of energy reduction of CMOS technology, but moving beyond those limits by accepting hardware faults in a controlled manner. Significance-based computing promises to be a preferred alternative to dark silicon, which requires that large portions of a chip be powered-off in every cycle to avoid excessive power dissipation.

9.4. International Initiatives

9.4.1. Inria International Labs

The University of Illinois at Urbana-Champaign, Inria, the French national computer science institute, Argonne National Laboratory, Barcelona Supercomputing Center, Jülich Supercomputing Centre and the Riken Advanced Institute for Computational Science formed the Joint Laboratory on Extreme Scale Computing, a follow-up of the Inria-Illinois Joint Laboratory for Petascale Computing. The Joint Laboratory is based at Illinois and includes researchers from Inria, and the National Center for Supercomputing Applications, ANL, BSC and JSC. It focuses on software challenges found in extreme scale high-performance computers.

Research areas include:

- Scientific applications (big compute and big data) that are the drivers of the research in the other topics of the joint-laboratory.
- Modeling and optimizing numerical libraries, which are at the heart of many scientific applications.
- Novel programming models and runtime systems, which allow scientific applications to be updated or reimaged to take full advantage of extreme-scale supercomputers.
- Resilience and Fault-tolerance research, which reduces the negative impact when processors, disk drives, or memory fail in supercomputers that have tens or hundreds of thousands of those components.
- I/O and visualization, which are important part of parallel execution for numerical simulations and data analytics
- HPC Clouds, that may execute a portion of the HPC workload in the near future.

Several members of the ROMA team are involved in the JLESC joint lab through their research on resilience. Yves Robert is the Inria executive director of JLESC.

9.4.2. Inria Associate Teams not involved in an Inria International Labs

- Laure Gonnord and Maroua Maalej are involved in the PROSPIEL Associate Team (Inria/ Brasil, <https://team.inria.fr/alf/prospiel/>). The PROSPIEL project aims at optimizing parallel applications for high performance on new throughput-oriented architectures: GPUs and many-core processors. Specifically, Laure Gonnord and Maroua Maalej are in charge of designing static analyses for GPUs. In Feb.-Apr. 2016, ROMA will host one student coming from the Brazilian team.

9.4.3. Inria International Partners

9.4.3.1. Declared Inria International Partners

- Christophe Alias has a regular collaboration with Sanjay Rajopadhye from Colorado State University (USA) through the advising of the PhD thesis of Guillaume Iooss. Since September 2015, this collaboration led to one publication, see Section 7.27 .
- Anne Benoit and Yves Robert have a regular collaboration with Padma Raghavan from Penn State University (USA). They have achieved several publications in 2015, see Sections 7.8 and 7.26 .

- Anne Benoit, Frédéric Vivien and Yves Robert have a regular collaboration with Henri Casanova from Hawaii University (USA). This is a follow-on of the Inria Associate team that ended in 2014. They have achieved one publication in 2015, see Section 7.1 .

9.5. International Research Visitors

9.5.1. Visits of International Scientists

- Fernando M. Pereira was invited in Jan. 2015 to work with Maroua Maalej and Laure Gonnord on static analyses for pointers.
- Oliver Sinnen was invited for two months (Sept./Oct. 2015) to work with Loris Marchal, Bertrand Simon and Frédéric Vivien on scheduling malleable task trees.
- Samuel McCauley visited the team for four months (Oct. 2015 - Feb. 2016) to work with Loris Marchal, Bertrand Simon and Frédéric Vivien on the minimization of I/Os during the out-of-core execution of task trees.

9.5.1.1. Internships

- Anne Benoit and Yves Robert advised the M2 internship of Loic Pottier on resilient application co-scheduling with processor redistribution.
- Christophe Alias advised the M2 internship of Adilla Susungi on the compilation of pipelined parallelism on multi-GPU.
- Guillaume Aupy and Loris Marchal advised the L3 internship of Clément Brasseur on memory minimization for the parallel processing of task trees.
- Julien Herrmann and Yves Robert advised the L3 internship of Nicolas Vidal on the evaluation of the makespan of stochastic computational workflows.

9.5.2. Visits to International Teams

9.5.2.1. Research stays abroad

- Yves Robert has been appointed as a visiting scientist by the ICL laboratory (headed by Jack Dongarra) at the University of Tennessee Knoxville. He collaborates with several ICL researchers on high-performance linear algebra and resilience methods at scale.
- Bertrand Simon spent six months (Feb.-Jul. 2015) at Stony Brooks University (USA) to work with Michael Bender.

SOCRATE Project-Team

8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. Equipex FIT- Future Internet of Things (2011-..., 1.064 keuros)

The FIT projet is a national equipex (*équipement d'excellence*), headed by the Lip6 laboratory. As a member of Inria, Socrate is in charge of the development of an Experimental Cognitive Radio platform that should be used as test-bed for SDR terminals and cognitive radio experiments. This should be operational in 2013 for a duration of 7 years. To give a quick view, the user will have a way to configure and program through Internet several SDR platforms (MIMO, SISO, and baseband processing nodes).

8.1.2. ANR - Cormoran - "Cooperative and Mobile Wireless Body Area Networks for Group Navigation" (2012-2015, 150 keuros)

Cormoran project targets to figure out innovative communication functionalities and radiolocation algorithms that could benefit from inter/intra-BAN cooperation. More precisely, the idea is to enable accurate nodes/body location, as well as Quality of Service management and communications reliability (from the protocol point of view), while coping with inter-BAN coexistence, low power constraints and complying with the IEEE 802.15.6 standard. The proposed solutions will be evaluated in realistic applicative scenarios, hence necessitating the development of adapted simulation tools and real-life experiments based on hardware platforms. For this sake, Cormoran will follow an original approach, mixing theoretical work (e.g. modelling activities, algorithms and cross-layer PHY/MAC/NWK design) with more practical aspects (e.g. channel and antennas measurement campaigns, algorithms interfacing with real platforms, demonstrations).

8.1.3. ANR - MetalibM - "Automatic Generation of Function and Filters" (2014-2017, 200 keuros)

The goal of the Metalibm project is to provide a tool for the automatic implementation of mathematical (libm) functions. A function f is automatically transformed into machine-proven C code implementing an polynomial approximation in a given domain with given accuracy. This project is led by Inria, with researchers from Socrate and AriC; PEQUAN team of Laboratoire d'Informatique de Paris 6 (LIP6) at Université Pierre et Marie Curie, Paris; DALI team from Université de Perpignan Via Domitia and Laboratoire d'Informatique, Robotique et Microélectronique de Montpellier (LIRMM); and SFT group from Centre Européen de Recherche Nucléaire (CERN).

8.1.4. FUI SMACS - "SMart And Connected Sensors" (2013-2016, 267 keuros)

The SMACS projet targets the deployment of an innovating wireless sensor network dedicated to many domains sport, health and digital cities. The projet involves Socrate (Insavalor), HIKOB and wireless broadcasting company Euro Media France. The main goal is to develop a robust technologie enabling real-time localization of mobile targets (like cyclist for instance), at a low energy (more generally low cost). The technology will be demonstrated at real cycling races (Tour de France 2013 and 2014). One of the goal is to include localisation information with new radio technology. Another subject of study is distributed wireless consensus algorithms for maintaining a neighborhood knowledge with a low energy budget that scales (more than 200 cycles together)

8.1.5. ADT Sytare (Développement d'un SYSTème embArqué faible consommation à mémoiRE persistante) ADT Inria 2015-2017

The SYTARE project aims to develop and study novel operating system mechanisms for NVRAM-based embedded systems. The term NVRAM collectively describes an emerging generation of memory technologies which are both non-volatile and byte-addressable. These two properties together make the classical RAM+ROM memory architecture obsolete, and enable the design of embedded systems running on intermittent power. This is very attractive in the context of energy-constrained scenarios, for instance systems harvesting their power from the environment. But working with NVRAM also poses novel challenges in terms of software programming. For instance, application state consistency must be guaranteed accross reboots, even though the system includes both NVRAM and volatile elements (e.g. CPU, hardware peripherals). The SYTARE project is funded by Inria via the ADT program.

8.1.6. ADT CorteXlab, ADT Inria 2015-2017

The Socrate project-team is in charge of the FIT/CorteXlab platform (section 5.6). This platform makes use of many complex technologies from signal processing to computer science through micro-electronics and FPGA. The objectiv of the CorteXlab ADT is to maintain a support to the user of the FPGA-based platform of CorteXlab and to provide tutorial and running experiment that will help them in builing experimentation using the PicoSDR machines.

8.1.7. Taiwan III - research proposal on 5G M2M 2015-2016

In the context of the MoU signed between Inria and The National Science Council of Taiwan. Taiwan's Institute for Information Industry (III) and Socrate signed a one-year contract for a research proposal containing two items: a first to study the OFDMA-based RACH access from theoretical or mathematical models and a second to set up an experiment in CorteXlab that will emulate a given number of M2M device using a narrow band radio protocol and record the resulting radio environment. This document described in more detail the research proposal.

8.2. European Initiatives

8.2.1. FP7 & H2020 Projects

8.2.1.1. CYBERNETS

Title: Cybernetic Communication Networks: Fundamental Limits and Engineering Challenges

Programm: H2020 - Marie Skłodowska-Curie Actions - Individual Fellowships

Duration: June 2015 - June 2017

Coordinator: Inria

Recipient: Samir Perlaza

This Reintegration Panel proposal, CYBERNETS, focuses on the study of Cybernetic Communication Networks (CCN). CCNs are wireless networks that are context-aware, possess learning capabilities and artificial intelligence to guarantee reliability, efficiency and resilience to changes, failures or attacks via autonomous, self-configuring and self-healing individual and network behavior. Typical examples of CCNs are beyond-5G cellular systems and critical communication systems, e.g., law enforcement, disaster relief, body- area, medical instruments, space, and indoor/outdoor commercial applications. A practical implementation of a CCN requires extending classical communication systems to embrace the dynamics of fully decentralized systems whose components might exhibit either cooperative, non-cooperative or even malicious behaviors to improve individual and/or global performance. In this context, CYBERNETS aims to develop a relevant understanding of the interactions between information theory, game theory and signal processing to tackle two particular problems from both theoretical and practical perspectives: (I) use of feedback and (II) behavior adaptation in fully decentralized CCNs. In the former, the main objectives are: (i) to determine the fundamental

limits of data transmission rates in CCNs with feedback; and (ii) to develop and test in real-systems, transmit-receive configurations to provide a proof-of-concept of feedback in CCNs. For the achievement of these practical objectives, CYBERNETS relies on the world-class testbed infrastructure of Inria at the CITI Lab for fully closing the gap between theoretical analysis and real-system implementation. In the latter, the main objectives are: (i) to identify and explore alternatives for allowing transmitter-receiver pairs to learn equilibrium strategies in CCNs with and without feedback; (ii) to study the impact of network-state knowledge on scenarios derived from the malicious behavior of network components.

8.3. International Initiatives

8.3.1. CoWIN

Title: CoWin: Cognitive Wireless Networks from Theory to Implementation

International Partners:

Princeton University (N.J., United States) - School of Engineering and Applied Science - Prof. H. Vincent Poor

Rutgers University (N.J., United States) - Winlab - Dr. Ivan Seskar.

Start year: 2015

See also: <https://project.inria.fr/cowin/>

The objective of this team is to strengthen the research efforts on emerging software radio and cognitive radio technologies. The team will count on: first, the cognitive radio test-bed CorteXlab recently set up by the Socrate team within the FIT Equipex, second the leading position of Vincent Poor's team in the field of network information theory and third the Orbit Platform of Rutgers university. The goal is to lead research in both the information theory community and the applied research community so as to reinforce the link between both communities. This work will concern architecture and programs of software radio equipments, distributed and cognitive algorithms for radio resource allocation, cognitive radio scenario experimentations, fundamental limits of cooperative wireless channels and the set up of common experimental infrastructure and protocols for research on cognitive wireless networks.

8.3.2. Inria International Partners

8.3.2.1. Informal International Partners

Socrate has strong collaborations with several international partners.

- **Princeton University**, School of Applied Science, Department of Electrical Engineering, NJ. USA. This cooperation with Prof. H. Vincent Poor is on topics related to decentralized wireless networks. Samir Perlaza has been appointed as Visiting Research Collaborator at the EE Department for the academic period 2016-2017. Scientific-Leaders at Inria: Samir Perlaza and Jean-Marie Gorce.
- **Rutgers University**, Winlab, Orbit testbed. This cooperation with Ivan Seskar is related to experimental wireless testbed. Orbit has been one of the first wireless testbeds of its type. Tanguy Risset and Leonardo Sampaio Cardoso have visited Winlab and I. Seskar visited the Socrate team for one week. Their collaboration is on the development of tools to ease experiment handling on wireless testbeds: visualisation, synchronization etc. Scientific-Leader at Inria: Tanguy Risset
- **University of Sheffield**, Department of Automatic Control and Systems Engineering, Sheffield, UK. This cooperation with Prof. Inaki Esnaola is on topics related to information-driven energy systems and multi-user information theory. Scientific-in-charge at Inria: Samir Perlaza.
- **University of Arizona**, Department of Electrical and Computer Engineering, Tucson, AZ, USA. This cooperation with Prof. Ravi Tandon is on topics related to channel-output feedback in wireless networks. Scientific-Leader at Inria: Samir Perlaza.

- **University of Cyprus**, Department of Electrical and Computer Engineering, University of Cyprus, Nicosia, Cyprus. This cooperation with Prof. Ioannis Krikidis is on topics related to energy-harvesting and wireless communications systems. Scientific-Leaders at Inria: Guillaume Villemaud and Samir Perlaza.
- **Universidade Federal do Ceará**, GTEL, Departamento de Teleinformática, Fortaleza, Brazil. This recently started cooperation with Prof. Tarcisio Ferreira Maciel is on topics related to the optimization of radio resources for massive MIMO in 5G and 5G-like wireless communications systems. Scientific-in-charge at Inria: Leonardo Sampaio Cardoso.
- **Universidad Nacional del Sur**, LaPSyC laboratory, Bahía Blanca, Argentina. This cooperation with Prof. Juan Cousseau is on topics related to Full-Duplex communications and Interference Alignment. Scientific-in-charge at Inria: Guillaume Villemaud.

8.4. International Research Visitors

8.4.1. Visits of International Scientists

Prof. Ioannis Krikidis from the Department of Electrical and Computer Engineering, University of Cyprus, was appointed as Visiting Professor at the Department of Telecommunications at the INSA de Lyon hosted at the CITI Lab by Samir Perlaza.

Prof. Guiseppe Durisi from the Chalmers University of Technology, Sweden was visiting our group and delivered the following talk: "Towards Low-Latency Wireless Communications: The Art of Sending Short Packets".

Prof. Michèle Wigger from Télécom ParisTech, France, was visiting our group and delivered the following talk: "New Results on Cache-Aided One-to-Many Compression and Communication"

Prof. Albert Guillén i Fabregas from Universitat Pompeu Fabra, Spain, was visiting our group and delivered the following talk: "Hypothesis Testing and Error Probability in Information Theory"

Prof. Iñaki Esnaola from University of Sheffield, UK was visiting our group and delivered the following talk: "The Impact of Prior Knowledge in Data Injection Attacks"

Ivan Seskar from Rutgers University, USA was visiting our group and delivered the following talk: "ORBIT Testbed"

8.4.2. Visits to International Teams

Samir Perlaza was visiting the Department of Automatic Control and Systems Engineering at the University of Sheffield, UK, hosted by Prof. Iñaki Esnaola.

Samir Perlaza was visiting the Department of Electrical and Electronic Engineering at Imperial College London, UK hosted by Prof. Deniz Gunduz.

Yasser Fadlallah was visiting the Department of Electrical and Telecommunications Engineering at the University of Naples Federico II, hosted by Prof. Antonia M. Tulino .

Jean-Marie Gorce was visiting the Electrical Department at Princeton university, hoster by Prof. Vincent Poor Dean of School of Engineering and Applied Science of Princeton University.

Tanguy Risset and Leonardo Sampaio Cardoso were visiting the Winlab research lab at Rutgers University, hosted by Ivan Seskar Associate Director of Information Technology of Winlab.

URBANET Team

9. Partnerships and Cooperations

9.1. Regional Initiatives

- BQR INSA CROME 12/2013-12/2016
Participants: Fabrice Valois
The partners in this project are the CITI DynaMid team and LIRIS. The project studies the coordination of a fleet of mobile robots for the multi-view analysis of complex scenes.
- Labex IMU Priva'Mov 10/2013-10/2016
Participants: Patrice Raveneau, Hervé Rivano, Razvan Stanica
The partners in this project are DRIM LIRIS, Inria Privatics, INSA EVS, and LET ENTPE. The aim of this project is to develop and deploy a crowdsensing platform to collect mobility traces from a sample of real users equipped with android devices, while carrying research on privacy preservation issues. Our contribution consists on developing the platform and using the collected data to analyze cellular network offloading strategies.
- Labex IMU UrPolSens 10/2015-10/2018
Participants: Ahmed Boubrima, Leo Le Taro, Walid Bechkit, Hervé Rivano
The partners in this project are Ifsttar, LMFA, EVS, and TUBA, with Inria Urbanet leading the project. UrPolSens deals with the monitoring of air pollution using low-cost sensors interconnected by a wireless networks. Although they are less accurate than the high-end sensors used today, low-cost autonomous air quality sensors allow to achieve a denser spatial granularity and, hopefully, a better monitoring of air pollution. The main objectives of this project are to improve the modeling of air pollution dispersion; propose efficient models to optimize the deployment the sensors while considering the pollution dispersion and the impact of urban environment on communications; deploy a small-scale network for pollution monitoring as a proof of concept; compare the measured and estimated levels of exposure; study the spatial disparities in exposure between urban areas.

9.2. National Initiatives

9.2.1. ANR

- ANR ABCD 10/2013-04/2017.
Participants: Diala Naboulsi, Marco Fiore, Razvan Stanica
The partners in the ANR ABCD project are: Orange Labs, Ucopia, Inria UrbaNet, UPMC LIP6 PHARE, Telecom ParisTech. The objective of ABCD is to characterize large-scale user mobility and content consumption in urban areas via mobile data mining, so as to achieve efficient deployment and management of cloud resources via virtual machines. Our contribution in the project consists on the characterization of human mobility and service consumption at a city scale, and the design of appropriate resource allocation techniques at the cellular network level.
- ANR IDEFIX 10/2013-04/2017.
Participants: Soukaina Cherkaoui, Hervé Rivano, Fabrice Valois
The partners in the ANR IDEFIX project are: Orange Labs, Alcatel Lucent - Bell Labs, Telecom Paris Tech, Inria UrbaNet, Socrate and Dyogene.

9.2.2. Pôle ResCom

- Ongoing participation (since 2006)
Communication networks, working groups of GDR ASR/RSD, CNRS (<http://rescom.inrialpes.fr>).
Hervé Rivano is member of the scientific committee of ResCom.

9.2.3. EquipEx

- SenseCity
We have coordinated the participation of several Inria teams to the SenseCity EquipEx. Within the SenseCity project, several small reproduction of 1/3rd scale city surroundings will be built under a climatically controlled environment. Micro and nano sensors will be deployed to experiment on smart cities scenarios, with a particular focus on pollution detection and intelligent transport services. Urbanet will have the opportunity to tests some of its capillary networking solutions in a very realistic but controlled urban environment. The first deployment is scheduled early 2015.

9.2.4. Inria Project lab

- CityLab
Urbanet is involved in the CityLab Inria Project Lab lead by Valérie Issarny. Within this project, Hervé Rivano is the networking referent for the PhD thesis of Raphael Ventura, advised by Vivien Mallet, in the Clime Inria team.

9.3. International Initiatives

9.3.1. Inria International Partners

9.3.1.1. Declared Inria International Partners

- DTN for IOT - Bilateral contract with III Taiwan 2015.
This collaboration, funded by III, focuses on the feasibility to implement Delay Tolerant Network protocols within the Internet Of Things context. The motivation for using generic protocols able to handle the constraints of the Intenet of Things is highlighted with the choice of the Bundle Protocol. A study of existing implementations of this protocol is realized within a sensor context and a tailored implementation is proposed. This collaboration has partially funded the postdoc of Patrice Raveneau.

9.3.1.2. Informal International Partners

- **Ecole Polytechnique de Montréal, QC, Canada.** Cooperation on subjects related to mobile networks with the group of Prof. Samuel Pierre.
- **University of Waterloo, ON, Canada.** Joint publications and visits to/from the group of Prof. Catherine Rosenberg.

9.4. International Research Visitors

9.4.1. Visits of International Scientists

- Dennis Chen, Research Engineer, III, Taiwan: one week visit (June 2015).
- Ling-Jyh Chen, Associate Research Fellow, Academia Sinica, Taiwan: one week visit (December 2015).
- Mario Gerla, Professor, UCLA, USA: one day visit (March 2015).
- Roch Glitho, Associate Professor, Concordia University, Montreal, Canada: one week visit (September 2015).
- Catherine Rosenberg, Professor, University of Waterloo, Canada: two days visit (July 2015).

9.4.1.1. Internships

- F. Bernardo Duarte, intern, University of Lisbon, Portugal: Comfortable workplace using sensor motes (3 months).
- A. Boubrima, MS thesis, ESI Algiers, Algeria: Optimal deployment of wireless sensor networks for air pollution monitoring (6 months).
- A. Dobre, intern, Polytechnic University of Bucharest, Romania: Comfortable workplace using sensor motes (3 months).

- A. Hanganu, intern, Polytechnic University of Bucharest, Romania: Comfortable workplace using sensor motes (3 months).
- J. Lallana, intern, Universidad Politécnica de Madrid, Spain: Performance evaluation of RPL resiliency using Cooja (5 months)
- D. Martella, intern, Politecnico di Torino, Italy: Coordination of robots fleet (6 months).
- M. Iliushkina, intern, University of Saint Petersburg, Russia: Comfortable workplace using sensor motes (3 months).
- Z. Plokhovska, intern, University of Pittsburgh, PA, USA: Combining DSRC and VLC in Safety Vehicular Networks (3 months).

Chroma Team

9. Partnerships and Cooperations

9.1. Regional Initiatives

9.1.1. *Projet AAP ARC6 "" (2015-18)*

Participants: Olivier Simonin, Anne Spalanzani, Fabrice Valois (insa de Lyon, Inria Urbanet).

Regional project (Rhône-Alpes) "Mobilité au sein de flottes de robots sous contrainte de maintien de la connectivité" ARC6, 2015-2018. Leader : O. Simonin.

This project funds the PhD thesis of Mihai-Ioan Popescu, who started on november 2015, and co-advized by O. Simonin, A. Spalanzani and F. Valois. The project involves also the Pole de compétitivité "Via Meca".

9.2. National Initiatives

9.2.1. ANR

9.2.1.1. ANR "VIMAD" (2015-17)

The VIMAD project aims at developing a robust and reliable perception system, only based on visual and inertial measurements, to enhance the navigation capabilities of fully autonomous micro aerial drones. It also aims at acquiring a deep theoretical comprehension of the problem of fusing visual and inertial measurements, by investigating its observability properties in challenging scenarios.

The activities related to this project, followed the work-plan (first year). They regarded the usage of our closed-form solution (recently published on the journal of computer vision, [42]) in the framework of micro aerial navigation in order to:

1. automatically perform state initialization;
2. improve the data matching process.

Additionally, the activities of VIMAD regarded the investigation of an unsolved problem in control theory, which is the unknown input observability problem in the nonlinear case, and its applications to the visual-inertial structure from motion problem.

See section 7.1.1 for a description of the results obtained during this first year of the project.

9.2.1.2. ANR "Valet" (2016-18)

The ANR VALET project proposes a novel approach for solving car-sharing vehicles redistribution problem using vehicle platoons guided by professional drivers. An optimal routing algorithm is in charge of defining platoons drivers' routes to the parking areas where the followers are parked in a complete automated mode. The consortium is made of 2 academic partners : Inria (RITS, Chroma, Prima) and Ircyyn Ecole Centrale de Nantes and the AKKA company.

In the VALET project we will propose a novel approach for solving car-sharing vehicles redistribution problem using vehicle platoons guided by professional drivers, retrieving vehicles parked randomly on the urban parking network by users. The PhD student (Pavan Vashista) recruited in this project will focus on integrating models of human behaviors (pedestrian and/or drivers), proxemics (human management of space) and traffic rules to evaluate and communicate a risk to pedestrians that may encounter the trajectory of the VALET vehicle. His PhD thesis will start on february 2016 and will be codirected by D. Vaufreydaz (Inria/PervasiveInteraction).

9.3. European Initiatives

9.3.1. FP7 & H2020 Projects

9.3.1.1. "ENABLE" Ecsel Project

ENABLE-S3 means "European Initiative to Enable Validation for Highly Automated Safe and Secure Systems". It is a H2020 Ecsel project.

ENABLE-S3 is *industry-driven* and therefore aims to foster the leading role of the European industry. This is also reflected in its *use case driven approach*. The main technical objectives are extracted from the use cases defined by the industrial partners, in order to validate the success of the developed methods and tools.

Recent scientific publications from the automotive domain predict that more than 100 Mio km of road driving is required for the thorough validation of a fully automated vehicle. Only if this extensive test is done, it is statistically proven that the automated vehicle is as safe as a manually driven car. Taking further into account the high number of vehicle variants and software versions, one can easily understand that *new validation approaches* are required to validate new Electronics, Components and Systems (ECS) for automated vehicles within a reasonable time period at reasonable costs. The same characteristic hold for other transportation domains such as aeronautics, maritime or rail.

The ENABLE-S3 project will provide European industry with leading-edge technologies that *support the development of reliable, safe and secure functions for highly automated and/or autonomously operating systems* by enabling the *validation and verification at reduced time and costs*.

Enables-S3 is a large European consortium, involving a French consortium led by Valeo, and including Thales, Renault and Inria. The project will start in March-April 2016 and will have a duration of 3 years.

9.3.2. Collaborations in European Programs, except FP7 & H2020

Program: PHC (Barande) French-Czech bilateral project

Project acronym: MURROTEX

Project title: Multi-Agent Coordination in Robotic Exploration and Reconnaissance Missions

Duration: Jan. 2014 - Dec. 2015

Coordinator: O. Simonin & J. Faigl (Prague Univ.)

Other partners: CTU (Czech Republic), Inria Larsen team.

Abstract: The main objective of the project is to develop a distributed planning framework for efficient task-allocation planning in exploration and reconnaissance missions by a group of mobile robots operating in an unknown environment with considering communication constraints and uncertainty in localization of the individual team members. One main challenge is to decentralize the decision, in order to scaling up with large fleet of robots (existing solutions are centralized or depend on full communication).

9.3.3. Collaborations with Major European Organizations

- Autonomous System laboratory: ETHZ, Zurich (Switzerland)
Subject: Vision and IMU data Fusion for 3D navigation in GPS denied environment.
- Robotics and Perception Group: University of Zurich (Switzerland)
Subject: Vision and IMU data Fusion for 3D navigation in GPS denied environment.
- Karlsruhe Institut für Technologie (KIT, Germany)
Subject: Autonomous Driving (student exchanges and common project).
- Vislab Parma (Italy)
Subject: Embedded Perception & Autonomous Driving (visits, projects submissions, and book chapter in the new edition of the Handbook of Robotics).
- Czech Technical University CTU in Prague (Czech Republic)

- Subject: Distributed algorithms for multi-robot cooperation (PHC "Murotex" 2013-15 and renewal).
- Department of Electrical & Computer Engineering: University of Thrace, Xanthi (GREECE)
Subject: 3D coverage based on Stochastic Optimization algorithms
- Universidade de Aveiro (Portugal)
Subject: Leader following. co-direction of P. Stein PhD.
- Centro De Automatica y Robotica, UPM-CSIC, Madrid (Spain)
Subject: Target interception.
- Bonn-Rhein-Sieg University of Applied Sciences (Germany)
Subject: Using Semantic Information for Robot Navigation.
- Social Robotics Laboratory, Freiburg (Germany)
Subject: Human behavior understanding.
- BlueBotics: BlueBotics Company, Lausanne (Switzerland)
Subject: Implementation of self-calibration strategies for wheeled robots and SLAM algorithms for industrial purposes.

9.4. International Initiatives

9.4.1. Inria International Labs

- iCeIRA⁰ international robotics laboratory led by Prof Ren Luo from NTU (Taiwan). Christian Laugier (Inria) and Raja Chatila (UPMC & CNRS) have actively participated to the starting of this laboratory in 2012 and are external Principal Investigators.
Subject: Human centered robotics.

- **SAMPEN**

Title: self adaptive mobile perception and navigation

International Partner (Institution - Laboratory - Researcher):

NTU (TAIWAN)

Duration: 2014 - 2016

See also: <http://emotion.inrialpes.fr/people/spalanzani/HomeSAMPEN.html>

The associate team project is a Robotic project. The aim of the project is to propose a self-adaptive system of perception combined with a system of autonomous navigation. Usually, systems of perception rely on a set of specific sensors and a calibration is done in a specific environment. We propose to develop some methods to make perception systems adaptive to the environmental context and to the set of sensors used. This perception, that can be embedded on the mobile robot as well as on home structures (wall, ceiling, floor), will be helpful to localize agents (people, robot) present in the scene. Moreover, it will give information to better understand social scenes. All information will be used by the navigation system to move with a behavior that fit the context.

9.4.1.1. Informal International Partners

- UC Berkeley & Stanford University (CA, USA)
Subject: Autonomous Driving (postdoc in the scope of Inria@SV, common publications and patent).
- Massachusetts Institute of Technology (MIT), Cambridge, MA (USA)
Subject: Decentralized Control of Markov Decision Processes.

9.4.2. Participation In other International Programs

- IEEE Robotics and Automation. Christian Laugier is member of several IEEE committees, in particular: IROS Steering committee, co-chair of Technical Committee on Autonomous Ground vehicles and Intelligent Transport Systems, Steering committee and Senior Editor of IEEE Transactions on Intelligent Vehicles. Olivier Simonin is member of the TC on Multi-Robot Systems (MRS).
Subject: International Robotics Research Supporting.

⁰International Center of Excellence in Intelligent Robotics and Automation Research.

EXMO Project-Team

9. Partnerships and Cooperations

9.1. National Initiatives

9.1.1. ANR Lindicle

Program: ANR-Blanc international 2

Project acronym: LINDICLE

Project title: Linking data in cross-lingual environment

Duration: January 2013 - December 2016

Coordinator: Inria EXMO/Jérôme David

Participants: Jérôme Euzenat, Manuel Atencia Arcas, Jérôme David, Tatiana Lesnikova, Adam Sanchez Ayte, Armen Inants

Other partners: Tsinghua university (CN)

See also: <http://lindicle.inrialpes.fr>

Abstract: The LINDICLE project investigates multilingual data interlinking between French, English and Chinese data sources (see §7.2).

9.2. European Initiatives

9.2.1. FP7 & H2020 Projects

9.2.1.1. Ready4SmartCities

Title: ICT Roadmap and Data Interoperability for Energy Systems in Smart Cities

Programm: FP7

Duration: October 2013 - September 2015

Coordinator: D'Appolonia SPA

Partners:

Aec3 Ltd (United Kingdom)

Ait Austrian Institute of Technology (Austria)

Ethniko Kentro Erevnas Kai Technologikis Anaptyxis (Greece)

Centre Scientifique et Technique Du Batiment (France)

D'appolonia Spa (Italy)

Empirica Gesellschaft für Kommunikations- und Technologie Forschung Mbh (Germany)

Politecnico di Torino (Italy)

Universidad Politecnica de Madrid (Spain)

Teknologian Tutkimuskeskus Vtt (Finland)

Inria contact: Jérôme Euzenat

See also: <http://ready4smartcities.eu>

READY4SmartCities operates in a European context where other initiatives are currently running in order to create a common approach on Smart Cities, Such initiatives, even if of fundamental importance for the EU, have some relevant gaps not allowing them to fully cover fundamental aspects for Smart Cities, i.e. to define a common data framework allowing full interoperability among different city system, as well as a consistent vision on how ICT can support energy systems in smart cities. Within this context READY4SmartCities cover a unique role thanks to its specific mission of bringing together relevant stakeholders including engineering specialists, ICT software and equipment providers, RES providers, energy companies (including ESCOs – Energy Service Companies), construction sector companies, as well as local and regional authorities. In co-operation with these stakeholders, the aim is to deliver:

A new energy data ecosystem that will accommodate cross-domain data (climatic, occupation, pollution, traffic, activity, etc.) and will allow the exploitation of such data at global scale; by identifying the set of ontologies relevant to energy-efficiency in Smart Cities and the different requirements and guidelines on how to use (publish and interchange) data described according to those ontologies.

An holistic and shared vision, allowing feasible step-by-step action plans for city authorities and other relevant stakeholder groups to develop and use ICT-based solutions for energy system in urban and rural communities towards future Smart Cities, and thus, leading to reduced energy consumption and CO2 emissions.

9.3. International Initiatives

9.3.1. Informal International Partners

EXMO (and other colleagues from Oxford, Trento, Mannheim, Linköping, Milano, Amsterdam, Galway and the Open university) organises yearly the Ontology alignment evaluation initiative (OAEI).

9.3.2. Participation in other international programs

Jérôme Euzenat is benefiting from a special visiting researcher grant from the Brazilian Ciência sem Fronteiras program on “Methodology and algorithms for ontology refinement and matching” (2015-2017). He will be working with the team of Fernanda Baião and Kate Revoredo at the Universidade Federal do Estado do Rio de Janeiro (UNIRIO). Together, we investigate methods for evolving ontologies and alignments which involve users and agents. The goal of the project is to design methods and algorithms for both revising ontologies to represent the evolution of knowledge in a reliable manner and obtaining better quality alignments.

9.4. International Research Visitors

9.4.1. Visits of International Scientists

Kate Revoredo and Fernanda Baião (Federal University of the State of Rio de Janeiro) visited EXMO in May 2015, working on learning alignments to evolve alignments.

9.4.2. Visits to International Teams

9.4.2.1. Research stays abroad

Tatiana Lesnikova and Jérôme Euzenat visited Tsinghua University from March 30 to April 15, 2015 within the LINDICLE project (§9.1.1) on multilingual data interlinking and key extraction.

IMAGINE Project-Team

7. Partnerships and Cooperations

7.1. Regional Initiatives

7.1.1. Labex Persyval

Participants: Rémi Ronfard, Olivier Palombi, Armelle Bauer.

We received a doctoral grant from LABEX PERSYVAL, as part of the research program on authoring augmented reality (AAR) for PhD student Adela Barbelescu. Her thesis is entitled *directing virtual actors by imitation and mutual interaction - technological and cognitive challenges*. Her advisors are Rémi Ronfard and Gérard Bailly (GIPSA-LAB).

Additionally, this project funds the PhD thesis of Armelle Bauer which has started in October, co-advised by François Faure, Olivier Palombi, and Jocelyne Troccaz from TIMC-GMCAO. The goal is to tackle the scientific challenges of visualizing one's self anatomy in motion using Augmented Reality techniques.

7.1.2. ARC6 PoTAsse (2015 - 2018)

Participants: Pablo Coves, Jean-Claude Léon, Damien Rohmer.

We received a doctoral grant (AdR) from the ARC6 program to generate functional CAD assemblies from scanned data (*PoTAsse*: POint clouds To ASSEMBlies) as a collaboration between Imagine team (LJK/Inria) and Geomod team (LIRIS). Our PhD student Pablo Coves is advised by Jean-Claude Léon and Damien Rohmer at Imagine, Raphaëlle Chaine and Julie Digne in Geomod team.

7.2. National Initiatives

7.2.1. FUI Collodi (October 2013 - October 2016)

Participants: François Faure, Romain Testylier.

This 3-year contract with two industrial partners: TeamTo and Mercenaries Engineering (software for production rendering), is a follow-up and a generalization of Dynam'it. The goal is to propose an integrated software for the animation and final rendering of high-quality movies, as an alternative to the ever-ageing Maya. It will include dynamics similarly to Dynam'it, as well as innovative sketch-based kinematic animation techniques invented at Imagine by Martin Guay and Rémi Ronfard. This contract, started in October, funds 2 engineers for 3 years.

7.2.2. ANR CHROME (01/2012 - 08/2015)

Participant: Rémi Ronfard.

Chrome is a national project funded by the French Research Agency (ANR). The project is coordinated by Julien Pettré, member of MimeTIC. Partners are: Inria-Grenoble IMAGINE team (Rémi Ronfard), Golaem SAS (Stéphane Donikian), and Archivideo (François Gruson). The project has been launched in September 2012. The Chrome project develops new and original techniques to massively populate huge environments. The key idea is to base our approach on the crowd patch paradigm that enables populating environments from sets of pre-computed portions of crowd animation. These portions undergo specific conditions to be assembled into large scenes. The question of visual exploration of these complex scenes is also raised in the project. We develop original camera control techniques to explore the most relevant part of the animations without suffering from occlusions due to the constantly moving content. A long-term goal of the project is to enable populating a large digital mockup of the whole France (Territoire 3D, provided by Archivideo). Dedicated efficient human animation techniques are required (Golaem). A strong originality of the project is to address the problem of crowded scene visualisation through the scope of virtual camera control, as a task which is coordinated by Imagine team-member Rémi Ronfard.

Three phd students are funded by the project. Kevin Jordao is working on interactive design and animation of digital populations and crowds for very large environments. His advisors are Julien Pettré and Marie-Paule Cani. Quentin Galvanne is working on automatic creation of virtual animation in crowded environments. His advisors are Rémi Ronfard and March Christie (Mimetic team, Inria Bretagne). Julien Pettre. Chen-Kin Lim is working on crowd simulation and rendering of the behaviours of various populations using crowd patches. Her advisors are Rémi Ronfard and March Christie (Mimetic team, Inria Bretagne). Julien Pettre.

7.2.3. AEN MorphoGenetics (10/2012 - 09/2015)

Participant: François Faure.

3-year collaboration with Inria teams Virtual Plants and Demar, as well as INRA (Agricultural research) and the Physics department of ENS Lyon. The goal is to better understand the coupling of genes and mechanical constraints in the morphogenesis (creation of shape) of plants. Our contribution is to create mechanical models of vegetal cells based on microscopy images. This project funds the Ph.D. thesis of Richard Malgat, who started in October, co-advised by François Faure (IMAGINE) and Arezki Boudaoud (ENS Lyon).

7.3. European Initiatives

7.3.1. ERC Grant Expressive

Title: EXPLoring REsponsive Shapes for Seamless desIgn of Virtual Environments.

Programm: ERC Advanced Grant

Duration: 04/2012 - 03/2017

Inria contact: Marie-Paule Cani

To make expressive and creative design possible in virtual environments, the goal is to totally move away from conventional 3D techniques, where sophisticated interfaces are used to edit the degrees of freedom of pre-existing geometric or physical models: this paradigm has failed, since even trained digital artists still create on traditional media and only use the computer to reproduce already designed content. To allow creative design in virtual environments, from early draft to progressive refinement and finalization of an idea, both interaction tools and models for shape and motion need to be revisited from a user-centred perspective. The challenge is to develop reactive 3D shapes – a new paradigm for high-level, animated 3D content – that will take form, refine, move and deform based on user intent, expressed through intuitive interaction gestures inserted in a user-knowledge context. Anchored in Computer Graphics, this work reaches the frontier of other domains, from Geometry, Conceptual Design and Simulation to Human Computer Interaction.

7.3.2. PIPER

Title: Position and Personalize Advanced Human Body Models for Injury Prediction

Programm: FP7

Duration: November 2013 - April 2017

Inria contact: F. Faure

In passive safety, human variability is currently difficult to account for using crash test dummies and regulatory procedures. However, vulnerable populations such as children and elderly need to be considered in the design of safety systems in order to further reduce the fatalities by protecting all users and not only so called averages. Based on the finite element method, advanced Human Body Models for injury prediction have the potential to represent the population variability and to provide more accurate injury prediction than alternatives using global injury criteria. However, these advanced HBM are underutilized in industrial R&D. Reasons include difficulties to position the models – which are typically only available in one posture – in actual vehicle environments, and the lack of model families to represent the population variability (which reduces their interest when compared to dummies). The main objective of the project will be to develop new tools to position

and personalize these advanced HBM. Specifications will be agreed upon with future industrial users, and an extensive evaluation in actual applications will take place during the project. The tools will be made available by using an Open Source exploitation strategy and extensive dissemination driven by the industrial partners. Proven approaches will be combined with innovative solutions transferred from computer graphics, statistical shape and ergonomics modeling. The consortium will be balanced between industrial users (with seven European car manufacturers represented), academic users involved in injury biomechanics, and partners with different expertise with strong potential for transfer of knowledge. By facilitating the generation of population and subject-specific HBM and their usage in production environments, the tools will enable new applications in industrial R&D for the design of restraint systems as well as new research applications.

7.4. International Research Visitors

7.4.1. Visits of International Scientists

- Laurent Grisoni (Univ. Lille / Inria): An HCI view of sketch-based interaction. (12/11/2015).
- Philippe Guillotel (Technicolor), Arnav Jhala (Univ. of California Santa Cruz), Mateu Sbert (University of Girona), Karan Singh (University of Toronto), participated to the Expressive Cinematography seminar (26/10/2015).
- Adrien Bousseau (Inria Sofia Antipolis): Computer Drawing Tools for Assisting Learners, Hobbyists, and Professionals (01/10/2015).
- Ludovic Hoyet (Inria Rennes), Perception of Biological Human Motion: Towards New Perception-Driven Virtual Character Simulations (10/09/2015).
- Michiel van de Panne (University of British Columbia), Animation Potpourri: New Models for Animated Vector Graphics, Motion Optimization, and Data-driven Animation (03/07/2015).
- Henri Gouraud, Histoire de l'ombrage de Gouraud (05/06/2015).
- Jean-Michel Dischler (Univ. Strasbourg), Procedural texturing from Example (28/05/2015).
- Paul Kry (MacGill University), Balancing Speed and Fidelity in Physics Based Animation and Control (23/04/2015).

LEAR Project-Team

9. Partnerships and Cooperations

9.1. National Initiatives

9.1.1. ANR Project *Physionomie*

Participants: Jakob Verbeek, Shreyas Saxena, Guosheng Hu.

Face recognition is nowadays an important technology in many applications ranging from tagging people in photo albums, to surveillance, and law enforcement. In this 3-year project (2013–2016) the goal is to broaden the scope of usefulness of face recognition to situations where high quality images are available in a dataset of known individuals, which have to be identified in relatively poor quality surveillance footage. To this end we will develop methods that can compare faces despite an asymmetry in the imaging conditions, as well as methods that can help searching for people based on facial attributes (old/young, male/female, etc.). The tools will be evaluated by law-enforcement professionals. The participants of this project are: Morpho, SensorIT, Université de Caen, Université de Strasbourg, Fondation pour la Recherche Stratégique, Préfecture de Police, Service des Technologies et des Systèmes d'Information de la Sécurité Intérieure, and LEAR.

9.1.2. ANR Project *Macaron*

Participants: Julien Mairal, Zaid Harchaoui, Laurent Jacob [CNRS, LBBE Laboratory], Michael Blum [CNRS, TIMC Laboratory], Joseph Salmon [Telecom ParisTech].

The project MACARON is an endeavor to develop new mathematical and algorithmic tools for making machine learning more scalable. Our ultimate goal is to use data for solving scientific problems and automatically converting data into scientific knowledge by using machine learning techniques. Therefore, our project has two different axes, a methodological one, and an applied one driven by explicit problems. The methodological axis addresses the limitations of current machine learning for simultaneously dealing with large-scale data and huge models. The second axis addresses open scientific problems in bioinformatics, computer vision, image processing, and neuroscience, where a massive amount of data is currently produced, and where huge-dimensional models yield similar computational problems.

This is a 3 years and half project, funded by ANR under the program “Jeunes chercheurs, jeunes chercheuses”, which started in October 2014. The principal investigator is Julien Mairal.

9.1.3. MASTODONS Program CNRS - Project *Titan*

Participants: Zaid Harchaoui, Julien Mairal.

The project is concerned with machine learning and mathematical optimization for big data. The partners are from LJK (Grenoble), LIG (Grenoble), LIENS (ENS, Paris), Lab. P. Painleve (Lille). Principal investigator/leader: Zaid Harchaoui. Dates: Jan 2015-Dec. 2015

9.1.4. Equipe-action ADM du Labex *Persyval (Grenoble) “Khronos”*

Participants: Zaid Harchaoui, Massih-Reza Amini [LIG].

The partners of this project are from the laboratories LJK, LIG, GIPSA, TIMC, CEA. The principal investigators/leaders are Zaid Harchaoui (Inria and LJK), Massih-Reza Amini (LIG). The project started in Jan. 2014 and ends in Dec. 2016.

9.2. European Initiatives

9.2.1. FP7 & H2020 Projects

9.2.1.1. AXES

Participants: Ramazan Cinbis, Matthijs Douze, Zaid Harchaoui, Dan Oneata, Danila Potapov, Cordelia Schmid, Jakob Verbeek, Clement Leray, Anoop Cherian.

This 4-year project started in January 2011 and ended in May 2015. Its goal is to develop and evaluate tools to analyze and navigate large video archives, eg. from broadcasting services. The partners of the project are ERCIM, Univ. of Leuven, Univ. of Oxford, LEAR, Dublin City Univ., Fraunhofer Institute, Univ. of Twente, BBC, Netherlands Institute of Sound and Vision, Deutsche Welle, Technicolor, EADS, Univ. of Rotterdam. See <http://www.axes-project.eu/> for more information.

9.2.1.2. ERC Advanced grant *Allegro*

Participants: Cordelia Schmid, Karteek Alahari, Jerome Revaud, Pavel Tokmakov, Nicolas Chesneau, Vicky Kalogeiton, Konstantin Shmelkov, Daan Wynen, Xiaojiang Peng.

The ERC advanced grant ALLEGRO started in April 2013 for a duration of five years. The aim of ALLEGRO is to automatically learn from large quantities of data with weak labels. A massive and ever growing amount of digital image and video content is available today. It often comes with additional information, such as text, audio or other meta-data, that forms a rather sparse and noisy, yet rich and diverse source of annotation, ideally suited to emerging weakly supervised and active machine learning technology. The ALLEGRO project will take visual recognition to the next level by using this largely untapped source of data to automatically learn visual models. We will develop approaches capable of autonomously exploring evolving data collections, selecting the relevant information, and determining the visual models most appropriate for different object, scene, and activity categories. An emphasis will be put on learning visual models from video, a particularly rich source of information, and on the representation of human activities, one of today's most challenging problems in computer vision.

9.3. International Initiatives

9.3.1. Inria International Partners

- **UC Berkeley:** This collaboration between Bin Yu, Jack Gallant, Yuval Benjamini, Adam Bloniarz (UC Berkeley), Ben Willmore (Oxford University) and Julien Mairal (Inria LEAR) aims to discover the functionalities of areas of the visual cortex. We have introduced an image representation for area V4, adapting tools from computer vision to neuroscience data. The collaboration started when Julien Mairal was a post-doctoral researcher at UC Berkeley and is still ongoing. Yuansi Chen, from UC Berkeley visited LEAR in the summer 2015 to work on this project.
- **University of Edinburgh:** C. Schmid collaborates with V. Ferrari, associate professor at university of Edinburgh. Vicky Kalogeiton started a co-supervised PhD in September 2013; she is bi-localized between Uni. Edinburgh and Inria. Her subject is the automatic learning of object representations in videos. J. Mairal also started a collaboration with Peter Richtarik, professor at university of Edinburgh and Dominik Csiba (PhD student), on the topic of local low-rank matrix estimation.
- **MPI Tübingen:** C. Schmid collaborates with M. Black, a research director at MPI since 2013. She spent one month at MPI in January 2015. End of 2015 she was awarded a Humboldt research award funding a long-term research project with colleagues at MPI.
- **Technion:** J. Mairal started a collaboration with Yonina Eldar (Technion) and Andreas Tillmann (Darmstadt university) to develop dictionary learning techniques for phase retrieval. Andreas Tillmann visited the LEAR team for a week in May 2015. Their collaboration resulted in a paper accepted to the ICASSP'16 conference.

9.3.2. Participation In other International Programs

- **France-Berkeley fund:** The LEAR team was awarded in 2014 a grant from the France-Berkeley fund for a project between Julien Mairal and Pr. Bin Yu (statistics department, UC Berkeley) on "Invariant image representations and high dimensional sparse estimation for neurosciences". The award amounts to 10,000 USD for a period of one year, from November 2014 to April 2016. The funds are meant to support scientific and scholarly exchanges and collaboration between the two teams.

9.4. International Research Visitors

9.4.1. Visits of International Scientists

Andreas Tillmann (Darmstadt university) and Dominik Csiba (Edinburgh university) visited Julien Mairal for a week, respectively in May and October 2015.

9.4.2. Visits to International Teams

- **Sabbatical program** Zaid Harchaoui was on sabbatical at New-York university, from October 2014 to September 2015.

MAVERICK Project-Team

8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. ANR *BLANC*: *ALTA*

Participants: Nicolas Holzschuch [contact], Cyril Soler.

We are funded by the ANR research program "Blanc" for a joint research project with two other Inria research teams, REVES in Sophia-Antipolis and Manao in Bordeaux. The goal of this project is studying light transport operators for global illumination, both in terms of frequency analysis and dimensional analysis. The grant started in October 2011, for 54 months.

8.1.2. ANR *CONTINT*: *Galaxy/veRTIGE*

Participants: Jean-Dominique Gascuel, Nicolas Holzschuch, Fabrice Neyret [contact].

RTIGE stands for Real-Time and Interactive Galaxy for Edutainment. This is an ANR CONTINT (Contents and Interactions) research program, for a joint research project with the EVASION Inria project-team, the GEPI and LERMA research teams at Paris Observatory, and the RSA Cosmos company. The goal of this project is to simulate the quality multi-spectral real-time exploration of the Galaxy with Hubble-like images, based on simulation data, statistical data coming from observation, star catalogs, and procedural amplification for stars and dust clouds distributions. RSA-Cosmos aims at integrating the results in digital planetariums. The grant started in December 2010, for 60 months.

8.1.3. ANR *CONTINT*: *MAPSTYLE*

Participants: Joëlle Thollot [contact], Hugo Loi.

The MAPSTYLE project aims at exploring the possibilities offered by cartography and expressive rendering to propose original and new cartographic representations. Through this project, we target two types of needs. On the one hand, mapping agencies produce series paper maps with some renderings that are still derived from drawings made by hand 50 years ago: for example, rocky areas in the series TOP25 (to 1/25000) of the French Institut Géographique National (IGN). The rendering of these rocky areas must be automated and its effectiveness retained to meet the requirements of hikers safety. On the other hand, Internet mapping tools allow any user to become a cartographer. However, they provide default styles that cannot be changed (GeoPortal, Google Maps) or they are editable but without any assistance or expertise (CloudMade). In such cases, as in the case of mobile applications, we identify the need to offer users means to design map styles more personalised and more attractive to meet their expectations (decision-making, recreation, etc.) and their tastes. The grant started on October 2012, for 48 months.

8.1.4. ANR: *Materials*

Participants: Nicolas Holzschuch [contact], Romain Vergne.

We are funded by the ANR for a joint research project on acquisition and restitution of micro-facet based materials.

two other Inria research teams, REVES in Sophia-Antipolis and iPARLA in Bordeaux. The goal of this project is studying light transport operators for global illumination, both in terms of frequency analysis and dimensional analysis. The grant started in October 2011, for 54 months.

8.2. International Initiatives

8.2.1. Inria International Partners

8.2.1.1. Informal International Partners

We have an ongoing cooperation with the Université De Montréal (Derek Nowrouzhezari, Pierre Poulin), dealing with light transport and isotropic filter decomposition in the spherical domain, based on zonal harmonic basis.

We also have an ongoing cooperation with Polytechnique de Montréal (Thomas Hurtut) dealing with procedural texture design and color transfer.

8.3. International Research Visitors

8.3.1. Visits to International Teams

8.3.1.1. Sabbatical programme

Soler Cyril

Date: Aug 2015 - Jul 2016

Institution: **Université de Montréal** (Canada)

8.3.1.2. Research stays abroad

Neyret Fabrice

Date: Jan 2015 - Mar 2015 and Nov 2015 - Mar 2016

Institution: **WETA Digital** (New-Zeland)

MORPHEO Project-Team

9. Partnerships and Cooperations

9.1. ARC6 project PADME – Perceptual quality Assessment of Dynamic MESHes and its applications

In this project, we propose to use a new and experimental “bottom-up” approach to study an interdisciplinary problem, namely the objective perceptual quality assessment of 3D dynamic meshes (i.e., shapes in motion with temporal coherence). The objectives of the proposed project are threefold:

1. to understand the HVS (human visual system) features when observing 3D animated meshes, through a series of psychophysical experiments;
2. to develop an efficient and open-source objective quality metric for dynamic meshes based on the results of the above experiments;
3. to apply the learned HVS features and the derived metric to the application of compression and/or watermarking of animated meshes.

This work is funded by the Rhône-Alpes région through an ARC6 grant for the period 2013-2016. The three partners are LIRIS (University Lyon 1, Florent Dupont), GIPSA-Lab (CNRS, Kai Wang) and LJK (University of Grenoble, Franck Hétroy-Wheeler). A PhD student, Georges Nader, is working on this project.

9.2. National Initiatives

9.2.1. Motion analysis of laboratory rodents

In order to evaluate the scalability of previous work on motion analysis of laboratory rodents, a collaboration has been initiated with the Institut Clinique de la Souris (ICS), in Institut de Génétique et de Biologie Moléculaire et Cellulaire (IGBMC). This institute is dedicated to phenotyping of mice and requires reliable motion analysis tools. A multicamera platform has been deployed at ICS and will be exploited next year for tests ranging from one to two hundreds mice.

9.2.2. ANR

9.2.2.1. ANR project Achmov – Accurate Human Modeling in Videos

The technological advancements made over the past decade now allow the acquisition of vast amounts of visual information through the use of image capturing devices like digital cameras or camcorders. A central subject of interest in video are the humans, their motions, actions or expressions, the way they collaborate and communicate. Analyzing video data of humans, collected for complex real-world events—extracting high-fidelity content, transferring raw data into knowledge—, detecting, reconstructing or understanding human motion are problems of key importance for the advancement of a variety of technological fields, including video coding, entertainment, culture, animation and virtual reality, intelligent human-computer interfaces, protection and security. The visual analysis of humans in real-world environments, indoors and outdoors, faces major scientific and computational challenges however. The proportions of the human body vary largely across individuals, any single human body has many degrees of freedom due to articulations, and individual limbs deform due to moving muscles and clothing. Finally, real-world events involve multiple interacting humans occluded by each other or by other objects, and the scene conditions may also vary due to camera motion or lighting changes. All these factors make appropriate models of human structure, motion and action difficult to construct and difficult to estimate from images. The goal of ACHMOV is to extract detailed representations of multiple interacting humans in real-world environments in an integrated fashion through a synergy between detection, figure-ground segmentation and body part labeling, accurate 3D geometric methods for kinematic and shape modeling, and large-scale statistical learning techniques. By integrating

the complementary expertise of two teams (one French, MORPHEO and one Romanian, CLVP), with solid prior track records in the field, there are considerable opportunities to move towards processing complex real world scenes of multiple interacting people, and be able to extract rich semantic representations with high fidelity. This would enable interpretation, recognition and synthesis at unprecedented levels of accuracy and in considerably more realistic setups than currently considered. This project was kicked off on November 26th, 2015, in Bucharest, Romania.

9.2.3. Competitivity Clusters

9.2.3.1. FUI project Creamove

Creamove is a collaboration between the Morpheo team of the Inria Grenoble Rhône-Alpes, the 4D View Solution company specialised in multi-camera acquisition systems, the SIP company specialised in multi-media and interactive applications and a choreographer. The objective is to develop new interactive and artistic applications where humans can interact in 3D with virtual characters built from real videos. Dancer performances will be pre-recorded in 3D and used on-line to design new movement sequences based on inputs coming from human bodies captured in real time. Website: <http://www.creamove.fr>.

9.3. European Initiatives

9.3.1. FP7 & H2020 Projects

9.3.1.1. Re@ct

Type: FP7 COOPERATION

Defi: IMMERSIVE PRODUCTION AND DELIVERY OF INTERACTIVE 3D CONTENT

Instrument: Specific Targeted Research Project

Objectif: Networked Media and Search Systems

Duration: December 2011 - November 2014 (Evaluation January through March 2015)

Coordinator: BBC (UK)

Partner: BBC (UK), Fraunhofer HHI (Germany), University of Surrey (UK), Artefacto (France), OMG (UK).

Inria contact: Jean-Sébastien Franco, Edmond Boyer

Abstract:RE@CT will introduce a new production methodology to create film-quality interactive characters from 3D video capture of actor performance. Recent advances in graphics hardware have produced interactive video games with photo-realistic scenes. However, interactive characters still lack the visual appeal and subtle details of real actor performance as captured on film. In addition, existing production pipelines for authoring animated characters are highly labour intensive. RE@CT aims to revolutionise the production of realistic characters and significantly reduce costs by developing an automated process to extract and represent animated characters from actor performance capture in a multiple camera studio. The key innovation is the development of methods for analysis and representation of 3D video to allow reuse for real-time interactive animation. This will enable efficient authoring of interactive characters with video quality appearance and motion. The project builds on the latest advances in 3D and free-viewpoint video from the contributing project partners. For interactive applications, the technical challenges are to achieve another step change in visual quality and to transform captured 3D video data into a representation that can be used to synthesise new actions and is compatible with current gaming technology.

9.4. International Initiatives

9.4.1. Inria International Partners

9.4.1.1. Declared Inria International Partners

9.4.1.1.1. Joint projects with the Forestry Commission, UK

Two common works with an ecophysiologicalist from the British Forestry Commission, Eric Casella, are currently carried out. The first one aims at detecting, analysing and correcting acquisition noise from terrestrial laser scans (t-LiDAR) of plants and trees. The second one aims at reconstructing accurate virtual models of forest trees, for biomass measurement purposes. Both projects are funded by the University of Grenoble Alpes, through the AGIR framework. A PhD student, Romain Rombourg, is working on them.

9.4.1.2. Informal International Partners

The long term collaboration with TU Munich and Slobodan Ilic on human motion capture is ongoing with the work of Paul Huang [4] and [12] that was published at CVPR and IJCV this year. The work contributes with an approach that identifies and takes benefit of key poses when tracking shapes and 4D modeling.

9.5. International Research Visitors

9.5.1. Visits of International Scientists

9.5.1.1. Internships

Victoria Fernández Abrevaya

Date: 29th June 2015 - 27th September 2015

Institution: Universidad de Buenos Aires (Argentina)

Supervisor: Franck Hétroy-Wheeler

9.5.2. Visits to International Teams

9.5.2.1. Sabbatical programme

Reveret Lionel

Date: Jul 2014 - June 2015

Institution: **Brown University** (United States)

PERCEPTION Project-Team

8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. ANR

8.1.1.1. MIXCAM

Type: ANR BLANC

Duration: March 2014 - February 2016

Coordinator: Radu Horaud

Partners: 4D View Solutions SAS

Abstract: Humans have an extraordinary ability to see in three dimensions, thanks to their sophisticated binocular vision system. While both biological and computational stereopsis have been thoroughly studied for the last fifty years, the film and TV methodologies and technologies have exclusively used 2D image sequences, including the very recent 3D movie productions that use two image sequences, one for each eye. This state of affairs is due to two fundamental limitations: it is difficult to obtain 3D reconstructions of complex scenes and glass-free multi-view 3D displays, which are likely to need real 3D content, are still under development. The objective of MIXCAM is to develop novel scientific concepts and associated methods and software for producing live 3D content for glass-free multi-view 3D displays. MIXCAM will combine (i) theoretical principles underlying computational stereopsis, (ii) multiple-camera reconstruction methodologies, and (iii) active-light sensor technology in order to develop a complete content-production and -visualization methodological pipeline, as well as an associated proof-of-concept demonstrator implemented on a multiple-sensor/multiple-PC platform supporting real-time distributed processing. MIXCAM plans to develop an original approach based on methods that combine color cameras with time-of-flight (TOF) cameras: TOF-stereo robust matching, accurate and efficient 3D reconstruction, realistic photometric rendering, real-time distributed processing, and the development of an advanced mixed-camera platform. The MIXCAM consortium is composed of two French partners (Inria and 4D View Solutions). The MIXCAM partners will develop scientific software that will be demonstrated using a prototype of a novel platform, developed by 4D Views Solutions, and which will be available at Inria, thus facilitating scientific and industrial exploitation.

8.2. European Initiatives

8.2.1. FP7 & H2020 Projects

8.2.1.1. EARS

Title: Embodied Audition for RobotS

Program: FP7

Duration: January 2014 - December 2016

Coordinator: Friedrich Alexander Universität Erlangen-Nürnberg

Partners:

Aldebaran Robotics (France)

Ben-Gurion University of the Negev (Israel)

Friedrich Alexander Universität, Erlangen, Nuremberg (Germany)

Imperial College London (United Kingdom)

Humboldt-Universität Zu Berlin (Germany)

Inria contact: Radu Horaud

The success of future natural intuitive human-robot interaction (HRI) will critically depend on how responsive the robot will be to all forms of human expressions and how well it will be aware of its environment. With acoustic signals distinctively characterizing physical environments and speech being the most effective means of communication among humans, truly humanoid robots must be able to fully extract the rich auditory information from their environment and to use voice communication as much as humans do. While vision-based HRI is well developed, current limitations in robot audition do not allow for such an effective, natural acoustic human-robot communication in real-world environments, mainly because of the severe degradation of the desired acoustic signals due to noise, interference and reverberation when captured by the robot's microphones. To overcome these limitations, EARS will provide intelligent 'ears' with close-to-human auditory capabilities and use it for HRI in complex real-world environments. Novel microphone arrays and powerful signal processing algorithms shall be able to localise and track multiple sound sources of interest and to extract and recognize the desired signals. After fusion with robot vision, embodied robot cognition will then derive HRI actions and knowledge on the entire scenario, and feed this back to the acoustic interface for further auditory scene analysis. As a prototypical application, EARS will consider a welcoming robot in a hotel lobby offering all the above challenges. Representing a large class of generic applications, this scenario is of key interest to industry and, thus, a leading European robot manufacturer will integrate EARS's results into a robot platform for the consumer market and validate it. In addition, the provision of open-source software and an advisory board with key players from the relevant robot industry should help to make EARS a turnkey project for promoting audition in the robotics world.

8.2.1.2. VHIA

Title: Vision and Hearing in Action

Program: FP7

Type: ERC

Duration: February 2014 - January 2019

Coordinator: Inria

Inria contact: Radu Horaud

The objective of VHIA is to elaborate a holistic computational paradigm of perception and of perception-action loops. We plan to develop a completely novel twofold approach: (i) learn from mappings between auditory/visual inputs and structured outputs, and from sensorimotor contingencies, and (ii) execute perception-action interaction cycles in the real world with a humanoid robot. VHIA will achieve a unique fine coupling between methodological findings and proof-of-concept implementations using the consumer humanoid NAO manufactured in Europe. The proposed multi-modal approach is in strong contrast with current computational paradigms influenced by unimodal biological theories. These theories have hypothesized a modular view, postulating quasi-independent and parallel perceptual pathways in the brain. VHIA will also take a radically different view than today's audiovisual fusion models that rely on clean-speech signals and on accurate frontal-images of faces; These models assume that videos and sounds are recorded with hand-held or head-mounted sensors, and hence there is a human in the loop who intentionally supervises perception and interaction. Our approach deeply contradicts the belief that complex and expensive humanoids (often manufactured in Japan) are required to implement research ideas. VHIA's methodological program addresses extremely difficult issues: how to build a joint audiovisual space from heterogeneous, noisy, ambiguous and physically different visual and auditory stimuli, how to model seamless interaction, how to deal with high-dimensional input data, and how to achieve robust and efficient human-humanoid communication tasks through a well-thought tradeoff between offline training and online execution. VHIA bets on the high-risk idea that in the next decades, social robots will have a considerable economical impact, and there will be millions of humanoids, in our homes, schools and offices, which will be able to naturally communicate with us.

8.2.2. Inria International Partners

8.2.2.1. Informal International Partners

- Professor Sharon Gannot, Bar Ilan University, Tel Aviv, Israel,
- Professor Yoav Schechner, Technion, Haifa, Israel,
- Dr. Miles Hansard, Queen Mary University London,
- Dr. Thomas Hueber, Gipsa Lab, CNRS, Grenoble,
- Professor Daniel Gatica Perez, IDIAP Institute, Martigny, Switzerland,
- Professor Nicu Sebe, University of Trento, Trento, Italy,
- Professor Adrian Raftery, University of Washington, Seattle, USA.
- Dr. Zhengyou Zhang, Microsoft, Redmond WA, USA.

8.3. International Research Visitors

8.3.1. Visits of International Scientists

- Professor Sharon Gannot (Bar Ilan University), February and October 2015.
- Dr. Romain S erizel (Telecom Paris Tech), February 2015.
- Dr. Christine Evers (Imperial College), March 2015.
- Dr. Xavier Alameda-Pineda (University of Trento), November 2015.

PRIMA Project-Team

8. Partnerships and Cooperations

8.1. Nationally Funded Projects

8.1.1. ANR project Involved

Participants: Amr Al-Zouhri Al-Yafi, Patrick Reignier [correspondant].

The partners are G-SCOP, LIG (Prima, IIHM), CEA Liten, PACTE, Vesta Systems and Elithis.

The project focuses on bringing solutions to building actors for upcoming challenges in energy management in residential buildings. Many technical solutions have been proposed so far, but without sufficiently considering sufficiently actors as key. It is generally considered that energy management can be done by measurement and computation means with few contributions of actors. The project explores a new paradigm: a user centric energy management system, where user needs and tacit knowledge drive the search of solutions. These are calculated thanks to a flexible energy model of the living areas. The system is personified by energy consultants with which building actors such as building owners, building managers, technical operators but also occupants, can interact with in order to co-define energy strategies, benefiting of both assets: tacit knowledge of human actors, and measurement with computation capabilities of calculators. Putting actors in the loop, i.e. making energy not only visible but also controllable is the needed step before large deployment of energy management solutions. It is proposed to develop interactive energy consultants for all the actors, which are energy management aided systems embedding models in order to support the decision making processes. MIRROR (interactive monitoring), WHAT-IF (interactive quantitative simulation), EXPLAIN (interactive qualitative simulation), SUGGEST-AND-ADJUST (interactive management) and RECOMMEND (interactive diagnosis) functionalities will be developed.

8.1.2. ANR Project CEEGE

CEEGE is a multidisciplinary scientific research project conducted by the Inria PRIMA team in cooperation with the Dept of Cognitive Neuroscience at the University of Bielefeld. The primary impacts will be improved scientific understanding in the disciplines of Computer Science and Cognitive Neuro-Science. The aim of this project is to experimentally evaluate and compare current theories for mental modeling for problem solving and attention, as well as to refine and evaluate techniques for observing the physiological reactions of humans to situation that inspire pleasure, displeasure, arousal, dominance and fear.

In this project, we will observe the visual attention, physiological responses and mental states of subject with different levels of expertise solving classic chess problems, and participating in chess matches. We will observe chess players using eye-tracking, sustained and instantaneous face-expressions (micro-expressions), skin conductivity, blood flow (BVP), respiration, posture and other information extracted from audio-visual recordings and sensor readings of players. We will use the recorded information to estimate the mental constructs with which the players understand the game situation. Information from visual attention as well as physiological reactions will be used to determine and model the degree to which a player understands the game situation in terms of abstract configurations of chess pieces. This will provided a structured environment that we will use for experimental evaluation of current theories of mental modelling and emotional response during problem solving and social interaction.

The project is organised in three phases. During the first phase, we will observe individual players of different levels of chess expertise solving known chess problems. We will correlate scan-path from eye tracking and other information about visual attention to established configurations of pieces and known solutions to chess problems. This will allow us to construct a labeled corpus of chess play that can be used to evaluate competing techniques for estimating mental models and physiological responses. In a second phase, we will observe the attention and face expressions of pairs of players of different levels of chess ability during game play.

In particular, we will seek to annotate and segment recordings with respect to the difficulty of the game situation as well as situations which elicit particularly strong physiological reactions. In the final phase, we will use these recordings to evaluate the effectiveness of competing techniques for mental modelling and observation of emotions in terms of their abilities to predict the chess abilities of players, game outcomes and individual moves and player self reports. . Results of our work will be published in scientific conferences and journals concerned with cognitive science and cognitive neuroscience as well as computer vision, multi-modal interaction, affective computing and pervasive computing. Possible applications include construction of systems that can monitor the cognitive abilities and emotional reactions of users of interactive systems to provide assistance that is appropriate but not excessive, companion systems that can aid with active healthy ageing, and tutoring systems that can assist users in developing skills in a variety of domains including chess.

8.1.3. EquipEx AmiQual4Home - Ambient Intelligence for Quality of Life

Participants: Stanislaw Borkowski, Sabine Coquillart, Joelle Coutaz, James Crowley [correspondant], Alexandre Demeure, Thierry Fraichard, Amaury Negre, Patrick Reignier, Dominique Vaufreydaz, Nicolas Bonnefond, Remi Pincent.

Ambient Intelligence, Equipment d'Excellence, Investissement d'Avenir

The AmiQual4Home Innovation Factory is an open research facility for innovation and experimentation with human-centered services based on the use of large-scale deployment of interconnected digital devices capable of perception, action, interaction and communication. The Innovation Factory is composed of a collection of workshops for rapid creation of prototypes, surrounded by a collection of living labs and supported by a industrial innovation and transfer service. Creation of the Innovation Factory has been made possible by a 2.140 Million Euro grant from French National programme "Investissement d'avenir", together with substantial contributions of resources by Grenoble INP, Univ Joseph Fourier, UPMF, CNRS, Schneider Electric and the Commune of Montbonnot. The objective is to provide the academic and industrial communities with an open platform to enable research on design, integration and evaluation of systems and services for smart habitats.

The AmiQual4Home Innovation Factory is a unique combination of three different innovation instruments: (1) Workshops for rapid prototyping of devices that embed perception, action, interaction and communication in ordinary objects based on the MIT FabLab model, (2) Facilities for real-world test and evaluation of devices and services organised as open Living Labs, (3) Resources for assisting students, researchers, entrepreneurs and industrial partners in creating new economic activities. The proposed research facility will enable scientific research on these problems while also enabling design and evaluation of new forms of products and services with local industry.

The core of the AmiQual4Home Innovation Factory is a Creativity Lab composed of a collection of five workshops for the rapid prototyping of devices that integrate perception, action, interaction and communications into ordinary objects. The Creativity Lab is surrounded by a collection of six Living Labs for experimentation and evaluation in real world conditions. The combination of fabrication facilities and living labs will enable students, researchers, engineers, and entrepreneurs to experiment in co-creation and evaluation. The AmiQual4Home Innovation Factory will also include an innovation and transfer service to enable students, researchers and local entrepreneurs to create and grow new commercial activities based on the confluence of digital technologies with ordinary objects. The AmiQual4Home Innovation Factory will also provide an infrastructure for participation in education, innovation and research activities of the European Institute of Technology (EIT) KIC ICTLabs.

The AmiQual4Home Innovation Factory enables a unique new form of coordinated ICT-SHS research that is not currently possible in France, by bringing together expertise from ICT and SHS to better understand human and social behaviour and to develop and evaluate novel systems and services for societal challenges. The confrontation of solutions from these different disciplines in a set of application domains (energy, comfort, cost of living, mobility, well-being) is expected to lead to the emergence of a common, generic foundation for Ambient Intelligence that can then be applied to other domains and locations. The initial multidisciplinary

consortium will progressively develop interdisciplinary expertise with new concepts, theories, tools and methods for Ambient Intelligence.

The potential impact of such a technology, commonly referred to as "Ambient Intelligence", has been documented by the working groups of the French Ministry of Research (MESR) [29] as well as the SNRI (Stratégie Nationale de la Recherche et de l'Innovation).

The Amigual4Home Innovation Factory has been constructed with the Atelier Numerique Technology incubator across the street from the Inria Grenoble Rhone-Alpes Research Center in Monbonnot. The workshops, storage space and multi-functional workspace occupy 300 square meters on the ground floor. The LovelyLoft smart home technologies living lab occupies the apartment on the ground and 1st floor formerly occupied by the building guardian. The entire building has been equipped with an extensive suite of sensors and an open building management system and is currently used as the smart energy living lab.

8.1.4. IRT Silver Economy

IRT Silver economy is a multi-year collaboration between the PRIMA team of Inria, Université Grenoble Alpes, CEA LETI and Schneider Electric to develop smart devices and services for healthy ageing. The project is funded by the IRT nanoelec and has begun during the final months of 2015.

Within this project, Inria PRIMA and Schneider Electric are have begun development of a smart LW infrared imaging sensor for fall detection. The target system would build on a embedded integrated sensor system constructed by PRIMA with Schneider electric in 2014 and 2015.

8.1.5. FUI PRAMAD

Participants: Maxime Portaz, Amaury Negre, Dominique Vaufreydaz [correspondant].

Pramad is a collaborative project about *Plateforme Robotique d'Assistance et de Maintien à Domicile*. There are seven partners:

- R&D/industry: Orange Labs (project leader) and Covéa Tech (insurance company),
- Small companies: Interaction games (game designer, note that Wizardbox, the original partner was bought by Interaction games) and Robosoft (robot).
- Academic labs: Inria/PRIMA, ISIR (Paris VI) and Hôpital Broca (Paris).

The objectives of this project are to design and evaluate robot companion technologies to maintain frail people at home. Working with its partners, PRIMA research topics are:

- social interaction,
- robotic assistance,
- serious game for frailty evaluation and cognitive stimulation.

8.2. International Initiatives

8.2.1. Inria International Labs

Anne Spalanzani is implied in the iceira lab (in cooperation with the CNRS laboratories LAAS, ISIR and Taiwan). The laboratory is hosted by the National University of Taiwan, it is supported for 5 years (2013-2018), and the collaborative research focuses on Human centered Robotics.

8.2.2. Inria Associate Teams

Sampen is a associate team managed by Anne Spalanzani and Ren Luo (NTU Taipei) and involves other inria researchers (David Daney for Inria Bordeaux and Marie Babel from Lagadic-Rennes). In the scope of thi associate team, Anne Spalanzani gave a seminar à NTU in may 2015. Vishnu Narayanan (PhD student co-directed by Anne Spalanzani and Marie Babel) and Aurélien Mallein (PhD student supervised by David Daney) spent 3 months at the Iceira Lab (Taipei) to work respectively on Navigation following conventions and Localization using heterogenous sensors.

8.3. European Projects

8.3.1. CATRENE Project AppsGate - Smart Home Application Gateway

Duration: june 2012 - June 2015

Coordinator: ST Microelectronics

Other partners: Pace, Technicolor, NXP, Myriad France SAS, 4MOD Technology, HI-IBERIA Ingeniería y Proyectos, ADD Semiconductor, Video Stream Network, SoftKinetic, Optrima, Fraunhofer, Vsonix, Evalan, University UJF/LIG, and Institut Telecom.

The Prima Project team has worked with 15 other partners to develop a new generation of set-top box for smart home applications. In close collaboration with ST Microelectronics and Immotronics, Prima has developed the core middleware components for plug and play integration of smart home devices for distributed smart home services, as well as interactive tools for End User Development of Smart Home services.

AppsGate has developed an Open Platform to provide integrated home applications to the consumer mass market. The set-top box is the primary point of entry into the digital home for television services including cable TV, satellite TV, and IPTV. AppsGate will transform the set-box into a residential gateway, capable of delivering multiple services to the home, including video, voice and data. PRIMA is involved in designing End User Development tools dedicated for the Smart Home

8.4. International Research Visitors

8.4.1. Visits to International Teams

8.4.1.1. Sabbatical programme

Fraichard Thierry

Date: May 2014 - June 2015

Institution: **BIU** (Israel)

TYREX Project-Team

7. Partnerships and Cooperations

7.1. National Initiatives

7.1.1. Investissements d'avenir

Datalyse

Title: Entrepôt Intelligent pour Big Data hétérogènes. Investissements d'Avenir Développement de l'Economie Numérique.

Call: Cloud Computing, num 3 – Big Data.

Duration: May 2013 - November 2016

Coordinator: **Business & Decision Eolas**

Others partners: Groupement des Mousquetaires, Inria Saclay (OAK EPC), LIG (Hadas and Erods teams), LIRMM (Montpellier), LIFL (Lille).

See also: <http://www.datalyse.fr/>

Abstract: Project Datalyse aims at designing and deploying an infrastructure for big data storage, collection, certification, integration, categorisation, enrichment and sharing over very large heterogeneous data sets. It relies on an industrial platform, to be made available on the cloud, and focuses on three flagship applications, showcasing three uses of big data over different data sets:

- Data-Center Monitoring: The goal of this application is to provide features such as traceability, reporting, optimisation and analysis of abnormal behaviour regarding energy efficiency and security issues. The application will be built with an existing application called ScopeBR (Eolas) and will be deployed in two different green data centers, those of Eolas and GDF SUEZ.
- “Territoire de données ouvertes et liées”: This application aims at extracting and provisioning public open data collected from the city of Grenoble and its suburbs. The goal is to make public data available to third-party application developers and to federate local actors around a single platform.
- Real-time Business Intelligence for the management and processing of points of sale: this application will focus on real-time data analytics and will be deployed within “Groupement des Mousquetaires” in support of their business intelligence platforms.

7.1.2. ANR

Typex

Title: Typeful certified XML: integrating language, logic, and data-oriented best practices

Call: Programme Blanc

Duration: January 2012 - December 2015

Coordinator: PPS (CNRS - Paris 7 Diderot)

Others partners: LRI (Orsay)

See also: <http://typex.lri.fr>

Abstract: The highly ambitious and final goal of this project is to produce a new generation of XML programming languages stemming from the synergy of integrating three approaches into a unique framework:

- a logical approach based on solvers
- a programming language (PL) approach
- a data-oriented approach

These languages will feature precise and polymorphic type systems that merge PL typing techniques with logical-solver-based type inference. They will be implemented efficiently using the latest research on tree automata and formally certified using modern theorem prover technology. They will offer the capacity to specify and formally verify invariants, business rules, and data integrity, and will have a direct and immediate impact on standardization processes.

7.1.3. Transfer Contracts with Startups

Oppidoc

Title: Study of Potential Benefits of Introducing Static Analyses in the Oppidum Development Process

Duration: November - December 2015

Coordinator: Pierre Genevès

Abstract: The Oppidoc startup develops “Oppidum”: an XQuery web application framework which simplifies the development of XML-REST-XQuery applications (XRX) with the full XML technology stack (XQuery, XSLT, native XML database). It relies on a RESTful approach and on a well defined application model using concepts (routes, conventions, pipelines) popularized in other frameworks such as Ruby On Rails, Orbeon Forms and more recently Express on nodejs. Our collaboration concerns a study about the introduction of advanced static analyses techniques in the Oppidum development process.

7.2. International Research Visitors

7.2.1. Internships

Marti Bosch Padros from Universitat Politècnica de Catalunya (UPC) Spain spent six months in the team to work on Automated Refactoring for Size Reduction of CSS Style Sheets.

Joel Ferreira Dos Santos from Universidade Federal Fluminense, UFF, Brasil spent a one year sandwich PhD in the team to work on the formal verification of multimedia presentations.