



RESEARCH CENTER  
Grenoble - Rhône-Alpes

FIELD

Activity Report 2017

# Section Partnerships and Cooperations

Edition: 2018-02-19



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## ARIC Project-Team

# 9. Partnerships and Cooperations

## 9.1. Regional Initiatives

The PhD grant of Valentina Popescu has been funded since September 2014 by Région Rhône-Alpes through the “ARC6” programme.

## 9.2. National Initiatives

### 9.2.1. 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 <https://www.irif.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.

### 9.2.2. ANR FastRelax Project

**Participants:** Nicolas Brisebarre, Guillaume Hanrot, Vincent Lefèvre, Jean-Michel Muller, Bruno Salvy, Serge Torres.

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 Pequana 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.

### 9.2.3. ANR MetaLibm Project

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

MetaLibm is a four-year project (started in October 2013 and recently extended till March 2018) 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.

#### 9.2.4. ANR ALAMBIC Project

**Participants:** Benoît Libert, Fabien Laguillaumie, Ida Tucker.

ALAMBIC is a four-year project (started in October 2016) focused on the applications of cryptographic primitives with homomorphic or malleability properties. The web page of the project is <https://crypto.di.ens.fr/projects/alambic:description>. It is headed by Damien Vergnaud (ENS Paris and CASCADE team) and, besides AriC, also involves teams from the XLIM laboratory (Université de Limoges) and the CASCADE team (ENS Paris). The main goals of the project are: (i) Leveraging the applications of malleable cryptographic primitives in the design of advanced cryptographic protocols which require computations on encrypted data; (ii) Enabling the secure delegation of expensive computations to remote servers in the cloud by using malleable cryptographic primitives; (iii) Designing more powerful zero-knowledge proof systems based on malleable cryptography.

#### 9.2.5. RISQ Project

**Participants:** Benoît Libert, Fabien Laguillaumie, Damien Stehlé, Chitchanok Chuengsatiansup.

RISQ (Regroupement de l'Industrie française pour la Sécurité Post – Quantique) is a BPI-DGE four-year project (started in January 2017) focused on the transfer of post-quantum cryptography from academia to industrial products. The web page of the project is <http://risq.fr>. It is headed by Secure-IC and, besides AriC, also involves teams from ANSSI (Agence Nationale de la Sécurité des Systèmes d'Information), Airbus, C&S (Communication et Systèmes), CEA (CEA-List), CryptoExperts, Gemalto, Orange, Thales Communications & Security, Paris Center for Quantum Computing, the EMSEC team of IRISA, and the Cascade and Polsys Inria teams. The outcome of this project will include an exhaustive encryption and transaction signature product line, as well as an adaptation of the TLS protocol. Hardware and software cryptographic solutions meeting these constraints in terms of security and embedded integration will also be included. Furthermore, documents guiding industrials on the integration of these post-quantum technologies into complex systems (defense, cloud, identity and payment markets) will be produced, as well as reports on the activities of standardization committees.

### 9.3. European Initiatives

#### 9.3.1. FP7 & H2020 Projects

##### 9.3.1.1. 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.

##### 9.3.1.2. PROMETHEUS Project

**Participants:** Benoît Libert, Fabien Laguillaumie, Damien Stehlé.

PROMETHEUS (Privacy-Preserving Systems from Advanced Cryptographic Mechanisms Using Lattices) is a 4-year European H2020 project (call H2020-DS-2016-2017, Cybersecurity PPP Cryptography, DS-06-2017) that will start in January 2018. It gathers 7 academic partners (ENS de Lyon and Université de Rennes 1; CWI, Pays-Bas; Royal Holloway University of London, United Kingdom; Universitat Politècnica de Catalunya, Spain; Ruhr-Universität Bochum, Germany; Weizmann Institute, Israel), 5 industrial partners (Orange, IBM, Thales, TNO, ScytI). The goal of this project is to develop a toolbox of privacy-preserving cryptographic algorithms and protocols (like group signatures, anonymous credentials, or digital cash systems) that resist quantum adversaries. Solutions will be mainly considered in the context of Euclidean lattices and they will be analyzed from a theoretical point of view (i.e., from a provable security aspect) and a practical angle (which covers the security of cryptographic implementations and side-channel leakages). The project is hosted by ENS de Lyon and Benoît Libert is the administrative coordinator while Orange is the scientific leader.

## **9.4. International Initiatives**

### ***9.4.1. Participation in International Programs***

Vincent Lefèvre participated in the standardization of interval arithmetic (simplified version of the standard, IEEE 1788.1). He actively participates in the revision of the IEEE 754 standard for 2018.

## **9.5. International Research Visitors**

### ***9.5.1. Visits of International Scientists***

- Lloyd Nicholas Trefethen, from Oxford University (UK), is an expert in numerical analysis and notably the systematic use of Chebyshev approximation. He is spending the academic year 2017-2018 with AriC.
- Warwick Tucker, from Uppsala University (Sweden), is an expert of certified computation for dynamical systems. He is spending the academic year 2017-2018 with AriC.
- Huaxiong Wang, from Nanyang Technological University (Singapore), is an expert in cryptographic protocols and multi-party computation. He visited us in March and April 2017.
- Jung Hee Cheon, from Seoul National University (South Korea), is an expert in algorithmic number theory and the mathematical foundations of cryptography. He is visiting us since October 2017, until January 2018.

### ***9.5.2. Internships***

Benjamin Graillot

Date: May 2017–July 2017

Institution: ENS de Cachan

Supervisor: Bruno Salvy

### ***9.5.3. Visits to International Teams***

#### ***9.5.3.1. Research Stays Abroad***

Benoît Libert spent one month in the cryptography team of Nanyang Technological University (Singapore), to collaborate with Khoa Nguyen and Huaxiong Wang.

## CONVECS Project-Team

# 8. Partnerships and Cooperations

## 8.1. Regional Initiatives

### 8.1.1. ARC6 Programme

**Participants:** Lina Marsso, Radu Mateescu [correspondent], Wendelin Serwe.

ARC6 is an academic research community funded by the Auvergne Rhône-Alpes region, whose objective is to foster the scientific collaborations between different academic institutions of the region working in the domain of information and communication technologies. ARC6 organizes various scientific animations (conferences, working groups, summer schools, etc.) and issues a yearly call for PhD and post-doctorate research project proposals.

Lina Marsso is supported by an ARC6 grant (from October 2016 to October 2019) on formal methods for testing networks of programmable logic controllers, under the supervision of Radu Mateescu and Wendelin Serwe (CONVECS), Ioannis Parissis and Christophe Deleuze (LCIS, Valence).

## 8.2. National Initiatives

### 8.2.1. PIA (*Programme d'Investissements d'Avenir*)

#### 8.2.1.1. CAPHCA

**Participants:** Frédéric Lang, Radu Mateescu [correspondent], Wendelin Serwe.

CAPHCA (*Critical Applications on Predictable High-Performance Computing Architectures*) is a project funded by the PIA. The project, led by IRT Saint-Exupéry (Toulouse), involves a dozen of industrial partners (among which Airbus, CS Systèmes d'Information, Synopsis, and Thalès Avionics), the University Paul Sabatier (Toulouse), and Inria Grenoble – Rhône-Alpes (CONVECS and SPADES project-teams). CAPHCA addresses the dual problem of achieving performance and determinism when using new, high performance, multicore System-on-Chip (SoC) platforms for the deployment of real-time, safety-critical applications. The methodology adopted by CAPHCA consists in building a pragmatic combination of methods, tools, design constraints and patterns deployable at a short-term horizon in the industrial domains targeted in the project.

CAPHCA started in December 2017 for four years. The main contributions of CONVECS to CAPHCA are the detection of concurrency errors in parallel applications by means of formal methods and verification techniques.

### 8.2.2. Competitiveness Clusters

#### 8.2.2.1. SECURIOT-2

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

SECURIOT-2 is a project funded by the FUI (*Fonds Unique Interministériel*) within the *Pôle de Compétitivité Minalogic*. The project, led by Tiempo Secure (Grenoble), involves the SMEs (*Small and Medium Enterprises*) Alpwise, Archos, Sensing Labs, and Trusted Objects, the Institut Fourier and the VERIMAG laboratories of Université Grenoble Alpes, and CONVECS. SECURIOT-2 aims at developing a secure micro-controller unit (SMCU) that will bring to the IoT a high level of security, based on the techniques used for smart cards or electronic passports. The SMCU will also include an original power management scheme adequate with the low power consumption constraints of the IoT.

SECURIOT-2 started in September 2017 for three years. The main contributions of CONVECS to SECURIOT-2 are the formal modeling and verification of the asynchronous hardware implementing the secure elements developed by the project partners.

### 8.2.3. Other National Collaborations

We had sustained scientific relations with the following researchers:

- Pierre Boullier (Inria, team ALPAGE),
- Anne-Lise Courbis (Ecole des Mines, Alès, France),
- Christophe Deleuze and Ioannis Parissis (LCIS, Valence),
- Xavier Etchevers (Orange Labs, Meylan),
- Laurent Georget (Centrale/Supelec, Rennes, France),
- Claude Girault (LIP6, Paris),
- Fabrice Kordon and Lom Messan Hillah (LIP6, Paris),
- Xavier Leroy (Inria, team GALLIUM),
- Pascal Poizat (LIP6, Paris).

## 8.3. European Initiatives

### 8.3.1. Collaborations in European Programs, Except FP7 & H2020

Program: PHC Amadeus

Project acronym: RIDINGS

Project title: Rigorous Development of GALS Systems

Duration: January 2017 – December 2018

Coordinator: Inria Grenoble – Rhône-Alpes / CONVECS

Other partners: TU Graz, Institute of Software Technology (Austria)

Abstract: GALS systems, composed of synchronous components (driven by local clocks) that communicate through a network, are increasingly spreading with the development of the IoT. GALS systems are intrinsically complex due to the interplay of synchronous and asynchronous aspects, which make their development and debugging difficult. Therefore, it is necessary to adopt rigorous design methodologies, based on formal methods assisted by efficient validation tools. The RIDINGS project aims at enhancing the design flow of a GALS system by integrating the automatic generation of conformance tests from the formal model and the temporal properties used for verifying the system. This yields a double benefit for the designer: (i) it makes possible to check that a physical implementation conforms to the verified model; (ii) the development cost of the model and properties is distributed on the verification and testing phases of the design process, therefore increasing the return on investment.

### 8.3.2. Collaborations with Major European Organizations

The CONVECS project-team is member of the FMICS (*Formal Methods for Industrial Critical Systems*) working group of ERCIM<sup>0</sup>. H. Garavel and R. Mateescu are members of the FMICS board, H. Garavel being in charge of dissemination actions.

## 8.4. 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.

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<sup>0</sup><http://fmics.inria.fr>



### **8.4.1. Inria International Partners**

#### **8.4.1.1. Informal International Partners**

Saarland University (Germany): we collaborate on a regular basis with the DEPEND (*Dependable Systems and Software*) research group headed by Holger Hermanns, who received an ERC Advanced Grant (“POWVER”) in 2016.

### **8.4.2. Other International Collaborations**

In 2017, we had scientific relations with several universities and institutes abroad, including:

- University of Málaga, Spain (Francisco Duran),
- University of Boumerdes, Algeria (Sarah Chabane),
- Saarland University, Germany (Alexander Graf-Brill),
- ISTI/CNR, Pisa, Italy (Franco Mazzanti),
- FBK, Torino, Italy (Gianni Zampedri),
- RWTH Aachen, Germany (Christian Dehnert),
- University of Twente, The Netherlands (Enno Ruijters),
- University of York, UK (Jan Staunton),
- University Rio Grande do Norte, Brazil (Wellison Raul Mariz Santos),
- University of Cali, Colombia (Camilo Rocha),
- Utah State University, USA (Nazmus Sakib and Zhen Zhang).

## **8.5. International Research Visitors**

### **8.5.1. Visits of International Scientists**

- Mahsa Shirmohammadi (University of Oxford, UK) visited us on February 23–24, 2017. She gave a talk on February 24, entitled “*Minimal Probabilistic Automata have to make Irrational Choices*”.
- Josip Bozic, Birgit Hofer, Hermann Felbinger, and Franz Wotawa (TU Graz, Austria) visited us from May 15 to May 19, 2017, and attended the 1st RIDINGS Workshop held on May 17, 2017 at Inria Grenoble – Rhône-Alpes. J. Bozic gave a talk entitled “*Security Testing Based on Attack Patterns and Planning*”. B. Hofer gave a talk entitled “*Fault Localization in Software and Spreadsheets*”. H. Felbinger gave a talk entitled “*Test-Suite Reduction Does Not Necessarily Require Executing The Program Under Test*”. F. Wotawa gave a talk entitled “*Research Activities at the Institute for Software Technology / TU Graz*”.
- Soren Enevoldsen (Aalborg University, Denmark) visited us from September 27 to December 27, 2017. He gave a talk entitled “*Parallel Model Checking and Quantitative Models*” on October 24, 2017.

### **8.5.2. Visits to International Teams**

- H. Garavel is an invited professor at Saarland University (Germany) as a holder of the Gay-Lussac Humboldt Prize.
- G. Salaün visited the University of Málaga (Spain) from May 31 to June 14, 2017.
- L. Marsso and W. Serwe visited TU Graz (Austria) from November 13 to November 17, 2017 in the framework of the PHC RIDINGS project.

## CORSE Project-Team

# 8. Partnerships and Cooperations

## 8.1. Regional Initiatives

### 8.1.1. HEAVEN Persyval Project

- Title: Heterogeneous 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 run-time 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. AGIR DEREVES

- Title: DEcentralised Run-Time Verification and Enforcement of distributed and cyber-physical Systems
- DEREVES leader: Yliès Falcone
- CORSE participants: Yliès Falcone, Antoine El-Hokayem, Raphaël Jakse
- DEREVES aims at advancing the theory of decentralized run-time verification and enforcement for distributed systems, with the objective of proposing realistic monitoring and monitor-synthesis algorithms for expressive specifications that can be used for the efficient monitoring of multi-threaded, distributed and cyber-physical systems. The project shall help transferring run-time verification and enforcement to a wider audience of programmers of distributed systems by providing them techniques and tools to help them guaranteeing the correctness of their systems.

## 8.2. National Initiatives

### 8.2.1. PIA ELCI

- Title: Software environment for computation-intensive applications
- Coordinator: Corinne Marchand (BULL SAS)
- CORSE participants: François Broquedis, Philippe Viroulet
- INRIA Partners: Avalon, Cardamon, Myriads; Realopt, Roma, Storm, Tadaam
- Other Partners: Algo'Tech, CEA, Cenaero, CERFACS, CORIA, Kitware, Onera, SAFRAN
- Duration: from Sept. 2014 to Sept. 2017
- Abstract: 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 run-time systems. In particular, the CORSE team is studying the scalability of OpenMP run-time systems on large scale shared memory machines through the PhD of Philippe Viroulet, co-advised by researchers from the CORSE and AVALON Inria teams. This work intends to propose new approaches based on a compiler/run-time cooperation to improve the execution of scientific task-based programs on NUMA platforms. The PhD of Philippe Viroulet is funded by this project.

### 8.2.2. IPL ZEP

- Title: Zero-Power computing systems
- Coordinator: Kevin Marquet (INRIA Socrate)
- CORSE participants: Fabrice Rastello
- Other INRIA Partners: Cairn, Pacap
- Duration: from Apr. 2017 to Sept. 2019
- Abstract: The ZEP project addresses the issue of designing tiny computing objects with no battery by combining non-volatile memory (NVRAM), energy harvesting, micro-architecture innovations, compiler optimizations, and static analysis. The main application target is Internet of Things (IoT) where small communicating objects will be composed of this computing part associated to a low-power wake-up radio system. The ZEP project gathers four Inria teams that have a scientific background in architecture, compilation, operating system and low power together with the CEA Lialp and Lisan laboratories of CEA LETI & LIST. The major outcomes of the project will be a prototype harvesting board including NVRAM and the design of a new microprocessor associated with its optimizing compiler and operating system.

## 8.3. European Initiatives

### 8.3.1. FP7 & H2020 Projects

#### 8.3.1.1. Mont-Blanc2

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

Program FP7

Duration: 01/10/2013 - 31/01/2017

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 project 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.

#### 8.3.1.2. EoCoE

Title: Energy oriented Centre of Excellence for computer applications

Programm: H2020

Duration: October 2015 - October 2018

Coordinator: CEA

Partners:

Barcelona Supercomputing Center - Centro Nacional de Supercomputacion (Spain)

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

Centre Europeen de Recherche et de Formation Avancee en Calcul Scientifique (France)

Consiglio Nazionale Delle Ricerche (Italy)

The Cyprus Institute (Cyprus)

Agenzia Nazionale Per le Nuove Tecnologie, l'energia E Lo Sviluppo Economico Sostenibile (Italy)

Fraunhofer Gesellschaft Zur Forderung Der Angewandten Forschung Ev (Germany)

Instytut Chemii Bioorganicznej Polskiej Akademii Nauk (Poland)

Forschungszentrum Julich (Germany)

Max Planck Gesellschaft Zur Foerderung Der Wissenschaften E.V. (Germany)

University of Bath (United Kingdom)

Universite Libre de Bruxelles (Belgium)

Universita Degli Studi di Trento (Italy)

INRIA contact: Michel Kern

CORSE contact: Jean-François Méhaut

CORSE participants: Jean-François Méhaut, Frédéric Desprez and Francieli Zanon Boito

The aim of the present proposal is to establish 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 modeling. These four pillars will be anchored within a strong transverse 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 modeling 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.

Francieli Zanon Boito started in November 2017 as post-doc for the EoCoe project. She is working with Frédéric Desprez, Thierry Deutsch (CEA INAC) and Jean-François Méhaut. Francieli is investigating the data storage issues for the scientific workflows on the nano-scale characterization center (PFNC@Minatec [http://inac.cea.fr/en/Phoccea/Vie\\_des\\_labos/Ast/ast\\_technique.php?id\\_ast=217](http://inac.cea.fr/en/Phoccea/Vie_des_labos/Ast/ast_technique.php?id_ast=217)).

### 8.3.1.3. HPC4e

Title: HPC for Energy (HPC4E), Brazil and Europe

<https://hpc4e.eu>

H2020 European program

2 Years Duration (December 2015 - November 2017)

H2020 program: consortium

Coordinator: Barcelona Supercomputing Center

## Partners:

Centro de Investigaciones Energeticas, Medioambientales Y Tecnologicas-Ciemat (Spain)  
 Inria (France)  
 Queen Mary University of London (United Kingdom)  
 Iberdrola Renovables Energia (Spain)  
 Repsol (Spain)  
 Total S.A. (France)  
 COPPE Federal University of Rio de Janeiro (Brazil)  
 Laboratório Nacional Computação Científica (LNCC), Petropolis, (Brazil)  
 Instituto Tecnológico de Aeronautica (ITA), Brazil  
 Universidade Federal do Rio Grande do Sul (UFRGS), Brazil  
 Universidade Federal de Pernambuco (Brazil)  
 Petrobras (Brazil)

INRIA contact: Stephane Lanteri

CORSE participants: Jean-François Méhaut, Frédéric Desprez, François Broquedis, Emmanuelle Saillard (Post-Doct since Dec 2016)

This project aims to apply the new exascale HPC techniques to energy industry simulations, customizing them, and going beyond the state-of-the-art in the required HPC exascale simulations for different energy sources: wind energy production and design, efficient combustion systems for biomass-derived fuels (biogas), and exploration geophysics for hydrocarbon reservoirs. For wind energy industry HPC is a must. The competitiveness of wind farms can be guaranteed only with accurate wind resource assessment, farm design and short-term micro-scale wind simulations to forecast the daily power production. The use of CFD LES models to analyze atmospheric flow in a wind farm capturing turbine wakes and array effects requires exascale HPC systems. Biogas, i.e. biomass-derived fuels by anaerobic digestion of organic wastes, is attractive because of its wide availability, renewably and reduction of CO<sub>2</sub> emissions, contribution to diversification of energy supply, rural development, and it does not compete with feed and food feed-stock. However, its use in practical systems is still limited since the complex fuel composition might lead to unpredictable combustion performance and instabilities in industrial fuels. The next generation of exascale HPC systems will be able to run combustion simulations in parameter regimes relevant to industrial applications using alternative fuels, which is required to design efficient furnaces, engines, clean burning vehicles and power plants. One of the main HPC consumers is the oil & gas (O&G) industry. The computational requirements arising from full wave-form modeling and inversion of seismic and electromagnetic data is ensuring that the O&G industry will be an early adopter of exascale computing technologies. By taking into account the complete physics of waves in the subsurface, imaging tools are able to reveal information about the Earth's interior with unprecedented quality.

Emmanuelle Saillard was one year post-doc for the HPC4e project. She used the BOAST framework on the Alya application (BSC) and the Hou10ni application (Inria Magique 3D). Emmanuelle Saillard got an Inria Research position (CR2) in the Storm team at Bordeaux.

Two papers [18], [16] were accepted this year with the Brazilian researchers at UFRGS and also with the Magique3D team.

Jean-François Méhaut got a *Chaire* position at Laboratório Nacional Computação Científica (LNCC) in Petrópolis (Brazil). The LNCC is also partner of the HPC4e project. Jean-François Méhaut is working on the optimization of the MHM (Multiscale Hybrid-Mixed Methods) simulator by using the binLPT loop scheduling strategies and also new memory allocators.

#### 8.3.1.4. PRACE-5IP

Title: PRACE-5IP (PRACE Fifth Implementation Phase)

Program H2020

Duration: 01/01/2013 - 30/04/2019

Inria partners: Hiepacs team (Inria Bordeaux Sud-Ouest), Storm team (Inria Bordeaux Sud-Ouest), Nachos team (Inria Sophia Antipolis Méditerranée), CORSE team (Inria Grenoble Rhône Alpes)  
INRIA contact: Stéphane Lanteri (Nachos, Sophia Antipolis)

CORSE contact: Jean-François Méhaut

CORSE participants: François Broquedis, Jean-François Méhaut

The objectives of PRACE-5IP are to build on and seamlessly continue the successes of PRACE and start new innovative and collaborative activities proposed by the consortium. These include:

- assisting the transition to PRACE2 including analysis of TransNational Access;
- strengthening the internationally recognized PRACE brand;
- continuing and extend advanced training which so far provided more than 18800 person-training days;
- preparing strategies and best practices towards Exascale computing;
- coordinating and enhancing the operation of the multi-tier HPC systems and services;
- supporting users to exploit massively parallel systems and novel architectures.

The INRIA contribution is in the prolongation of involvement (jointly with CINES) in PRACE 4IP – WP7. The participation of Inria's researchers has been enlarged to include project-teams that were all involved in the C2S@Exa Inria Project Lab. The Inria teams will contribute to the WP7 and the following sub-tasks:

- Task 7.1: Applications Enabling Services for PRACE systems
- Task 7.4 Provision of Numerical Libraries for Heterogeneous/Hybrid Architectures

The activities are organized along two complementary lines

- Generic (or transverse) technologies for simulation software
- Specific (or vertical) technologies i.e. simulation software

The CORSE activities for PRACE-5IP will start with the hiring of one year postdoc in 2018. We will work on the DIOGENEs (DisOntinuous GalErkin Nanoscale Solvers) software suite developed in the Nachos team. The post-doc will investigate the new vectorization features of processors.

### **8.3.2. Collaborations in European Programs, Except FP7 & H2020**

Program: COST

Project acronym: ArVI

Project title: Run-Time Verification beyond Monitoring

Duration: December 2014 - Dec 2018

Coordinator: Martin Leucker, University of Lubeck

Abstract: Run-Time verification (RV) is a computing analysis paradigm based on observing a system at run-time to check its expected behavior. RV has emerged in recent years as a practical application of formal verification, and a less ad-hoc approach to conventional testing by building monitors from formal specifications.

There is a great potential applicability of RV beyond software reliability, if one allows monitors to interact back with the observed system, and generalizes to new domains beyond computers programs (like hardware, devices, cloud computing and even human centric systems). Given the European leadership in computer based industries, novel applications of RV to these areas can have

an enormous impact in terms of the new class of designs enabled and their reliability and cost effectiveness.

This Action aims to build expertise by putting together active researchers in different aspects of run-time verification, and meeting with experts from potential application disciplines. The main goal is to overcome the fragmentation of RV research by (1) the design of common input formats for tool cooperation and comparison; (2) the evaluation of different tools, building a growing sets benchmarks and running tool competitions; and (3) by designing a road-map and grand challenges extracted from application domains.

## 8.4. International Initiatives

### 8.4.1. Inria Associate Teams Not Involved in an Inria International Labs

#### 8.4.1.1. IOComplexity

Title: Automatic characterization of data movement complexity

International Partner (Institution - Laboratory - Researcher):

Ohio State University (United States) - P. Sadayappan

Colorado State University (United States) - Louis-Noël Pouchet

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 stark contrast with all known previous work that are strictly 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.

#### 8.4.1.2. 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 run-time 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. Participation in Other International Programs

- EnergySFE (STIC-Amsud)
  - Leader: University Federal of Santa Catarina (UFSC): Mârcio Castro
  - Partners: UFSC (Florianapolis, Brazil), UFRGS (Porto Alegre, Brazil), ESPE (Ecuador), CNRS (LIG/CORSE, TIMA, LSPSC)
  - <http://energysfe.ufsc.br/>
  - Duration: January 2016 - December 2017
  - CORSE participants: Jean-François Méhaut, François Broquedis, Frédéric Desprez
  - The main goal of the EnergySFE research project is to propose fast and scalable energy-aware scheduling and fault tolerance techniques and algorithms for large-scale highly parallel architectures. To achieve this goal, it will be crucial to answer the following research questions:
    - \* How to schedule tasks and threads that compete for resources with different constraints while considering the complex hierarchical organization of future Exascale supercomputers?
    - \* How to tolerate faults without incurring in too much overhead in future Exascale supercomputers?
    - \* How scheduling and fault tolerance approaches can be adapted to be energy-aware?

The first EnergySFE workshop was organized by the CORSE team at the INRIA Minatéc building in September 2016.

## 8.5. International Research Visitors

### 8.5.1. Visits of International Scientists

- Julien Langou (UCDenver) is visiting professor from September 2016 till July 2017
- Henrique Cota de Freitas (PUC Minas) visited the team for a week in April 2017 (Pedro Penna's thesis)
- Philippe Navaux (UFRGS) visited the team for a week in February 2017. (HPC4e project)
- Paolo Rech (UFRGS) visited the team for a week in September 2017 (EnergySFE project).
- Mohamad Jaber (American University of Beirut, Lebanon) visited the team for a week in January 2017.
- Maurice Tchunte (Yaoundé 1) visited the team for a week in June 2017 (related to Thomas Messi Nguele's thesis).
- Mârcio Castro (UFSC) visited the team for two weeks in February 2017 (EnergySFE project).
- Laercio Pilla (UFSC) visited the team for a week in December 2017 (EnergySFE project).

### 8.5.2. Visits to International Teams

- Jean-François Méhaut visited for one week (July 2017) the UFRGS (Porto Alegre) and the GPPD group for the HPC4e project.
- Jean-François Méhaut visited for one week (July 2017) the Federal University of Rio de Janeiro for the HPC4e project.
- Jean-François Méhaut visited for one day (July 2017) the LNCC to prepare the research work for the chaire position and also for the HPC4e project.
- Jean-François Méhaut visited for a week (August 2017) the LaPeSD and ECL laboratories at UFSC (Florianapolis). He was member of the master jury of Pedro Penna. This visit was funded by the EnergySFE project.

- Jean-François Méhaut visited for one week (August 2017) the PUC Minas to prepare the cotutelle agreement of the Pedro Penna's PhD. This agreement is signed between PUC Minas, LIG, Ecole Doctorale MSTII, Post-Graduation program of PUC Minas and the COMUE Grenoble Alpes.
- Jean-François Méhaut visited for one day (December 2017) the French consulate in Rio de Janeiro and the CNRS Bureau. He presented the first results of the research work at LNCC.

#### *8.5.2.1. Sabbatical programme*

- Fabrice Rastello is on sabbatical at Colorado State University (USA) from July 2017 till July 2018

#### *8.5.2.2. Research Stays Abroad*

- Jean-François Méhaut holds a *Chaire* position at Laboratório Nacional Computação Científica (LNCC) in Petrópolis (Brazil). This *Chaire* position is funded by the LNCC and the French Consulate in Rio de Janeiro.

## **DATASPHERE Team**

# **8. Partnerships and Cooperations**

## **8.1. Regional Initiatives**

L'équipe est hébergée dans l'IXXI, l'Institut Rhônalpin des Systèmes Complexes au sein de l'ENS de Lyon, et très impliquée dans les partenariats interdisciplinaires.

## **8.2. National Initiatives**

- Chaire Castex, Ecole Militaire, Paris
- AMNECYS (Alpine Multidisciplinary NEtwork on CYber-security Studies), University of Grenoble-Alpes

## **8.3. International Initiatives**

### ***8.3.1. Informal International Partners***

- RIHN, Research Institute on Humanity and Nature, Kyoto
- Information School, UC Berkeley
- ICT, Institute of Computing Technologies, Chinese Academy of Sciences, Beijing
- CSIRO, Sydney
- Center for CyberSecurity, University Macquarie, Sydney
- Center for Internet Human Rights (CIHR), Berlin

## PRIVATICS Project-Team

# 8. Partnerships and Cooperations

## 8.1. National Initiatives

### 8.1.1. FUI

Title: ADAGE (Anonymous Mobile Traffic Data Generation).

Type: FUI.

Duration: July 2016 - September 2018.

Coordinator: Orange.

Others partners: Inria, CNRS LAAS.

Abstract: The project ADAGE aims at developing solutions for the anonymization of mobility traces produced by mobile operators.

### 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. SIDES 3.0

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

Type: ANR.

Duration: August 2017 - August 2020.

Coordinator: Uness (France).

Others partners: Inria, UGA, ENS, Theia, Viseo.

Abstract: Since 2013, faculties of medicine have used a shared national platform that enables them to carry out all of their validating exams on tablets with automatic correction. This web platform entitled SIDES allowed the preparation of the medical students to the Computerized National Classing Events (ECN) which were successfully launched in June 2016 (8000 candidates simultaneously throughout France). SIDES 3.0 proposes to upgrade the existing platform. Privatics goals in this project is to ensure that privacy is respected and correctly assessed .

#### 8.1.2.3. DAPCODS/IOTics

Title: DAPCODS/IOTics.

Type: ANR 2016.

Duration: May 2017 - Dec. 2020.

Coordinator: Inria PRIVATICS.

Others partners: Inria DIANA, EURECOM, Univ. Paris Sud, CNIL.

Abstract:

Thanks to the exponential growth of Internet, citizens have become more and more exposed to personal information leakage in their digital lives. This trend began with web tracking when surfing the Internet with our computers. The advent of smartphones, our personal assistants always connected and equipped with many sensors, further reinforced this tendency. And today the craze for “quantified self” wearable devices, for smart home appliances or for other connected devices enable the collection of potentially highly sensitive personal information in domains that were so far out of reach. However, little is known about the actual practices in terms of security, confidentiality, or data exchanges. The enduser is therefore prisoner of a highly asymmetric system. This has important consequences in terms of regulation, sovereignty, and leads to the hegemony of the GAFAs (Google, Amazon, Facebook and Apple). Security, transparency and user control are three key properties that should be followed by all the stakeholders of the smartphone and connected devices ecosystem. Recent scandals show that the reality is sometimes at the opposite.

The DAPCODS project gathers four renowned research teams, experts in security, privacy and digital economy. They are seconded by CNIL, the French data protection agency. The project aims at contributing along several axes:

- by analyzing the inner working of a significant set of connected devices in terms of personal information leaks. This will be made possible by analyzing their data flows (and associated smartphone application if applicable) from outside (smartphone and/or Wifi network) or inside, through ondevice static and dynamic analyses. New analysis methods and tools will be needed, some of them leveraging on previous works when applicable;
- by studying the device manufacturers’ privacy policies along several criteria (e.g., accessibility, precision, focus, privacy risks). In a second step, their claims will be compared to the actual device behavior, as observed during the test campaigns. This will enable an accurate and unique ranking of connected devices;
- by understanding the underlying ecosystem, from the economical viewpoint. Data collected will make it possible to define the blurred boundaries of personal information market, a key aspect to set up an efficient regulation;
- and finally, by proposing a public website that will rank those connected devices and will inform citizens. We will then test the impact of this information on the potential change of behavior of stakeholders.

By giving transparent information of hidden behaviors, by highlighting good and bad practices, this project will contribute to reduce the information asymmetry of the system, to give back some control to the endusers, and hopefully to encourage certain stakeholders to change practices.

### **8.1.3. Inria Innovation Laboratory**

Title: LEELCO (Low End-to-End Latency COmmunications).

Duration: 3 years (2015 - 2018).

Coordinator: Inria PRIVATICS.

Others partners: Expway.

Abstract:

This Inria Innovation Lab aims at strengthening Expway (<http://www.expway.com/>) commercial offer with technologies suited to real-time data transmissions, typically audio/video flows. In this context, the end-to-end latency must be reduced to a minimum in order to enable a high quality interaction between users, while keeping the ability to recover from packet losses that are unavoidable with wireless communications in harsh environments. In this collaboration we focus on

new types of Forward Erasure Correction (FEC) codes based on a sliding encoding windows, and on the associated communication protocols, in particular an extension to FECFRAME (RFC6363) to such FEC codes. The outcomes of this work are proposed to both IETF and 3GPP standardisation organisations, in particular in the context of 3GPP mission critical communication services activity. The idea of this 3GPP activity is to leverage on the 3GPP Evolved Multimedia Broadcast Multicast Services (eMBMS) and on the existing Long Term Evolution (LTE) infrastructure for critical communications and such services as group voice transmissions, live high-definition video streams and large data transmissions. In this context, the advanced FEC codes studied in LEELCO offer a significant improvement both from the reduced latency and increased loss recovery viewpoints compared to the Raptor codes included in the existing standard (<https://hal.inria.fr/hal-01571609v1/en/>).

#### **8.1.4. Inria CNIL project**

Privatics is in charged of the Cnil-Inria collaboration. This collaboration was at the origin of the Mobilities project and it is now at the source of many discussions and collaborations on data anonymisation, risk analysis, consent or IoT Privacy. Privatics and Cnil are both actively involved on the IoTics project, that is the follow-up of the Mobilities projects. The goal of the Mobilities project was to study information leakage in mobile phones. The goal of IoTics is to extend this work to IoT and connected devices.

Privatics is also in charged of the organization of the Cnil-Inria prize that is awarded every year to an outstanding publication in the field of data privacy.

## **8.2. European Initiatives**

### **8.2.1. Collaborations in European Programs, ANR Chistera**

#### **8.2.1.1. 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.

#### **8.2.1.2. UPRISE-IoT**

Title: User-centric PRiVacy & Security in IoT

Programm: CHISTERA

Duration: December 2016 - december 2019

Coordinator: SUPSI (Suisse)

Inria contact: Claude Castelluccia

The call states that “Traditional protection techniques are insufficient to guarantee users’ security and privacy within the future unlimited interconnection”: UPRISE-IoT will firstly identify the threats and model the behaviours in IoT world, and further will build new privacy mechanisms centred around the user. Further, as identified by the call “all aspects of security and privacy of the user data must be under the control of their original owner by means of as simple and efficient technical solutions as possible”, UPRISE-IoT will rise the awareness of data privacy to the users. Finally, it will deeply develop transparency mechanisms to “guarantee both technically and regulatory the neutrality of the future internet.” as requested by the call. The U-HIDE solution developed in UPRISE-IoT will “empower them to understand and make their own decisions regarding their data, which is essential in gaining informed consent and in ensuring the take-up of IoT technologies”, using a methodology that includes “co-design with users to address the key, fundamental, but inter-related and interdisciplinary aspects of privacy, security and trust.”

### 8.3. Regional Initiatives

#### 8.3.1. ACDC

Title: ACDC

Type: AGIR 2016 Pole MSTIC.

Duration: September 2016 - 2017.

Coordinator: Inria.

Others partners: UGA.

Abstract: The objective of this project is to evaluate the security and privacy impacts of drone. The project targets 2 milestones: the evaluation of the possibility to tamper with the drone control/command systems and the capacity of drone to collect private information (for instance text recognition).

#### 8.3.2. 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).

#### 8.3.3. Data Institute

- Title: Data Institute UGA
- Duration: 2017 - .
- Coordinator: TIMC-IMAG.
- Others partners: AGEIS, BIG, CESICE, GIN, GIPSA-lab, IAB, IGE, IPAG, LAPP, LARHRA, LIDILEM, LIG, LISTIC, LITT&ArTS, LJK, LUHCIE, LECA, OSUG, PACTE, TIMC-IMAG, Inria

- Abstract: Privatics is leading the WP5 (Data Governance, Data Protection and Privacy). This action (WP5) aims to analyze, in a multi-disciplinary perspective, why and how specific forms of data governance emerge as well as the consequences on the interaction between the state, the market and society. The focus will be on the challenges raised by the collection and use of data for privacy, on the data subjects' rights and on the obligations of data controllers and processors. A Privacy Impact/Risk assessments methodology and software will be proposed. A case study will focus on medical and health data and make recommendations on how they should be collected and processed



## SPADES Project-Team

# 8. Partnerships and Cooperations

## 8.1. Regional Initiatives

### 8.1.1. CASERM (*PERSYVAL-Lab project*)

**Participants:** Pascal Fradet, Alain Girault, Gregor Goessler, Xiaojie Guo, Xavier Nicollin, Stephan Plassart, Sophie Quinton, Jean-Bernard Stefani.

Despite recent advances, there exists currently no integrated formal methods and tools for the design and analysis of reconfigurable multi-view embedded systems. This is the goal of the CASERM project.

The CASERM project represents a significant effort towards a COQ-based design method for reconfigurable multi-view embedded systems, in order to formalize the structure and behavior of systems and to prove their main properties. The use of a proof assistant to support such a framework is motivated by the fact that the targeted systems are both extremely complex and critical. The challenges addressed are threefold:

1. to model software architectures for embedded systems taking into account their dynamicity and multiple constraints (functional as well as non functional);
2. to propose novel scheduling techniques for dynamically reconfiguring embedded systems; and
3. to advance the state of the art in automated proving for such systems.

The objectives of CASERM that address these challenges are organized in three tasks. They consist respectively in designing an architecture description framework based on a process calculus, in proposing online optimization methods for dynamic reconfiguration systems (this is the topic of Stephan Plassart's PhD), and in developing a formal framework for real-time analysis in the COQ proof assistant (this is the topic of Xiaojie Guo's and Maxime Lesourd's PhD). A fourth task focuses on common case studies for the evaluation of the obtained results.

The CASERM consortium gathers researchers from the G-SCOP, LIG and VERIMAG laboratories who are renowned specialists in these fields. The project started in November 2016 and will last three years.

## 8.2. National Initiatives

### 8.2.1. ANR

An ANR-PRCI project called RT-PROOFS will start in 2018, which involves the SPADES project-team, MPI-SWS, TU Braunschweig, and Onera.

## 8.3. European Initiatives

### 8.3.1. *Collaborations with Major European Organizations*

We have a strong collaboration with the Technische Universität Braunschweig in Germany. In particular, Sophie Quinton is involved 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, and in the TypicalCPA project which aims at computing deadline miss models for distributed systems.

We also have a recent collaboration with the MPI-SWS in Kaiserslautern (Germany) on formal proofs for real-time systems. This collaboration will be concretized by an ANR-PRCI project called RT-PROOFS starting in 2018, which involves MPI-SWS, TU Braunschweig, INRIA, and Onera.

## 8.4. International Initiatives

### 8.4.1. Inria Associate Teams Not Involved in an Inria International Labs

#### 8.4.1.1. 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.

## **BIPOP Project-Team**

# **9. Partnerships and Cooperations**

## **9.1. Regional Initiatives**

- Christophe Prieur and Bernard Brogliato are coordinator and member (respectively) of the Labex Persyval project e-Baccuss (2016-2018).
- Pierre-Brice Wieber is co-coordinator of the Labex Persyval project RHUM (2015-2018).

## **9.2. National Initiatives**

- Vincent Acary and Bernard Brogliato are members of the Inria IPL Modeliscale (coordinator: Benoit Caillaud, Inria Rennes).
- Vincent Acary and Bernard Brogliato are members of the FUI project Modeliscale (coordinator: Benoit Caillaud, Inria Rennes).

## **9.3. European Initiatives**

### **9.3.1. FP7 & H2020 Projects**

#### **9.3.1.1. GEM**

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

Programm: H2020

Type: ERC

Duration: September 2015 - August 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.

#### 9.3.1.2. COMANOID

Title: Multi-contact Collaborative Humanoids in Aircraft Manufacturing

Programm: H2020

Duration: January 2015 - December 2018

Coordinator: CNRS (Lirmm)

Partners:

Centre national de la recherche scientifique (France)

Deutsches Zentrum für Luft - und Raumfahrt Ev (Germany)

Airbus Groups (France)

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.

## 9.4. International Initiatives

### 9.4.1. Inria International Labs

- Inria-Chile: two engineers supervised by Vincent Acary (Stephen Sinclair and Salomé Candela)

## 9.5. International Research Visitors

### 9.5.1. Visits of International Scientists

- Jozsef Kovecses (McGill University, Mechanical Engineering).
- Alexandre Derouet-Jourdan (OLM Digital, Japan).

## **MISTIS Project-Team**

# **9. Partnerships and Cooperations**

## **9.1. National Initiatives**

### **9.1.1. Grenoble Idex projects**

MISTIS is involved in a newly accepted transdisciplinary project **NeuroCoG**.

F. Forbes is also responsible for a work package in another project entitled **Grenoble Alpes Data Institute**.

MISTIS is also involved in a newly accepted cross-disciplinary project (CDP) **RISK@UGA**.

- The main objective of the **RISK@UGA** project is to provide some innovative tools both for the management of risk and crises in areas that are made vulnerable because of strong interdependencies between human, natural or technological hazards, in synergy with the conclusions of Sendai conference. The project federates a hundred researchers from Human and Social Sciences, Information & System Sciences, Geosciences and Engineering Sciences, already strongly involved in the problems of risk assessment and management, in particular natural risks.
- The **NeuroCoG** project aims at understanding the biological, neurophysiological and functional bases of behavioral and cognitive processes in normal and pathological conditions, from cells to networks and from individual to social cognition. No decisive progress can be achieved in this area without an aspiring interdisciplinary approach. The interdisciplinary ambition of **NeuroCoG** is particularly strong, bringing together the best scientists, engineers and clinicians at the crossroads of experimental and life sciences, human and social sciences and information and communication sciences, to answer major questions on the workings of the brain and of cognition. One of the work package entitled **InnobioPark** is dedicated to Parkinson's Disease. The PhD thesis of Veronica Munoz Ramirez is one of the three PhDs in this work package.
- The **Grenoble Alpes Data Institute** aims at undertaking groundbreaking interdisciplinary research focusing on how data change science and society. It combines three fields of data-related research in a unique way: data science applied to spatial and environmental sciences, biology, and health sciences; data-driven research as a major tool in Social Sciences and Humanities; and studies about data governance, security and the protection of data and privacy. In this context, two 2-years multi-disciplinary projects were granted in November 2017 to Mistis in collaboration respectively with Team Necs from Inria and Gipsa-lab (**DATASAFE** project: understanding Data Accidents for Traffic SAFETY) and with IPAG and Univ. Paris Sud Orsay (Regression techniques for Massive Mars hyperspectral image analysis from physical model inversion), 9 keuros each.
- Also in the context of the **Grenoble Alpes Data Institute**, Julyan Arbel and Stéphane Girard were awarded a funding from IRS (Initiatives de Recherche Stratégique) for a research project dedicated to extreme and Bayesian statistics, 8 keuros.

### **9.1.2. Competitvity Clusters**

**The MINALOGIC VISION 4.0 project:** MISTIS is involved in a three-year (2016-19) project. The project is led by **VI-Technology**, a world leader in Automated Optical Inspection (AOI) of a broad range of electronic components. The other partners are the G-Scop Lab in Grenoble and ACTIA company based in Toulouse. Vision 4.0 (in short Vi4.2) is one of the 8 projects labeled by Minalogic, the digital technology competitiveness cluster in Auvergne-Rhône-Alpes, that has been selected for the Industry 4.0 topic in 2016, as part of the 22nd call for projects of the FUI-Régions, for a total budget of the project of 3,4 Meuros.

Today, in the printed circuits boards (PCB) assembly industry, the assembly of electronic cards is a succession of ultra automated steps. Manufacturers, in constant quest for productivity, face sensitive and complex adjustments to reach ever higher levels of quality. Project VI4.2 proposes to build an innovative software solution to facilitate these adjustments, from images and measures obtained in automatic optical inspection (AOI). The idea is - from a centralized station for all the assembly line devices - to analyze and model the defects finely, to adjust each automatic machine, and to configure the interconnection logic between them to improve the quality. Transmitted information is essentially of statistical nature and the role of sc mistis is to identify which statistical methods might be useful to exploit at best the large amount of data registered by AOI machines. Preliminary experiments and results on the Solder Paste Inspection (SPI) step, at the beginning of the assembly line, helped determining candidate variables and measurements to identify future defects and to discriminate between them. More generally, the idea is to analyze two databases at both ends (SPI and Component Inspection) of the assembly process so as to improve our understanding of interactions in the assembly process, find out correlations between defects and physical measures and generate accordingly proactive alarms so as to detect as early as possible departures from normality.

### 9.1.3. CNRS fundings

- **Defi Mastodons, La qualité des données dans le Big Data (2015-17).** S. Girard is involved in a 2-year project entitled “Classification de Données Hétérogènes avec valeurs manquantes appliquée au Traitement des Données Satellitaires en écologie et Cartographie du Paysage” [53], the other partners being members of Modal (Inria Lille Nord-Europe) or ENSAT-Toulouse. The total funding is 17,5 keuros.
- Stéphane Girard and Julyan Arbel were awarded a funding from TelluS-Insmi (with IPAG and Univ. Paris-Descartes), for a 1-year project entitled “unsupervised classification in high dimension”, 7000 euros.
- **Defi Imag’IN MultiPlanNet (2015-2017).** 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. The CNRS support for the network is of 20 keuros. A 2-day **workshop** was organized in November 2017 in Grenoble, on the analysis of multimodal data for planets observation and exploration.

### 9.1.4. 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).

### 9.1.5. 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.

## 9.2. International Initiatives

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

#### 9.2.1.1. SIMERGE

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

International Partner (Institution - Laboratory - Researcher):

UGB (Senegal) - LERSTAD - Abdou Ka Diongue

Starting year: 2015

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

Entered in the LIRIMA in January 2015, this team federates researchers from LERSTAD (Laboratoire d'Etudes et de Recherches en Statistiques et Développement, Université Gaston Berger), on the one part, and MISTIS (Inria Grenoble Rhône-Alpes) on the other part. This project consolidates the existing collaborations between these two Laboratories.

The team also involves 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.

The following two research themes are developed : (1) Spatial extremes with application to management of extreme risks ; (2) Classification with application to global epidemiology.

## **9.2.2. Inria International Partners**

### **9.2.2.1. 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 Michigan, in Ann Arbor, USA, the statistics department of McGill University in Montreal, Canada, Université Gaston Berger in Senegal and Universities of Melbourne and Brisbane in Australia.

The main active international collaborations in 2017 are with:

- F. Durante, Free University of Bozen-Bolzano, Italy.
- K. Qin, H. Nguyen and D. Wraith resp. from Swinburne University and La Trobe university in Melbourne, Australia and Queensland University of Technology in Brisbane, Australia.
- E. Deme and S. Sylla from Gaston Berger university and IRD in Senegal.
- M. Stehlik from Johannes Kepler Universitat Linz, Austria and Universidad de Valparaiso, Chile.
- M. Houle from National Institute of Informatics, Tokyo, Japan.
- N. Wang and C-C. Tu from University of Michigan, Ann Arbor, USA.
- R. Steele, from McGill university, Montreal, Canada.
- Guillaume Kon Kam King, Stefano Favaro, Igor Prünster, University of Turin, Italy.
- Bernardo Nipoti, Trinity College Dublin, Ireland.
- Yeh Whye Teh, Oxford University, UK.
- Stephen Walker, University of Texas at Austin, USA.

## **9.3. International Research Visitors**

### **9.3.1. Visits of International Scientists**

- Seydou Nourou Sylla (Université Gaston Berger, Sénégal) has been hosted by the MISTIS team for two months.
- Aboubacrène Ahmad (Université Gaston Berger, Sénégal) has been hosted by the MISTIS team for two months.
- Hien Nguyen from La Trobe university, Melbourne Australia, has been hosted for 2 days.

### **9.3.2. Visits to International Teams**

#### **9.3.2.1. Research Stays Abroad**

- F. Forbes spent 2 weeks in April 2017 in Australia, visiting Brisbane and Melbourne universities.
- J. Arbel spent 3 months at the University of Texas at Austin.

## **NANO-D Project-Team**

## **6. Partnerships and Cooperations**

### **6.1. National Initiatives**

#### **6.1.1. 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).

### **6.2. European Initiatives**

#### **6.2.1. FP7 & H2020 Projects**

##### **6.2.1.1. ADAPT**

Title: Theory and Algorithms for Adaptive Particle Simulation

Programm: FP7

Duration: September 2012 - August 2017

Coordinator: Inria

Inria contact: Stephane Redon

'During the twentieth century, the development of macroscopic engineering has been largely stimulated by progress in digital prototyping: cars, planes, boats, etc. are nowadays designed and tested on computers. Digital prototypes have progressively replaced actual ones, and effective computer-aided engineering tools have helped cut costs and reduce production cycles of these macroscopic systems. The twenty-first century is most likely to see a similar development at the atomic scale. Indeed, the recent years have seen tremendous progress in nanotechnology - in particular in the ability to control matter at the atomic scale. Similar to what has happened with macroscopic engineering, powerful and generic computational tools will be needed to engineer complex nanosystems, through modeling and simulation. As a result, a major challenge is to develop efficient simulation methods and algorithms. NANO-D, the Inria research group I started in January 2008 in Grenoble, France, aims at developing efficient computational methods for modeling and simulating complex nanosystems, both natural and artificial. In particular, NANO-D develops SAMSON, a software application which gathers all algorithms designed by the group and its collaborators (SAMSON: Software for Adaptive Modeling and Simulation Of Nanosystems). In this project, I propose to develop a unified theory, and associated algorithms, for adaptive particle simulation. The proposed theory will avoid problems that plague current popular multi-scale or hybrid simulation approaches by simulating a single potential throughout the system, while allowing users to finely trade precision for computational speed. I believe the full development of the adaptive particle simulation theory will have an important impact on current modeling and simulation practices, and will enable practical design of complex nanosystems on desktop computers, which should significantly boost the emergence of generic nano-engineering.'

#### **6.2.2. Collaborations with Major European Organizations**

Partner 1: Institut Laue-Langevin, SANS platform (France)

Partner 2: European Synchrotron Radiation Facility, SAXS platform (France)



The topic of collaboration is the development and validation of novel computational methods for small-angle scattering experiments.

## 6.3. International Initiatives

### 6.3.1. Inria Associate Teams Not Involved in an Inria International Labs

#### 6.3.1.1. PPI-3D

Title: Structure Meets Genomics

International Partner (Institution - Laboratory - Researcher):

Stony Brook 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.

### 6.3.2. Participation in Other International Programs

#### 6.3.2.1. International Initiatives

##### BIOTOOLS

Title: Novel Computational Tools for Structural Bioinformatics

International Partner (Institution - Laboratory - Researcher):

MIPT (Russia (Russian Federation)) - Vadim Strijov

Duration: 2016 - 2020

Start year: 2016

## **6.4. International Research Visitors**

### ***6.4.1. Visits of International Scientists***

- Dima Kozakov, Professor at the University of Stony Brook, visited Nano-D for 2 weeks in July 2017.
- Dzmitry Padhorny, PhD candidate at the University of Stony Brook, visited Nano-D for 2 weeks in July 2017.
- Mikhail Ignatov, PhD candidate at the University of Stony Brook, visited Nano-D for 2 weeks in June 2017.

#### ***6.4.1.1. Internships***

Mikhail Karasikov

Date: 1/08/2016 - 30/01/2017

Institution: Skolkovo Research Center / MIPT Moscow (Russia (Russian Federation))

Supervisor: Sergei Grudinin

## NECS Project-Team

## 8. Partnerships and Cooperations

### 8.1. Regional Initiatives

#### 8.1.1. ProCyPhyS

ProCyPhyS is a one year project funded by University Grenoble Alps, MSTIC department, with the aim to study privacy in cyberphysical system. A post-doc (H. Nouasse) has been hired to perform analysis of privacy protection through system-theoretic measures. We are interested with cyber-physical systems that can be viewed as systems of interconnected entities which are locally governed by difference equations of partial differential equations, namely intelligent transportation systems and indoor navigation. A first approach to analyze privacy preservation is to study observability of the overall system, see [8] where a large family of non-observable networks have been characterized for homogeneous systems of consensus type. In this approach, the network structure immunizes the overall system. A second approach, consists in adding information (noise) to the sensitive one: that is the differential privacy concept that leads to differential filtering where the aim is to develop an estimator that is robust enough according to the added noise [46]. In ProCyPhyS the main goal is to make the system partially nonobservable. The idea is to compress the state space while adding noise to the sensitive information in a smarter way.

#### 8.1.2. Control of Cyber-Social Systems (C2S2)

C2C2 is a two year project funded by the University Grenoble Alpes, MSTIC department. Evolving from recent research on network systems, this exploratory project has the objective to concentrate on “cyber-social” systems, that is, complex systems with interacting social and technological components. A strong motivation for this novel research direction comes from the need for innovative tools for the management of vehicular traffic. In this application, state-of-the-art approaches concentrate on hard control actions, like traffic lights: instead, future management methods should exploit soft control actions aimed at controlling the traffic demand, that is, the aggregated behaviors of the drivers.

### 8.2. European Initiatives

#### 8.2.1. FP7 & H2020 Projects

##### 8.2.1.1. SPEEDD (Scalable Proactive Event-Driven Decision making)

Type: STREP

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

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>

##### 8.2.1.2. Scale-FreeBack

Type: ERC Advanced Grant

Duration: Sep. 2016 to Aug. 2021

Coordinator: C. Canudas de Wit

Inria contact: C. Canudas de Wit

Abstract: The overall aim of Scale-FreeBack is to develop holistic scale-free control methods of controlling complex network systems in the widest sense, and to set the foundations for a new control theory dealing with complex physical networks with an arbitrary size. Scale-FreeBack envisions devising a complete, coherent design approach ensuring the scalability of the whole chain (modelling, observation, and control). It is also expected to find specific breakthrough solutions to the problems involved in managing and monitoring large-scale road traffic networks. Field tests and other realistic simulations to validate the theory will be performed using the equipment available at the Grenoble Traffic Lab center (see GTL), and a microscopic traffic simulator replicating the full complexity of the Grenoble urban network.

See also: <http://scale-freeback.eu>

## 8.3. International Initiatives

### 8.3.1. Participation in Other International Programs

#### 8.3.1.1. 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.

## 8.4. International Research Visitors

### 8.4.1. Visits of International Scientists

Dr. Walter Musakwa from Univ. of Johannesburg ( South Africa) visited the team in August 2017 for working with A. Kibangou on analysis on cycling data collected in Johannesburg and setting up a MoA between UGA and UJ.

Prof. Olga Quintero Montoya, from Universidad EAFIT (Colombia) visited teh team from May 2017 until June 2017 to work with C. Canudas de Wit on traffic flow problems.

Pr. Marcello L.R. de Campos (Federal Univ. of Rio de Janeiro, Brazil) visited the team in October 2017 in the framework of the TICO-MED project.

Dr. Paola Goatin (Inria Sophia Antipolis) visited the team in September to work with M. L. Delle Monache on traffic flow modeling and control using conservation laws.

F. Acciani (U. Twente, Netherlands) visited the team in November 2017 to work with P. Frasca.

W. S. Rossi (U. Twente, Netherlands) visited the team in November 2017 to work with P. Frasca.

Professor Per-Olof Gutman visited the on February 9th and 10th 2017. he gave two talks on “Modelling of and Controller Design for a Virtual Skydiver” and “Dynamic model for estimating the Macroscopic Fundamental Diagram” to the NeCS team. He exchanged ideas with Carlos Canudas de Wit, Paolo Frasca and Giacomo Casadei.

Professor Ioannis Paschalidis visited the team on September 2017. He gave a talk "Inverse Equilibrium Problems and Price-of-Anarchy Estimation in Transportation Networks". He exchanged ideas with Carlos Canudas De Wit, Paolo Frasca and Stephane Mollier.

#### 8.4.1.1. Research Stays Abroad

A. Kibangou visited the University of Johanesburg (UJ) in March and October 2017. During his stay, he gave lectures to students of Department of Town and Regional Planning of UJ on Mobility and traffic management.

A. Kibangou visited University of Cape Town (UCT) in October 2017. During his stay, he gave a lecture to students and researchers of Control department of UCT.

Federica Garin spent three weeks in Lund, Sweden, in June, for the LCCC Focus Period on Large-Scale and Distributed Optimization (<http://www.lccc.lth.se/index.php?page=june-2017-optimization>)

Paolo Frasca visited the University of Cagliari, Cagliari, Italy in April–May 2017.

M. L. Delle Monache visited Rutgers University (USA) in June 2017. During her stay they worked on control of traffic with conservation laws.

## AIRSEA Project-Team

## 9. Partnerships and Cooperations

### 9.1. Regional Initiatives

STAREX - Clémentine Prieur obtained a 8k€ two-years funding for a local project on risk by the Labex Persyval. Philippe Naveau (from LSCE, Paris) visited the team during one month in spring 2017 in this context.

C. Prieur is co-leader of work-package 3 of the cross-disciplinary-project Trajectories from IDEX Grenoble.

### 9.2. National Initiatives

#### 9.2.1. ANR

COCOA: COMprehensive Coupling approach for the Ocean and the Atmosphere. PI: E. Blayo. Duration: 4 years (Jan. 2017 - Dec. 2020). Other partners: Laboratoire des Sciences du Climat et de l'Environnement (UMR8212, Gif-sur-Yvette), Laboratoire de Météorologie Dynamique (UMR8539, Paris), Laboratoire d'Océanographie Physique et Spatiale (UMR6523, Brest), Centre National de Recherche Météorologique (UMR3589, Toulouse), Cerfacs (Toulouse). This project aims at revisiting the overall representation of air-sea interactions in coupled ocean-atmosphere models, and particularly in climate models, by coherently considering physical, mathematical, numerical and algorithmic aspects.

C. Prieur and E. Arnaud are involved as experts in project High-Tune <http://www.agence-nationale-recherche.fr/Projet-ANR-16-CE01-0010> funded by ANR.

A 4-year contract : ANR HEAT (Highly Efficient ATMospheric modelling) <http://www.agence-nationale-recherche.fr/?Project=ANR-14-CE23-0010>.

#### 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 6.6 .

C. Prieur chaired GdR MASCOT NUM 2010-2017, in which are also involved M. Nodet, E. Blayo, C. Helbert, E. Arnaud, L. Viry, S. Nanty, L. Gilquin. She is still strongly involved in this group (co-chair) <http://www.gdr-mascotnum.fr/doku.php>.

LEFE/GMMC CASIS, Coupled Assimilation Strategies for the Initialisation of an ocean- atmospheric boundary layer System, A. Vidard. en collaboration avec Mercator océan

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 6.6 .

### 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 Center 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

F. Lemarié is involved in the Inria associate team NEMOLOCO with Santiago University (Chile)

### 9.4.1. Inria International Partners

#### 9.4.1.1. Informal International Partners

C. Prieur collaborates with Jose R. Leon (UCV, Central University of Caracas), who was funded by the international Inria chair program. He moved in June 2017 to Montevideo, Uruguay, and the collaboration goes on.

C. Prieur is collaborating with AC Favre (LTHE, Grenoble) in the framework of a two-years canadian funding from CFQCU (Conseil franco-québécois de coopération universitaire) 2015-2016.

F. Lemarié and L. Debreu collaborate with Hans Burchard from the Leibniz-Institut für Ost-seeforschung in Warnemünde (Germany).

F. Lemarié and L. Debreu collaborate with Knut Klingbeil from the Dept. of Mathematics of the University of Hamburg (Germany).

### 9.4.2. Participation in Other International Programs

#### 9.4.2.1. International Initiatives

##### **SIDRE**

Title: Statistical inference for dependent stochastic processes and application in renewable energy

International Partners:

Universidad de Valparaiso (Chile) - CIMFAV - Facultad de Ingeniería - Karine Bertin

Universidad Central de Venezuela (Venezuela) - Departamento de Matemáticas - Jose León

Duration: 2016 - 2017

Start year: 2016

See also: <http://sidre.cimfav.cl/>

We want to develop, apply and study the properties of statistical tools in several non-parametric models, segmentation models, time series and random fields models, and to study some classes of long-range dependent processes, for their possible application in renewable energies and other domains. In particular non-parametric statistical procedure in Markov switching non-linear autoregressive models, finite mixture, non-parametric functional test and non-parametric estimators in stochastic damping Hamiltonian systems will be considered. Statistical tools for segmenting dependent multiples series, censoring processes in time series models and a new model interpolation scheme will be studied.

## 9.5. International Research Visitors

### 9.5.1. Visits of International Scientists

Werner Bauer (Imperial College, London) spent one week in the AIRSEA team from October 9th to October 13th to work on mimetic schemes for atmospheric models.

#### 9.5.1.1. Internships

Gino Rivano from the university of Valparaiso (Chile) : « High-resolution numerical modeling of the oceanic circulation in central Chile: application to larvae dispersal » (advisor: F. Lemarié), 3 months in the framework of the Inria MERIC center of excellence.

### 9.5.2. Visits to International Teams

#### 9.5.2.1. Research Stays Abroad

C. Prieur visited during two weeks Karine Bertin in Chile. CIMFAV – Facultad de Ingeniería Universidad de Valparaíso.

F.-X. Le Dimet visited Florida State University, Dpt of Mathematics during two weeks in May 2017

F.-X. Le Dimet visited Harbin Institute of Technology, Dpt of Mathematics during 10 days in July 2017



## BEAGLE Project-Team

## 7. Partnerships and Cooperations

### 7.1. Regional Initiatives

IntraCellXevo (2016-2018). Participants: E. Tannier, in collaboration with T Henry, Insem Lyon. This projects mixes an experimental evolution of *Franscicella tumarensis* in the cytosol and a bioinformatics analysis of the adaptive mutations. It has been funded by the Labex Ecofect up to 120keuros.

Lipuscale (2017-2019). Participants: C. Knibbe, in collaboration with S. Bernard (Inria Dracula) and M.-C. Michalski (CarMeN laboratory, INSERM U1060/ INRA U1397/ Université Lyon1/ INSA de Lyon). This project aims at reaching a quantitative understanding of the lipolysis and adsorption of dietary triglycerides, by using and adapting SimuScale (a multi-scale simulator developed by the Inria Dracula team) to model and simulate the processes, and by using wet experiments on in vitro systems and cellular cultures to calibrate the models parameters. It is funded by the Rhône-Alpes Institute for Complex Systems (IXXI, 5k€ for two years).

PMSISEE (2017-2019): The goal of the PMSISEE (Performance, Maintainability and Scalability of In-Silico Experimental Evolution Simulation) project is to improve the collaboration between the Inria Avalon team of the LIP laboratory and the Inria Beagle team of the LIRIS laboratory through research activities on programming model and tools for High Performance Computing applied to in-silico experimental evolution. One of the outcome is to improve the scalability and performance of the Aevol software. Moreover, we are formalizing a mini-application (mini-Aevol) representative of the resources usage of Aevol. The goal of this mini-application is to propose a simplify version of Aevol that could be used by the parallel computing community as use case to test new improvements. It is founded by the Lyon Computer Science Federation (FIL FR2000).

### 7.2. National Initiatives

#### 7.2.1. ANR

Ancestrhome (2012-2017): phylogenetic reconstruction of ancestral "-omes", a five-year project, 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 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 (2014-2017): Dopamine modulation of calcium influx underlying synaptic plasticity, a 4-year project 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

Dallish (2016-2020): Data Assimilation and Lattice Light Sheet imaging for endocytosis/exocytosis pathway modeling in the whole cell, Call AAPG ANR 2016. With C. Kervrann (Inria Rennes), J. Salamero (Institute Curie, Paris), B. Laroche (INRA, Jouy-en-Josas). Participants: H. Berry.

#### 7.2.2. Inria

ADT Phylophile. Participants: E Tannier, in collaboration with D Parsons, Inria, V Daubin, B Boussau, CNRS, Université de Lyon 1. This project aims at producing an easy to use software integrating modern algorithmic methods to build gene trees. It has been funded by Inria by a 24 month software engineer.

ADT Aevol. Participants: C Kinbbbe, G Beslon, V Liard, J Rouzaud-Cornabas, D Parsons. This project aims at speeding and scaling and maintaining the code for our most complex software, aevol. It has been funded by Inria by a 24 month software engineer.

## 7.3. European Initiatives

### 7.3.1. FP7 & H2020 Projects

#### 7.3.1.1. EvoEvo

Although the EvoEvo project was officially closed in December 2016, we let it in the 2017 report because (i) the scientific actions and the cooperations started in the project were still very active in 2017, (ii) the remaining of the project grant has served to fund many actions of the team in 2017 (including of course the continuation of the EvoEvo researches themselves).

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).

## 7.4. International Initiatives

### 7.4.1. Participation in International Programs

Beagle is a member of the CNRS "Laboratoire International Associé" (LIA) EvoAct together with Dominique Schneider's team at TIMC-IMAG (Université Grenoble Alpes) and the Beacon center at Michigan State University (Richard Lenski and Charles Ofria). EvoAct aims at studying "Evolution in Action" by *in vivo*, *in vitro* and *in silico* experiments. More specifically the Beagle team is in charge of the *in silico* experiments.

## DRACULA Project-Team

## 7. Partnerships and Cooperations

### 7.1. Regional Initiatives

In the context of the chair of applied mathematics “OQUAIDO”, driven by Olivier Roustand (Mines de St Etienne), Celine Vial is the scientific responsible of a contract with the BRGM (Orléans) 2016-2018: “Study of a submergence problem: identify the critical offshore conditions for coastal flooding”.

### 7.2. National Initiatives

#### 7.2.1. ANR

- 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”. 2012-2017 (<https://contraintes.inria.fr/~batt/iceberg/home.html>).
- Thomas Lepoutre is a member of the ANR KIBORD (head L. Desvillettes) dedicated to “kinetic and related models in biology”. 2014-2017: <https://www.ljll.math.upmc.fr/kibord/>.
- Céline Vial participates in the ANR PEPITO (head M. Henner) dedicated to “Design of Experiment for the Industry of transportation and Optimization”. 2014-2018: <http://www.agence-nationale-recherche.fr/?Project=ANR-14-CE23-0011>.

#### 7.2.2. Other projects

- Inria ADT : SiMuScale "Simulations Multi-Échelles de Populations Cellulaires", 2014-2017.  
**Participants:** Samuel Bernard [Coordinator], Fabien Crauste, Olivier Gandrillon, David Parsons.
- Association France Alzheimer Sciences Médicales: PAMELA “Prion et Alzheimer : Modélisation et Expérimentation d’une Liaison Agressive”, 2014-2017 (<https://www.youtube.com/watch?v=X0mLf8IJhV4>).  
**Participants:** Mostafa Adimy, Samuel Bernard, Thomas Lepoutre, Laurent Pujo-Menjouet [Coordinator], Léon Tine.
- Thomas Lepoutre is a member of the ERC MESOPROBIO (head V. Calvez) dedicated to "Mesoscopic models for propagation in biology". 2015-2020: [http://cordis.europa.eu/project/rcn/193664\\_en.html](http://cordis.europa.eu/project/rcn/193664_en.html).

### 7.3. International Initiatives

#### 7.3.1. Inria Associate Teams Not Involved in an Inria International Labs

- Associate Teams Inria project, "Modelling Leukemia", 2014-2017.
  - Participants (Dracula): Mostafa Adimy, Samuel Bernard, Apollos Besse, Abdenasser Chekroun, Raouf El-Cheikh, Thomas Lepoutre [Coordinator], Laurent Pujo-Menjouet, Léon Tine, Céline Vial.
  - Partners: This is joint with Center for Scientific Computing and Applied Mathematical Modeling (Doron Levy) at University of Maryland (USA) ([http://dracula.univ-lyon1.fr/modelling\\_leukemia.php](http://dracula.univ-lyon1.fr/modelling_leukemia.php)).

- The project Modelling Leukemia is devoted to the modeling of several aspects of Chronic Myeloid Leukemia. Leukemia is the most famous disease of the blood cell formation process (hematopoiesis). Chronic myeloid leukemia results in a uncontrolled proliferation of abnormal blood cells. As the hematopoiesis involves stem cells (not accessible to observations), mathematical modeling is here a great tool to test hypothesis. We want to add up 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).

## **7.4. International Research Visitors**

### ***7.4.1. Visits of International Scientists***

- Claudia Pio Ferreira holded an Invited Professor position in the dracula team for two months (October 14th - December 14th), she is affiliated to the Sao Paulo State University (UNESP), Institute of Biosciences, Department of Biostatistics, Botucatu, Brazil.

## 8. Partnerships and Cooperations

## 8.1. National Initiatives

### 8.1.1. ANR

#### 8.1.1.1. Aster

- Title: Algorithms and Software for Third gEneration Rna sequencing
- Coordinator: H  l  ne Touzet, University of Lille and Inria EPI Bonsai.
- ERABLE participants: Vincent Lacroix (ERABLE coordinator), Clara Beno  t-Pilven, Audric Cologne, Alex di Genova, Leandro I. S. de Lima, Arnaud Mary, Marie-France Sagot, Camille Sessegolo, Blerina Sinimeri.
- Type: ANR (2016-2020).
- Web page: <http://bioinfo.cristal.univ-lille.fr/aster/>.

#### 8.1.1.2. ExHyb

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

#### 8.1.1.3. GraphEn

- Title: Énumération dans les graphes et les hypergraphes : Algorithmes et complexité
- Coordinator: D. Kratsch
- ERABLE participant(s): A. Mary
- Type: ANR (2015-2019)
- Web page: <http://graphen.isima.fr/>

#### 8.1.1.4. Green

- Title: Deciphering host immune gene regulation and function to target symbiosis disturbance and endosymbiont control in insect pests
- Coordinator: A. Heddi
- ERABLE participant(s): M.-F. Sagot, C. Vieira
- Type: ANR (2018-2021)
- Web page: Not yet available

#### 8.1.1.5. *Hmicmac*

- Title: Host-microbiota co-adaptations: mechanisms and consequences
- Coordinator: F. Vavre
- ERABLE participant(s): F. Vavre
- Type: ANR PRC (2017-2020)
- Web page: Not available

#### 8.1.1.6. 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

#### 8.1.1.7. *Resist*

- Title: Rapid Evolution of Symbiotic Interactions in response to STress: processes and mechanisms
- Coordinator: N. Kremer
- ERABLE participant(s): F. Vavre
- Type: ANR JCJC (2017-2020)
- Web page: Not available

#### 8.1.1.8. *Suzukill*

- Title: Managing cold tolerance and quality of mass-produced *Drosophila suzukii* flies to facilitate the application of biocontrol through incompatible and sterile insect techniques
- Coordinator: H. Colinet
- ERABLE participant(s): F. Vavre
- Type: ANR PCRI (2015-2018)
- Web page: Not available

#### 8.1.1.9. *Swing*

- Title: Worldwide invasion of the Spotted WING *Drosophila*: Genetics, plasticity and evolutionary potential
- Coordinator: P. Gibert
- ERABLE participant(s): C. Vieira
- Type: ANR PCR (2016-2020)
- Web page: Not available

### 8.1.2. *ADT Inria*

#### 8.1.2.1. *ADT Inria Kirikomix*

- Main objective: Development of a portal to increase the visibility of the tools and resources elaborated by Erable around the analysis – using omics data – of metabolic networks modelled by hypergraphs, and enable to visualise the results. (the web page is for now private, it will be made public later in the project).
- Duration: 2016-2017, renewable one more year.
- Person responsible for ADT: Arnaud Mary with David Parsons (Inria).
- Beneficiary of ADT: Martin Wannagat.
- Funds received: Salary for engineer.

### 8.1.3. *Others*

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

*8.1.3.1. Advanced computational methodologies for the analysis of biomedical data*

- Title: Advanced computational methodologies for the analysis of biomedical data
- Coordinator: P. Milazzo
- ERABLE participant(s): R. Grossi, N. Pisanti
- Type: PRA, MIUR PRIN, Italian Ministry of Research National Projects (2017-2018)
- Web page: Not available

*8.1.3.2. Advanced Tools and Techniques for the analysis of criminal networks*

- Title: Advanced Tools and Techniques for the analysis of criminal networks
- Coordinator: G. Italiano
- ERABLE participant(s): G. Italiano
- Type: LEONARDO SpA (2015-2018)
- Web page: Not available

*8.1.3.3. Amanda*

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

*8.1.3.4. CMACBioSeq*

- Title: Combinatorial Methods for analysis and compression of biological sequences
- Coordinator: G. Rosone
- ERABLE participant(s): N. Pisanti
- Type: SIR, MIUR PRIN, Italian Ministry of Research National Projects (2015-2019)
- Web page: <http://pages.di.unipi.it/rosone/CMACBioSeq.html>

*8.1.3.5. Statistical Models for Structural Genetic Variants in the Genome of the Netherlands*

- Title: Statistical Models for Structural Genetic Variants in the Genome of the Netherlands
- Coordinator: A. Schönhuth
- ERABLE participant(s): A. Schönhuth
- Type: Nederlandse Wetenschappelijke Organisatie (NWO) (2013-2018)
- Web page: Not available

*8.1.3.6. TALS and splicing*

- Title: Development of bioinformatic methods for the analysis of splicing events in patients with the Taybi-Linder Syndrome (TALS)
- Coordinator: P. Edery
- ERABLE participant(s): C. Benoît-Pilven, Audric Cologne, V. Lacroix
- Type: INSERM
- Web page: Not available

**8.2. European Initiatives****8.2.1. FP7 & H2020 Projects***8.2.1.1. 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: <https://team.inria.fr/erable/en/microwine/> and <http://www.microwine.eu/>

### 8.2.2. Collaborations in European Programs, Except FP7 & H2020

#### 8.2.2.1. Combinatorics of co-evolution

- Title: The combinatorics of co-evolution
- Duration: 2015 - 2018
- Coordinator: Katharina Huber, University of Warwick, UK
- ERABLE participant(s): M.-F. Sagot, B. Sinimeri
- Type: The Royal Society
- Web page: not available

### 8.2.3. 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 hosted Alex di Genova in ERABLE as a PhD sandwich student (for 18 months in 2015-2017). Alex has now defended his PhD. He was co-supervised by Gonzalo Ruz from the University Adolfo Ibañez, Santiago, Chile. He now, since Dec 2017, joined again ERABLE as postdoc.

### 8.3.2. Inria Associate Teams Not Involved in an Inria International Lab

#### 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 BAOBAB-ERABLE. 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/erable/en/cnrs-lia-laboratoire-international-associe-lirio/>.



ERABLE has a Stic AmSud project that started 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 succinct web page for MAIA is available at this address: <http://team.inria.fr/erable/en/projects/maia/>.

ERABLE also participated to the BASIS project. This was funded by the European Community Seventh Framework Programme (Grant 242006 - 2010-2015). It was led by Dr. Mike Stratton and involved six European countries. It was primarily focused on ER+/HER2- breast cancers, but during the course of the project, was merged with the HER2+ French-ICGC and triple negative UK-ICGC projects, resulting in the analysis of the whole spectrum of breast cancers. The French group was initiated by Dr. Gilles Thomas and was pursued by Alain Viari after the loss of Dr. Thomas in 2014. The project resulted in the sequencing and thorough analysis of 560 breast cancer whole genomes (Nik-Zainai *et al.*, *Nature*, 534:47-54, 2016), including 75 HER2+ performed by the French working group (Ferrari *et al.*, *Nature Communications*, 7, 2016) and funded by the Institut National du Cancer and by Inserm.

Finally, Marie-France Sagot participates in a Portuguese FCT project, Perseids for “Personalizing cancer therapy through integrated modeling and decision” (2016-2019), with Susana Vinga and a number of other Portuguese researchers. The budget of Perseids is managed exclusively by the other Portuguese partner.

## 8.4. International Research Visitors

### 8.4.1. Visits of International Scientists

In 2017, ERABLE greeted the following International scientists:

- In France: Katharina Huber and Vincent Moulton (University of Warwick, UK), Ifigeneia Kyrkou (Aarhus University, Denmark), 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 de Janeiro, and Ana Tereza Vasconcelos from the LNCC, both in Brazil), two members of the Inria Associated Team Alegria (Andréa Ávila and Helisson Faoro), Ariel Silber (University of São Paulo, Brazil), Susana Vinga and various members of her team (IST Portugal).
- In Italy: May Alzamel, Lorraine A. K. Ayad, Panagiotis Charalampopoulos, Costas Iliopoulos, and Solon Pissis (King’s College, London, UK) visited the University of Pisa as did Luca Cardelli (Microsoft Research), Giulia Bernardini (University of Milano Bicocca), Anthony Cox (Illumina) and Raffaele Giancarlo (University of Palermo); Loukas Georgiadis (University of Ioannina, Greece), Shahbaz Khan (University of Vienna, Austria), and Adam Karczmarsz, (University of Warsaw, Poland) visited the University of Rome Tor Vergata.
- In the Netherlands: Martin Dyer (Leeds University, England), Frans Schalekamp (Cornell University, Ithaca, New York, USA), and Anke van Zuylen (College of William and Mary, Virginia, USA) visited the FU & CWI.

### 8.4.2. Internships

In 2017, ERABLE greeted the following internship students:

- In France: Irene Ziska, Master Free University Berlin (6 months).

#### **8.4.3. Visits to International Teams**

In 2017, members of ERABLE visited the following International teams:

- From France: Visit to members of the LIA LIRIO at the LNCC in Brazil, the Department of Computer Science of the University of São Paulo and to members of the TecSinapse company in Brazil, Susana Vinga and members of her team (IST Portugal).

## IBIS Project-Team

## 8. Partnerships and Cooperations

### 8.1. Regional Initiatives

Project name	RNAfluo: Quantification d'ARN régulateurs in vivo
Coordinators IBIS participants Type	S. Lacour S. Lacour AGIR program, Université Grenoble Alpes (2016-2019)

### 8.2. National Initiatives

Project name	COSY: real-time COntrol of SYnthetic microbial communities
Coordinator IBIS participants Type Web page	E. Cinquemani E. Cinquemani, H. de Jong, J. Geiselmann, M. Mauri, T. Muszbek, C. Pinel, D. Ropers Inria Project Lab (2017-2021) <a href="https://project.inria.fr/iplcosy/">https://project.inria.fr/iplcosy/</a>

Project name	AlgaeInSilico: Prédire et optimiser la productivité des microalgues en fonction de leur milieu de croissance
Coordinator IBIS participants Type Web page	O. Bernard H. de Jong, N. Giordano Inria Project Lab (2015-2019) <a href="https://project.inria.fr/iplalgaesilico/">https://project.inria.fr/iplalgaesilico/</a>

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

Project name	MEMIP – Modèles à effets mixtes de processus intracellulaires : méthodes, outils et applications
Coordinator IBIS participants Type	G. Batt E. Cinquemani, D. Ropers ANR project (2016-2020)

Project name	ENZINVIVO – Détermination in vivo des paramètres enzymatiques dans une voie métabolique synthétique
Coordinator IBIS participants Type	G. Truan J. Geiselmann, H. de Jong ANR project (2016-2020)

Project name	MAXIMIC – Optimal control of microbial cells by natural and synthetic strategies
Coordinator IBIS participants Type	H. de Jong C. Boyat, E. Cinquemani, J. Geiselmann, H. de Jong, C. Pinel, D. Ropers ANR project (2017-2021)

Project name	Analyse intégrative de la coordination entre stabilité des ARNm et physiologie cellulaire chez Escherichia coli
Coordinators IBIS participants Type	D. Ropers, M. Coccagn-Bousquet (Inra, LISBP) T. Etienne, D. Ropers Contrat Jeune Scientifique Inra-Inria (2016-2019)

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

Project name	FluoBacTracker – Adaptation et valorisation scientifique du logiciel FluoBacTracker
Coordinator IBIS participants Type	H. de Jong, H. Berry C. Dutrieux, H. de Jong, J. Geiselmann Inria Hub (2016-2017)

Project name	CoSoft – Control software for a system of mini-bioreactors
Coordinator IBIS participants Type	E. Cinquemani E. Cinquemani, H. de Jong, J. Geiselmann, T. Muszbek Inria Hub (2017-2018)

## 8.3. European Initiatives

### 8.3.1. Collaborations with Major European Organizations

**Laboratoire d'Automatique at Ecole Polytechnique Fédérale de Lausanne** (Switzerland), 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

## **NUMED Project-Team**

# **5. Partnerships and Cooperations**

## **5.1. National Initiatives**

### **5.1.1. ANR**

CNRS InFiniti, 2017-2018 (P. Vigneaux): 12ke in 2017 (pending for 2018)

## STEPP Project-Team

## 8. Partnerships and Cooperations

### 8.1. Regional Initiatives

#### 8.1.1. *QAMECS : ATMOSPHERIC POLLUTION: Characterization of novel exposure markers, of biological, health, economic and societal impacts and evaluation of public policies*

**Project funded by ADEME and Grenoble metropolis**

**Duration:** 2016 – 2019

**Project coordinator :** Remy Slama - INSERM. Inria Coordinator: Emmanuel Prados

**Other partners:** Air Rhône-Alpes, CNRS, Sciences Po Grenoble, Inserm, IAB, Université Grenoble-Alpes

**Abstract:** Urban atmospheric pollution is one of the main threats to human health that can be to some extent controlled by public action. In Europe, many cities have implemented various types of low emission zones (LEZ, focused on traffic and heating emissions), France being a notable exception. Although fine particulate matter (PM<sub>2.5</sub>) is usually assessed through its mass concentration, other metrics, such as PM chemical speciation as well as the so far little considered oxidative potential (OP) of PM, are worth considering, both in terms of associations with human health and in the context of monitoring of the efficiency of LEZ. QAMECS covers all dimensions from atmospheric emissions, impact of meteorological conditions on air pollution human behaviours related to transportation, environmental levels, health, associated economic costs and societal awareness. The project relies on environmental measurements, modelling, repeated observational (representative) population studies, an existing mother-child cohort, a controlled human experiment, health impact and related economic assessment. It is conducted by a consortium of specialists of chemistry and physics of air pollution, economics, sociology, epidemiology, geography, in relation with local authorities. It will bring results important for urban planning, public health, and more fundamental research on the measurement of PM and assessment of their biological and health impact.

### 8.2. National Initiatives

#### 8.2.1. *AF Filières : Analyse des Flux des Filières biomasse pour des stratégies régionales de bioéconomie*

**Project funded by ADEME**

**Duration:** 2017-2019

**Coordinator:** Jean-Yves COURTONNE (Equipe STEEP, Inria) [Emmanuel Prados (STEPP/Inria) for Inria partner]

**Other partners:** Equipe STEEP, Inria, Grenoble Rhône-Alpes Énergie-Environnement (RAEE), Lyon Laboratoire d'Economie Forestière (LEF), INRA / AgroParisTech Nancy.

**Keywords:** Environmental assessment, Ecological accounting, Material Flow Analysis, Sustainable supply chains, Multicriteria analysis.

**Abstract:** Flow analyses of biomass supply chains for regional bioeconomy policies. The goals of the project are the following:

- Improve knowledge on the material flows of the forest-wood and agri-food supply chains in France at national and regional levels,
- Provide a holistic vision of the situation by associating environmental and socio-economic indicators to material flows,
- Provide a more precise assessments (quantitatively and qualitatively) in the case of the Auvergne-Rhône-Alpes region.

### 8.2.2. *ESNET : Futures of ecosystem services networks for the Grenoble region*

**Project funded by FRB** (Fondation pour la Recherche sur la Biodiversité)

**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 – 2017

**Coordinator:** Sandra Lavorel (LECA)

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

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

### 8.2.3. *CITiES: Calibrage et validation de modèles Transport - usage des Sols*

**Project funded by ANR**

**Program:** “Modèles Numériques” 2012, ANR

**Duration:** 2013 – 2017

**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.

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**AGORA Team**

## 9. Partnerships and Cooperations

### 9.1. Regional Initiatives

- **Labex IMU UrPolSens 10/2015-10/2018**  
Participants: Amjed Belkhiri, Ahmed Boubrima, Leo Le Taro, Walid Bechkit, Hervé Rivano  
The partners in this project are Ifsttar, LMFA, EVS, TUBA, and Air Rhone-Alpes, with Inria Agora 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.
- **ARC6 “Robot fleet mobility under communication constraints” 10/2016-09/2019**  
Participants: Fabrice Valois  
This work is a joint project with the Inria Chroma research group. Considering a fleet of drones moving in a 3D area, looking for a given target, we focus on how to maintain the wireless connectivity of the network of drones while the drones patrol autonomously. The other partners in this project are University of Grenoble and Viameca.
- **Labex IMU Veleval 10/2017-10/2019**  
Participants: Hervé Rivano  
This pluridisciplinary project is leaded by the LAET and gathers researchers from EVS, LIRIS, LLSETI and CITI. The goal is to study, understand and model the behavior of cyclists in an urban environment with a methodology combining quantitative measurements of mobility traces and image analysis with qualitative informations from reactivation interviews. In particular the input of Agora is to provide crowdsourcing tools for gathering mobility data that are optimized for the practice of urban cycling.

### 9.2. National Initiatives

#### 9.2.1. ANR

- **ANR ABCD 10/2013-04/2017.**  
Participants: Razvan Stanica  
The partners in the ANR ABCD project are: Orange Labs, Ucopia, Inria Agora, 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 Agora, Socrate and Dyogene.

#### 9.2.2. DGA



- DGA CLOTHO 10/2016-03/2018.

Participants: Junaid Khan, Romain Pujol, Razvan Stanica, Fabrice Valois

The partners in the DGA CLOTHO project are Traqueur and Sigfox. The objective of the project is to reduce the energy consumption of the device tracking functionality, by taking profit of short-range communications between the tracked objects.

### 9.2.3. PIA

- PIA ADAGE 07/2016-06/2018.

Participants: Elli Zavou, Razvan Stanica

The partners in the PIA ADAGE project are Orange, LAAS-CNRS and Inria Privatics. The objective of the ADAGE project is to design and evaluate anonymization algorithms for the specific case of mobile traffic data. Our role in the project is focused on evaluating whether the anonymized data is still usable for adaptive networking mechanisms.

### 9.2.4. 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.

### 9.2.5. 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. Agora will have the opportunity to tests some of its capillary networking solutions in a very realistic but controlled urban environment. A proof of concept test site has been built in 2015. We have deployed an experiment on low cost sensor network for vehicle detection and one on atmospheric pollution sensor calibration. The operational site is build, the information system is being finalized and the equipment will be inaugurated in April 2018.

### 9.2.6. Inria Project lab

- CityLab

Agora is involved in the CityLab Inria Project Lab lead by Valérie Issarny. Within this project, Hervé Rivano co-advises, with Nathalie Mitton (FUN team, Inria Lille-Nord-Europe), the PhD thesis of Abdoul Aziz Mbacke on “Data gathering in sensor and passive RFID with energy harvesting for urban infrastructure monitoring”.

## 9.3. International Initiatives

### 9.3.1. Inria International Partners

#### 9.3.1.1. Informal International Partners

- **University of Waterloo, ON, Canada.** Joint publications and visits to/from the group of Prof. Catherine Rosenberg.
- **CNR-IEIIT, Turin, Italy.** Joint publications and projects with Dr. Marco Fiore.
- **IMDEA Networks, Madrid, Spain.** Collaboration around the OpenVLC platform with the group of Dr. Domenico Giustiniano.

### 9.3.2. Participation in Other International Programs

#### 9.3.2.1. PHC Campus France

- **University of Cluj-Napoca, Romania.** PHC DRONEM (2017-2019) on Monitoring using connected fleet of drones, a collaboration with the group of Prof. Gabriela Czibula.

## **9.4. International Research Visitors**

### ***9.4.1. Visits of International Scientists***

- Abdelmalik Bachir, Professor, Biskra University, Algeria: invited professor at INSA Lyon (Spring semester, 2017).
- Ramona Marfievici, Senior Researcher, Cork University of Technology, Ireland: visiting professor (one week, November 2017).

### ***9.4.2. Visits to International Teams***

#### ***9.4.2.1. Research Stays Abroad***

- Jad Oueis visited the group of Prof. Catherine Rosenberg, at University of Waterloo, ON, Canada (3 months, Sep-Dec 2017).
- Mihai Popescu visited the group of Prof. Gabriela Czibula, at University of Cluj-Napoca, Romania (3 periods of 1 month duration: April, July and November 2017).
- Razvan Stanica visited the group of Prof. Catherine Rosenberg, at University of Waterloo, ON, Canada (1 month, Sep-Oct 2017).

## 8. Partnerships and Cooperations

### 8.1. National Initiatives

### 8.1.1. PIA

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

**Participants:** Thierry Gautier, Laurent Lefèvre, Christian Perez, Issam Rais, Jérôme 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 as programming and execution environment. It also aims to validate the relevance of these developments 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  l  ne Coullon. Laurent Lef  vre is the Inria representative in the ELCI technical committee.

### 8.1.2. French National Research Agency Projects (ANR)

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

**Participants:** Laurent Lefèvre, Mathilde Boutigny, Christian Perez, Frédéric Suter.

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

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

### 8.1.3. Inria Large Scale Initiative

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

**Participants:** Laurent Lefèvre, Christian Perez, 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 proposes algorithms and contributes 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.

**8.1.3.2. DISCOVERY, DIStributed and COoperative management of Virtual EnviRonments autonomously, 4 years, 2015-2019**

**Participants:** Jad Darrous, Gilles Fedak, Christian Perez.

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.

**8.1.3.3. HAC SPECIS, High-performance Application and Computers, Studying PErformance and Correctness In Simulation, 4 years, 2016-2020**

**Participants:** Laurent Lefèvre, Frédéric Suter.

Over the last decades, both hardware and software of modern computers have become increasingly complex. Multi-core architectures comprising several accelerators (GPUs or the Intel Xeon Phi) and interconnected by high-speed networks have become mainstream in HPC. Obtaining the maximum performance of such heterogeneous machines requires to break the traditional uniform programming paradigm. To scale, application developers have to make their code as adaptive as possible and to release synchronizations as much as possible. They also have to resort to sophisticated and dynamic data management, load balancing, and scheduling strategies. This evolution has several consequences:

First, this increasing complexity and the release of synchronizations are even more error-prone than before. The resulting bugs may almost never occur at small scale but systematically occur at large scale and in a non deterministic way, which makes them particularly difficult to identify and eliminate.

Second, the dozen of software stacks and their interactions have become so complex that predicting the performance (in terms of time, resource usage, and energy) of the system as a whole is extremely difficult. Understanding and configuring such systems therefore becomes a key challenge.

These two challenges related to correctness and performance can be answered by gathering the skills from experts of formal verification, performance evaluation and high performance computing. The goal of the HAC SPECIS Inria Project Laboratory is to answer the methodological needs raised by the recent evolution of HPC architectures by allowing application and runtime developers to study such systems both from the correctness and performance point of view.

## 8.2. European Initiatives

### 8.2.1. Collaborations in European Programs, Except FP7 & H2020

#### 8.2.1.1. COST IC1305 : Nesus

**Participants:** Marcos Dias de Assunção, Laurent Lefèvre.

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 Lefèvre is co-chairing the Working on Energy Efficiency (WG5).

## 8.3. International Initiatives

### 8.3.1. Inria International Labs

#### 8.3.1.1. Joint Laboratory for Extreme Scale Computing (JLESC) (2014-2018)

**Participants:** Gilles Fedak, Thierry Gautier, Christian Perez, Jérôme Richard.

**Partners:** NCSA (US), ANL (US), Inria (FR), Jülich Supercomputing Centre (DE), BSC (SP), Riken (JP).

The purpose of the Joint Laboratory for Extreme Scale Computing (JLESC) is to be an international, virtual organization whose goal is to enhance the ability of member organizations and investigators to make the bridge between Petascale and Extreme computing. The founding partners of the JLESC are Inria and UIUC. Further members are ANL, BSC, JSC and RIKEN-AICS.

JLESC involves computer scientists, engineers and scientists from other disciplines as well as from industry, to ensure that the research facilitated by the Laboratory addresses science and engineering's most critical needs and takes advantage of the continuing evolution of computing technologies.

#### 8.3.1.2. Associate Team DALHIS – Data Analysis on Large-scale Heterogeneous Infrastructures for Science (2013-2018)

**Participant:** Frédéric Suter.

Partners: EPC Myriads (Rennes, Bretagne Atlantique), Avalon (Grenoble, Rhône-Alpes), Data Science and Technology Department (LBNL,USA).

The goal of the Inria-LBL collaboration is to create a collaborative distributed software ecosystem to manage data lifecycle and enable data analytics on distributed data sets and resources. Specifically, our goal is to build a dynamic software stack that is user-friendly, scalable, energy-efficient and fault tolerant. We plan to approach the problem from two dimensions: (i) Research to determine appropriate execution environments that allow users to seamlessly execute their end-to-end dynamic data analysis workflows in various resource environments and scales while meeting energy-efficiency, performance and fault tolerance goals; (ii) Engagement in deep partnerships with scientific teams and use a mix of user research with system software R&D to address specific challenges that these communities face, and inform future research directions from acquired experience.

#### 8.3.2. Inria Associate Teams Not Involved in an Inria International Labs

##### 8.3.2.1. Associate Team SUSTAM – Sustainable Ultra Scale compuTing, dAta and energy Management (2017-2020)

**Participants:** Eddy Caron, Hadrien Croubois, Marcos Dias de Assunção, Alexandre Da Silva Veith, Jean-Patrick Gelas, Olivier Glück, Laurent Lefèvre, Valentin Lorentz, Christian Perez, Issam Rais, Pedro de Souza Bento Da Silva.

International Partners: Rutgers University (United States) - RDI2 - Manish Parashar

The SUSTAM associate team will focus on the joint design of a multi-criteria orchestration framework dealing with resources, data and energy management in a sustainable way. The SUSTAM associated team will enable a long-term collaboration between the Inria Avalon team and the Rutgers Discovery Informatics Institute (RDI2) from Rutgers University (USA). The SUSTAM associated team is led by Laurent Lefèvre.

#### 8.3.3. Participation in Other International Programs

##### 8.3.3.1. Joint Project CNRS/University of Melbourne – Algorithms for Placement and Reconfiguration of Data Stream Processing Applications (2017-2018)

**Participants:** Marcos Dias de Assunção, Alexandre Da Silva Veith, Laurent Lefèvre.

Partner: Clouds Lab (The University of Melbourne, Australia).

Much of the “big data” produced today is created as continuous data streams that are most valuable when processed quickly. Several data stream processing frameworks have been designed for running on clusters of homogeneous computers. Under most frameworks, an application is a Direct Acyclic Graph (DAG) whose vertices are operators that execute transformations over the incoming data and edges that define how the data flows between operators. While cloud computing is a key infrastructure for deploying such frameworks, more modern solutions leverage the edges of the Internet (e.g. edge computing) to offload some of the processing from the cloud and hence reduce the end-to-end latency. The placement and reconfiguration of stream processing DAGs onto highly distributed and heterogeneous infrastructure are, however, challenging endeavours. This project aims to investigate algorithms for the placement and dynamic reconfiguration of stream processing components considering multiple criteria.

### 8.4. International Research Visitors

#### 8.4.1. Visits of International Scientists

Joao Ferreira Lima (visit from January 30<sup>th</sup> to March 2nd) from UFSM, Santa Maria, Brazil. Research collaboration funded by Labex Milyon. During the visit, he worked on energy consumption of OpenMP runtimes with Thierry Gautier.

Leila Helali (visit from June 5<sup>th</sup> to June 31<sup>th</sup>). Research collaboration with the University of Sousse (Tunisia). During the visit she worked with Eddy Caron on autonomic deployment and licenses management.

Manuel Dolz (from 25<sup>th</sup> September to 7<sup>th</sup> October 2017) from University Carlos III from Madrid, Spain. Research collaboration funded by the NESUS COST IC1305 european project. During the visit, he worked on operators placement for efficient data-streaming scenario with Marcos Dias de Assuncao, Laurent Lefevre and Alexandre Veith.

## CTRL-A Project-Team

# 8. Partnerships and Cooperations

## 8.1. Regional Initiatives

### 8.1.1. HPES action-team of the Labex Persyval-lab

The Labex Persyval-lab is a large regional initiative, supported by ANR, where we are contributing through the project *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 : <https://persyval-lab.org/en/sites/hpes>. Ctrl-A is directly involved in the co-advising of the PhD of Naweiluo Zhou, with J.F. Méhaut (Corse team of Inria/LIG), on the topic of autonomic management of software transactional memory mechanisms : <https://persyval-lab.org/en/research/phd/autonomic-thread-parallelism-and-mapping-control-software-transactional-memory>.

In 2017 we organized a workshop on Autonomic Computing and Control in Grenoble, supported by HPES (<https://team.inria.fr/ctrl-a/members/eric-rutten/autoctrl/>).

### 8.1.2. EcoSesa Cross-Disciplinary Project of the Idex

The Eco-SESA project, “Eco-district: Safe, Efficient, Sustainable and Accessible energy”, aims to produce knowledge, concepts, tools and methods to rethink the planning, management and governance of urban energy systems and the design of their components. Ctrl-A contributes to the research front 4 : Architectures for integration of renewable on-the-spot generation. A Post-doctoral position shared with G2Elab research lab will be funded.

## 8.2. National Initiatives

### 8.2.1. ANR HPeC

*HPeC* is an ANR project on Self-Adaptive, Energy Efficient High Performance Embedded Computing, with a UAV case study (<http://hpec.fr/>). The Coordinator is Lab-STICC / MOCS (Lorient / Brest), and the duration: 42 month from october 2015. Others Partners are: UBO, U. Clermont-Ferrand, InPixal.

In Ctrl-A, it is funding a post-doc position, hired in Grenoble and co-advised with Lorient : Soguy Gueye. A PhD based in Brest, Chabha Hireche, is co-advised by Stéphane Mocanu.

### 8.2.2. ANR Sacade

The ANR ASTRID Sacade project is funded by DGA. Stéphane Mocanu is in charge of several workpackages including a demonstrator. An expert engineer position is funded for the implementation of attack/defense scenarios in SCADA.

### 8.2.3. 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 (Ch. Perez, L. Lefevre, E. Caron), 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).



#### **8.2.4. 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, I. Saffiedine), ST Microelectronics (V. Bertin), Schneider Electric (C. El-Kaed, P. Nappey, M. Pitel), Orange labs (J. Pulou, T. Coupaye, G. Privat, Anne Roch).

### **8.3. International Initiatives**

#### **8.3.1. Inria International Labs**

We participate in the jLESC, Joint Laboratory for Extreme Scale Computing, with partners Inria, the University of Illinois, Argonne National Laboratory, Barcelona Supercomputing Center, Jülich Supercomputing Centre and RIKEN AICS.

We participated to the 7th Workshop of the JLESC at Urbana-Champaign in July 2017.

We started a cooperation with Argonne National Labs, on Improving the performance and energy efficiency of HPC applications using autonomic computing techniques.

#### **8.3.2. Inria International Partners**

##### *8.3.2.1. 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).

## DANTE Project-Team

## 9. Partnerships and Cooperations

### 9.1. Regional Initiatives

#### 9.1.1. IXXI

##### 9.1.1.1. ISI Torino / Dante

**Participant:** Márton Karsai [correspondant].

This project involves M. Karsai and L. Gauvin (ISI Torino) and funded by the IXXI Complex System Institute. The purpose of this project is to investigate the presence and the importance of higher-order correlations in dynamical networks. As the first attempt to address this problem we applied autoencoder, a recent representation using deep neural networks, on modelled and small-scale real temporal networks. However, since the results were trivial on the modelled network and not convincing on the real one we decided to take a different approach during the second phase of the project. We involved an IXXI PhD student, Jacobo Levy Abitbol, to work out a method for temporal network embedding. Our idea is to extend the node2vec representation of static networks for time-varying structures, by using a local random walk to explore the structural-temporal neighbourhood of a node. Based on such local information we can effectively propose an embedding, which captures the temporal and structural properties of nodes in a temporal network.

### 9.2. National Initiatives

#### 9.2.1. ANR

##### 9.2.1.1. Equipex FIT (*Futur Internet of Things*)

**Participant:** Éric Fleury [correspondant].

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 euro 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.

##### 9.2.1.2. ANR GRAPHSIP (*Graph Signal Processing*)

**Participants:** Paulo Gonçalves [correspondant], Éric Fleury, Thomas Begin, Sarra Ben Alaya.

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.

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

**Participants:** Thomas Begin [correspondant], Anthony Busson, Isabelle Guerin 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 prioritisation.

#### 9.2.1.4. ANR REFLEXION (*RE*silient and *FLEX*ible Infrastructure for Open Networking)

**Participants:** Thomas Begin [correspondant], Anthony Busson, Isabelle Guerin Lassous, Zidong Su.

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

#### 9.2.1.5. ANR CONTINT CODDDE

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

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).

#### 9.2.1.6. ANR SoSweet

**Participants:** Jean Pierre Chevrot, Éric Fleury, Márton Karsai [correspondant], Jean-Philippe Magué [PI].

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 linguistic behaviours. 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.

#### 9.2.1.7. ANR DylNet

**Participants:** Jean Pierre Chevrot, Jean-Philippe Magué, Éric Fleury [correspondant], Márton Karsai.

The DylNet project aims to observe and to characterise the relationships between childhood sociability and oral-language learning at kindergarten. With a view to this, it takes an multidisciplinary approach combining work on language acquisition, sociolinguistics, and network science. It will be implemented by following all the children ( $\approx 220$ ) and teaching staff in one kindergarten over a 3-year period. The use of wireless proximity sensors will enable collection of social contacts throughout the study. The data on sociability will be linked to the results of language tests and recordings of verbal interactions used to follow the children's progress on both a psycholinguistic level (lexicon, syntax, pragmatics) and a sociolinguistic level (features showing belonging to a social group). The aim is to better understand the mechanisms of adaptation and integration at work when young children first come into contact with the school context.

### 9.2.2. CNRS

#### 9.2.2.1. CNRS CO3I

**Participants:** Jean Pierre Chevrot [correspondant], Éric Fleury, Jean-Philippe Magué, Márton Karsai.

The CO3i project (Cognition individuelle et connaissance collective) is funded by the Mission pour l'Interdisciplinarité du CNRS. CO3i is an interdisciplinary theoretical project that aims at reanalyse and better articulate two distinctions: collective vs. individual and social vs. cognitive. Generally, the study of cognition is associated to the individual, whereas the social phenomena are seen as collective. In fact, there is an individual social cognition and there is a collective social knowledge. We have organised three days of interdisciplinary workshop confronting the views of sociologists, cognitive scientists, network scientists, linguists, and philosophers of science. Nourished by projects using various methodologies (massive data, experimentation, observation, corpus), the reflection will be finalised towards the publication of an international book. See: <https://co3i.hypotheses.org/>

### 9.2.3. Inria

#### 9.2.3.1. Inria PRE LIAISON

**Participants:** Márton Karsai [correspondant], Éric Fleury.

This project implements unsupervised deep learning approaches to infer correlations/patterns that exist between dynamic linguistic variables, the mesoscopic and dynamic structure of the social network, and their socio-economic attributes. This interdisciplinary project is positioned at the crossroads of Natural Language Processing (NLP), Network Science, Data Science and Machine Learning.

### 9.2.4. HCERES

#### 9.2.4.1. HCERES/Inria

**Participants:** Éric Fleury, Eric, Philippe Guichard [correspondant].

Bilateral project on the evolution of the Multi/inter-disciplinary of SHS. An increasing number of researchers in SHS has the desire to develop new researches with computer scientists or mathematicians because they want to apply new methodologies (according to various or numerous data) or to develop older ones, which can now be easily implemented online. Some also develop a reflexion on their discipline, with the idea that epistemological questions are revitalised by the internet. This reality invite them to discuss with philosophers or with other SHS scientists who have the same intuition (eg: cartography, visualisation).

The project is hence to measure these new forms or inter-multi-disciplinarity. The main source will be the publications of all academics of French SHS laboratories, to find out who writes a paper with somebody of a different discipline and/or laboratories. All data are anonymized,

### 9.2.5. Inria

#### 9.2.5.1. IPL BetterNet

**Participant:** Eric, Philippe Guichard.

BETTERNET: An Observatory to Measure and Improve Internet Service Access from User Experience <sup>0</sup>. BetterNet aims at building and delivering a scientific and technical collaborative observatory to measure and improve the Internet service access as perceived by users. In this Inria Project Lab, we will propose new original user-centered measurement methods, which will associate social sciences to better understand Internet usage and the quality of services and networks with a particular focus on geography and cartography.

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<sup>0</sup><https://www.inria.fr/en/research/research-teams/inria-project-labs>

## 9.3. European Initiatives

### 9.3.1. FP7 & H2020 Projects

#### 9.3.1.1. EMBERS

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

Programm: H2020

Duration: December 2015 - November 2018

Coordinator: UPMC

Partners:

Fraunhofer Gesellschaft Zur Forderung Der Angewandten Forschung Ev (Germany)

Technische Universitat Berlin (Germany)

Universite Pierre et Marie Curie - Paris 6 (France)

Ubiwhere Lda (Portugal)

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. Beyond its primary goal of bringing the MBaaS to market, EMBERS will stimulate development of an entire ecosystem around the MBaaS smart city mobility API. Separating out the back-end from the other components will, however, require rigorous testing. EMBERS will experiment with the system on two testbeds that are part of the FIRE OneLab facility: the FUSECO Playground, for M2M communications, and FIT IoT-LAB, for wireless sensor devices. EMBERS will host a hackathon and an app challenge to bring in third party developers. The project will also include three demonstrators by third parties via an open call. These activities will contribute back to FIRE by demonstrating successful experimentation by SMEs developing close-to-market products. The project will also conduct real world pilots in two or more cities as a final step in bringing the MBaaS to market.

#### 9.3.1.2. ARMOUR

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

Programm: H2020

Duration: 2015 Dec to 2018

Coordinator: UPMC

Partners:

Synelixis Lyseis Pliroforikis Automatismou & Tilepikoinonion Monoprosopi EPE (Greece)

Smartesting Solutions & Services (France)

Unparallel Innovation, Lda (Portugal)

Easy Global Market (France)

ODIN Solutions (Spain)

Universite Pierre et Marie Curie - Paris 6 (France)

Inria contact: Eric Fleury

ARMOUR will 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 à a FIRE OpenLAB / FIT IoT LAB facility à 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.

#### 9.3.1.3. CLARIN-PLUS

Title: European Research Infrastructure for Language Resources and Technology

Programm: H2020 and part of CLARIN ERIC

Duration: 28 months, from September 2015 to December 2017

Coordinator: Franciska de Jong, CLARIN ERIC

Partners:

CLARIN ERIC,

EKUT,

UCPH,

CUNI

Inria contact: Jean-Philippe Magué

CLARIN-PLUS is dedicated to enhancing CLARIN. Following the recommendations of the 2013 ESFRI Assessment Expert Group, CLARIN-PLUS proposes to accelerate the implementation and to strengthen and consolidate CLARIN in the following areas: 1. The central (technical) hub; 2. The central office; 3. Partnerships with other infrastructures; 4. Outreach; 5. Governance.

## 9.4. International Initiatives

### 9.4.1. Inria International Partners

#### 9.4.1.1. Declared Inria International Partners

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

Algorithms research group of the University of Bergen, Norway. PICS project of CNRS on graph editing problems for analysis and modeling of complex networks.

University of Massachusetts, Amherst, USA.

#### 9.4.1.2. Informal 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

University of South California (USA). Collaboration with Antonio Ortega on Graph Signal Processing

University of Pennsylvania (USA). Collaboration with Alejandro Ribeiro on Graph Signal Processing

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

College of Information and Computer Sciences at the University of Massachusetts Amherst.

University of California, Santa Cruz (USA). Collaboration with Alexandre Brandwajn on the solutions to multi-server queues.

#### 9.4.2. Participation in Other International Programs

STIC AMSUD MOTIf with Grand Data from Argentina and LNCC from Brazil. ,

The general goal of the MOTIf project is to understand, model, and predict individual behavior embedded in social and technological environments. We propose to work in two directions in order to tackle this challenge: (1) aim to understand spatiotemporal patterns of service usage of individuals to learn when, where, and what people are doing. (2) aim to understand the fine-grained sociodemographic structure of society and see how the demographic characteristics of individuals in a social network correlate with the dynamics of their egocentric and global network evolution.

##### 9.4.2.1. PHC Peridot

**Participants:** Mohammed Amer, Thomas Begin, Anthony Busson, Isabelle Guerin 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.

### 9.5. International Research Visitors

- Maximiliano Bueno Lopez from NTNU visited the Dante team for one week. His visit was part of an ERCIM program on Empirical Mode Decomposition.
- Alexandre Brandwajn, Professor Emeritus, Computer Engineering from UCSC (University of California, Santa Cruz) visited the Dante team for two months during Spring 2017. His visit was funded by ENS Lyon and Milyon labex.
- Cristhian Iza Paredes from UPC (Polytechnic University of Catalonia) visited the Dante team for three months. His visit was part of a Fonds Recherche project of ENS Lyon.
- Isabel Martin Faus from UPC (Polytechnic University of Catalonia) visited the Dante team for one month. Her visit was part of a Fonds Recherche project of ENS Lyon.
- Mukhtiar Bano and Sherjeel Gilani visited the Dante team for two weeks. Their visit was part of a Peridot project (PHC with Pakistan).
- Amir Qayyum visited the Dante team for one week. His visit was part of a Peridot project (PHC with Pakistan).
- Amer Mouawad (University of Bergen) visited the Dante team for one week in November 2017. His visit was part of a PICS project of CNRS with the Algorithms group of the University of Bergen, Norway.

- G. Iniguez from Aalto University visited M. Karsai two times for one week. One of these visits was financed from the CODDDE project, while the other was financed by the Finnish partner.

### ***9.5.1. Visits of International Scientists***

#### *9.5.1.1. Internships*

- Giuseppe Torrisi from Sapienza University, Erasmus Learning Agreement Student Mobility for Traineeships

### ***9.5.2. Visits to International Teams***

#### *9.5.2.1. Research Stays Abroad*

- Philippe Nain stayed at UMass from September 2016 to January 2017.



## DATAMOVE Project-Team

## 9. Partnerships and Cooperations

### 9.1. National Initiatives

#### 9.1.1. ANR

- **ANR grant MOEBIUS (2013-2017).** Multi-objective scheduling for large computing platforms. Coordinator: Grenoble-INP (DataMove). Partners: Grenoble-INP, Inria, BULL-ATOS .
- **ANR grant GRECO (2017-2020).** Resource manager for cloud of things. Coordinator: Quarnot Computing. Partners: Grenoble-INP, Inria,

#### 9.1.2. Competitvity Clusters

- **PIA Avido (2015-2018).** In situ analysis and visualization for large scale numerical simulation. Coordinator: EDF SA. Partners: EDF SA, Total SA, Kitware SAS , Université Pierre et Marie CURIE, Inria (DataMove).
- **FUI OverMind (2015-2017).** Task planification and asset management for the cartoon productions. Coordinator: Teamto Studio. Partners: Teamto Studio, Folimage Studio, Ecole de Gobelins, Inria (DataMove).

#### 9.1.3. Inria

- Inria PRE COSMIC (exploratory research project), 2017-2019. Photovoltaic Energy Management for Distributed Cloud Platforms. Myriads, DataMove.

## 9.2. International Initiatives

### 9.2.1. Inria International Labs

#### 9.2.1.1. JLESC

Title: Joint Laboratory for Extreme-Scale-Computing.

International Partners:

University of Illinois at Urbana Champaign (USA)

Argonne National Laboratory (USA),

Barcelona Supercomputing Center (Spain),

Jülich Supercomputing Centre (Germany)

Riken Advanced Institute for Computational Science (Japan)

Start year: 2009

See also: <https://jlesc.github.io/>

The purpose of the Joint Laboratory for Extreme Scale Computing is to be an international, virtual organization whose goal is to enhance the ability of member organizations and investigators to make the bridge between Petascale and Extreme computing. The JLESC organizes a workshop every 6 months DataMove participates to. DataMove developed several collaborations related to in situ processing with Tom Peterka group (ANL) , the Argo exascale operating system with Swann Perarnau (ANL).

### 9.2.2. Participation in Other International Programs

#### 9.2.2.1. 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 Internacional 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 Internacional 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). DataMove is deeply involved in the animation of LICIA. Bruno Raffin is LICIA associate director.

## 9.3. International Research Visitors

### 9.3.1. Visits of International Scientists

PhD in progress: Danilo Carastan Dos Santos, Dynamic Scheduling of Tasks in High Performance Platforms with Machine Learning (Sao Paulo, Brasil). 1 year "sandwich" visit. Local adviser: Denis Trystram

PhD in progress: Jorge Veiga Fachal, High Performance Map-Reduce, Universidade da Coruña, Spain. 3 month stay. Local adviser: Bruno Raffin.

### 9.3.2. Visits to International Teams

Yes Denneulin spent 3 months at University of Los Andes, Bogota, Columbia.

PhD in progress: Clement Mommessin spent 6 months at ANL, Argonne, USA. Adviser: Tom Perterka.

**POLARIS Team**

## 9. Partnerships and Cooperations

### 9.1. Regional Initiatives

Nicolas Gast received a grant from the IDEX UGA that fund a post-doctoral researcher for two years to work on the smart-grid project that focus on distributed optimization in electrical distribution networks.

### 9.2. National Initiatives

#### 9.2.1. Inria Project Labs

**HAC SPECIS:** The goal of the HAC SPECIS (High-performance Application and Computers: Studying Performance and Correctness In Simulation) project is to answer methodological needs of HPC application and runtime developers and to allow to study real HPC systems both from the correctness and performance point of view. To this end, we gather experts from the HPC, formal verification and performance evaluation community. Inria Teams : AVALON, POLARIS, MYRIADS, SUMO, HIEPACS, STORM, MEXICO, VERIDIS.

#### 9.2.2. PGMO Projects

PGMO projects are supported by the Jacques Hadamard Mathematical Foundation (FMJH). Our project (HEAVY.NET) is focused on congested networks and their asymptotic properties.

#### 9.2.3. ANR

- **GAGA (2014–2017)**  
GAGA is an ANR starting grant (JCJC) whose aim is 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 (ENS Cachan). Its aim is to perform a systematic study of the geometric aspects of game theory and, in so doing, to establish new links between application areas that so far appeared unrelated (such as the use of Hessian Riemannian optimization techniques in wireless communication networks).
- **MARMOTE (2013–2017)**  
Partners: Inria Sophia (MAESTRO), Inria Rocquencourt (DIOGEN), Université Versailles-Saint-Quentin (PRiSM lab), Telecom SudParis (SAMOVAR), Université 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).
- **NETLEARN (2013–2017)**  
Partners: Université Versailles – Saint-Quentin (PRiSM lab), Université Paris Dauphine, Inria Grenoble (POLARIS), Institut Mines–Telecom (Telecom ParisTech), Alcatel–Lucent Bell Labs (ALBF), and Orange Labs.  
The main objective of the project is to propose a novel approach of distributed, scalable, dynamic and energy efficient algorithms for mobile network resource management. 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 ensuring the more efficient utilization of the operator's resources.

- *ORACLESS (2016–2021)*

ORACLESS is an ANR starting grant (JCJC) coordinated by Panayotis Mertikopoulos. The goal of the project is to develop highly adaptive resource allocation methods for wireless communication networks that are provably capable of adapting to unpredictable changes in the network. In particular, the project will focus on the application of online optimization and online learning methodologies to multi-antenna systems and cognitive radio networks.

- *ANR SONGS, 2012–2016.* 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. Such aspects are also addressed in the SONGS project.

#### 9.2.4. National Organizations

- Jean-Marc Vincent is member of the scientific committees of the CIST (Centre International des Sciences du Territoire).
- *REAL.NET (2017)*  
REAL.NET is a CNRS PEPS starting grant (JCJC) coordinated by Panayotis Mertikopoulos. Its objective is to provide dynamic control methodologies for nonstationary stochastic optimization problems that arise in wireless communication networks.

### 9.3. European Initiatives

#### 9.3.1. FP7 & H2020 Projects

##### 9.3.1.1. 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.

#### 9.3.1.2. 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.

Polaris is a member of the COST program on *Game Theory in Europe*.

#### 9.3.2. Collaborations with Major European Organizations

**TU Wien:** Research Group Parallel Computing, Technische Universität Wien (Austria). We collaborate with Sascha Hunold on experimental methodology and reproducibility of experiments in HPC. In particular we co-organize the REPPAR workshop on “Reproducibility in Parallel Computing”.

**BSC (Barcelona):** Barcelona Supercomputer Center (Spain). We collaborate with the performance evaluation group through the HPC4E project and through the JLESC.

**University of Edinburgh, Istituto di Scienza e Tecnologie della Informazione and IMT Lucca.** we used to strongly collaborate through the Qanticol European project. Several projects are still actively developed, concerning the mean field and refined mean field approximation.

### 9.4. International Initiatives

#### 9.4.1. Inria International Labs

##### 9.4.1.1. 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 POLARIS are partners of this laboratory, and have done several visits to Urbana-Champaign or NCSA.

#### 9.4.2. Inria International Partners

##### 9.4.2.1. Declared Inria International Partners

- POLARIS 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.
- POLARIS has strong bounds with the University of Illinois Urbana Champaign and Barcelona Supercomputer Center, within the (Joint Laboratory on Petascale Computing, see previous section).

#### 9.4.3. Participation in Other International Programs

LICIA Bresil: Polaris is member of the common laboratory with Bresil. The founding director of LICIA is Jean-Marc Vincent.

##### 9.4.3.1. 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*). LICIA's main research themes are high performance computing, language processing, information representation, interfaces and visualization as well as distributed systems. Jean-Marc Vincent is the director of the laboratory on the French side and visited Porto Alegre for two weeks in November 2016.

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

- *ECOS-Sud*: POLARIS is a member of the Franco-Chilean collaboration network LEARN with CONICYT (the Chilean national research agency), formed under the ECOS-Sud framework. The main research themes of this network is the application of continuous optimization and game-theoretic learning methods to traffic routing and congestion control in data networks. Panayotis Mertikopoulos was an invited researcher at the University of Chile in October 2016.

More information can be found at <http://www.conicyt.cl/pci/2016/02/11/programa-ecos-conicyt-adjudica-proyectos-para-el-ano-2016>.

- POLARIS is the co-recipient of a project *STIC AmSud* that involves partners from Inria and CNRS (France), MINCYNT (Argentina) and ANII (from Uruguay).

### 9.5. International Research Visitors

#### 9.5.1. Visits to International Teams

##### 9.5.1.1. Research Stays Abroad

- 3/17: Panayotis Mertikopoulos visited Stanford University (Z. Zhou, N. Bambos, P. Glynn, S. Boyd)
- 04/17: Panayotis Mertikopoulos visited University of Wisconsin-Madison (W. Sandholm)
- 10/17: Panayotis Mertikopoulos visited Lancaster University (D. Leslie)
- 11/17: Panayotis Mertikopoulos visited U. Marseille-Aix (M. Faure, S. Bervoets).

## ROMA Project-Team

# 9. Partnerships and Cooperations

## 9.1. Regional Initiatives

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

The doctoral program from Labex MILYON dedicated to applied research in collaboration with industrial partners funds 50% of a 3-year PhD grant (the other 50% being funded by the MUMPS consortium) to work on improvements of the solution phase of the MUMPS solver. The PhD aims at answering industrial needs in application domains where the cost of the solution phase of sparse direct solvers is critical.

## 9.2. National Initiatives

### 9.2.1. ANR

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.

ANR JCJC Project CODAS (2018-2022), 4 years. The ANR project CODAS was accepted in July 2017. He will be launched in February 2018. It gathers a little team of five persons including Laure Gonnord (PI) and Christophe Alias.

This project aims at studying the combination of formal methods such as abstract interpretation and term rewriting to address the challenge of scheduling complex data structures as well as complex flow graph.

## 9.3. International Initiatives

### 9.3.1. Inria International Labs

#### 9.3.1.1. JLESC — Joint Laboratory on Extreme Scale Computing

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 scheduling and resilience. Yves Robert is the Inria executive director of JLESC.

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

#### *9.3.2.1. Keystone*

Title: Scheduling algorithms for sparse linear algebra at extreme scale

International Partner (Institution - Laboratory - Researcher):

Vanderbilt University (United States) - Electrical Engineering and Computer Science -  
Padma Raghavan

Start year: 2016

See also: <http://graal.ens-lyon.fr/~abenoit/Keystone>

The Keystone project aims at investigating sparse matrix and graph problems on NUMA multicores and/or CPU-GPU hybrid models. The goal is to improve the performance of the algorithms, while accounting for failures and trying to minimize the energy consumption. The long-term objective is to design robust sparse-linear kernels for computing at extreme scale. In order to optimize the performance of these kernels, we plan to take particular care of locality and data reuse. Finally, there are several real-life applications relying on these kernels, and the Keystone project will assess the performance and robustness of the scheduling algorithms in applicative contexts. We believe that the complementary expertise of the two teams in the area of scheduling HPC applications at scale (ROMA — models and complexity; and SSCL — architecture and applications) is the key to the success of this associate team. We have already successfully collaborated in the past and expect the collaboration to reach another level thanks to Keystone.

### ***9.3.3. Inria International Partners***

#### *9.3.3.1. Declared Inria International Partners*

- Anne Benoit, Frederic 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.
- Laure Gonnord has a regular collaboration with Sylvain Collange (Inria Rennes) in the context of the PROSPIEL associate team.

#### ***9.3.4. 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 HPC computing. Anne Benoit and Minsong Chen are leading a JORISS project on scheduling and resilience in cloud computing. In the context of this collaboration two students from ECNU, Li Han and Changjiang Gou, have joined Roma for their PhD.

#### *9.3.4.1. Informal International Partners*

- Christophe Alias has a regular collaboration with Sanjay Rajopadhye from Colorado State University (USA); this collaboration also includes Guillaume Iooss (Inria Parkas) and Sylvain Collange (Inria Rennes).

## **9.4. International Research Visitors**

### ***9.4.1. Visits of International Scientists***

#### *9.4.1.1. Internships*

- Louis-Claude Canon, Loris Marchal, and Frédéric Vivien supervised Dorel Butaciu, an Erasmus student, for three months (June–September 2017).
- Loris Marchal, Bertrand Simon and Frédéric Vivien supervised Hanna Nagy, an Erasmus student, for three months (June–September 2017).
- Laure Gonnord supervised Szabolcs-Martón Bagoly, an Erasmus student, for three months (June–September 2017).

### ***9.4.2. Visits to International Teams***

#### *9.4.2.1. 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.
- Anne Benoit and Bora Uçar visit the School of Computational Science and Engineering Georgia Institute of Technology, Atlanta, GA, USA (August 2017–May 2018). During this stay, Anne Benoit taught the course CSE-6140 Computational Science and Engineering (CSE) Algorithms, taken by both senior level undergraduate and graduate students, and by distant learners. Anne and Bora are collaborating with Prof. Çatalyürek and his group members on problems of high performance computing including partitioning, load balancing and scheduling.

## SOCRATE Project-Team

## 8. Partnerships and Cooperations

### 8.1. National Initiatives

#### 8.1.1. Equipex FIT- Future Internet of Things

The FIT project 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 is used as test-bed for SDR terminals and cognitive radio experiments. This has been operational since 2014 and is maintained 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. Insa-Spie IoT Chair

The Insa-Spie IoT Chair <http://www.citi-lab.fr/chairs/iot-chair/> relies on the expertise of the CITI Lab. The skills developed within the different teams of the lab integrate the study, modelling, conception and evaluation of technologies for communicating objects and dedicated network architectures. It deals with network, telecom and software matters as well as societal issues such as privacy. The chair will also lean on the skills developed at INSA Lyon or in IMU LabEx.

#### 8.1.3. Inria Project Lab: ZEP

The ZEP project addresses the issue of designing tiny computing objects with no battery by combining non-volatile memory (NVRAM), energy harvesting, micro-architecture innovations, compiler optimizations, and static analysis. The main application target is Internet of Things (IoT) where small communicating objects will be composed of this computing part associated to a low-power wake-up radio system. The ZEP project gathers four Inria teams that have a scientific background in architecture, compilation, operating system and low power together with the CEA Lialp and Lisan laboratories of CEA LETI & LIST. The major outcomes of the project will be a prototype harvesting board including NVRAM and the design of a new microprocessor associated with its optimizing compiler and operating system.

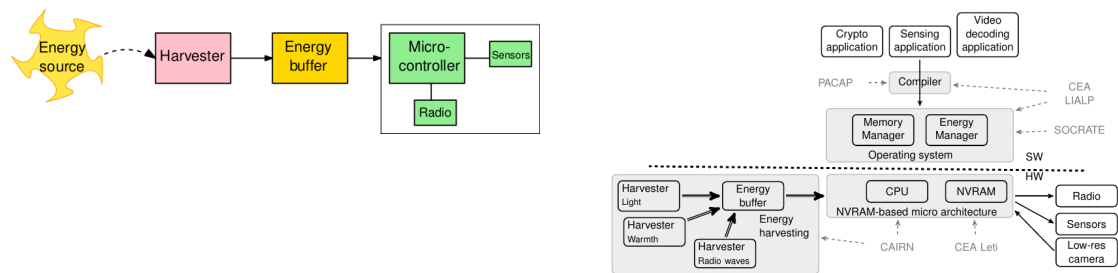


Figure 6. Example of system targeted by the ZEP project on the left, and on the right: the ZEP research program.

The scientific work (in progress) is organized around three fields :

- specific NVRAM-based architecture
- dedicated compiler pass that computes a worst-case energy consumption
- operating system managing NVRAM and energy, ensuring memory consistency across power outages

The project is illustrated by the figure 6, where PACAP, SOCRATE, CORSE, and CAIRN are the teams involved in the project.

Another important goal of the project is to structure the research and innovation that should occur within Inria to prepare the important technological shift brought by NVRAM technologies.

#### **8.1.4. ANR - MetalibM**

The goal of the MetalibM - “Automatic Generation of Function and Filters” (2014-2017, 200 keuros) 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).

#### **8.1.5. ADT Sytare**

The SYTARE project (Développement d’un SYStème embArqué faible consommation à mémoiRE persistante - ADT Inria 2015-2017) 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**

The Socrate project-team is in charge of the FIT/CorteXlab platform (section 5.6). This platform (ADT Inria 2015-2017) makes use of many complex technologies from signal processing to computer science through micro-electronics and FPGA. The objective 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 building experimentation using the PicoSDR machines.

#### **8.1.7. ANR - Ephyl**

The general objective of the project EPHYL - “Enhanced PHY for Cellular Low Power Communication IoT” (2016-2019, 183 keuros) is to investigate coming and future LPWA technologies with the aim to improve coverage, data rate and connectivity while keeping similar level of complexity and power consumption at the node for the access. New waveforms enablers will be investigated and trialled in order to increase the efficiency of future systems and to provide efficient and fair access to the radio resource. The proposed new waveforms should comply with system constraints and with the coexistence of multiple communications.

#### **8.1.8. ANR - Arburst**

In this project Arburst - “Achievable region of bursty wireless networks” (2016-2020, 195 KEuros), we propose an original approach complementary to other existing projects. Instead of proposing one specific technical solution, our objective is to define a unified theoretical framework devoted to the study of IoT networks fundamental limits. We aim at establishing the fundamental limits for a decentralized system in a bursty regime which includes short packets of information and impulsive interference regime. We are targeting the fundamental limits, their mathematical expression (according to the usual information theory framework capturing the capacity region by establishing a converse and achievability theorems). We will use the recent results relative to finite block-length information theory and we will evaluate the margin for improvement between existing approaches and these limits and we will identify the scientific breakthrough that may bring

significant improvements for IoT/M2M communications. This project will contribute to draw the roadmap for the development of IoT/M2M networks and will constitute a unified framework to compare existing techniques, and to identify the breakthrough concepts that may afford the industry the leverage to deploy IoT/M2M technical solutions.

## 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

Duration: June 2015 - June 2017

Coordinator: Inria

Inria contact: Samir M. 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.

#### 8.2.1.2. COM-MED

Title: COMMunication systems with renewable Energy micro-grid

Programm: H2020

Duration: October 2016 - October 2019

Coordinator: Inria

Inria contact: Samir M. Perlaza

A smart micro-grid is a small-scale power-grid system consisting of a number of distributed energy sources and loads which is responsible to ensure power sufficiency in a small area. The effectiveness of a smart micro-grid depends on the proper implementation of a communications and networking system which monitors, controls and manages the grid's operations. Due to the ever growing worldwide energy consumption, the need of an efficient framework for managing the way power is distributed and utilized has increased. The main objective of the project COM-MED is to study the

fundamental interplay between communications and power networks in the context of smart micro-grids and renewable energy sources. On one hand, we study advanced signal processing techniques and communications methods to optimize the operation of smart micro-grid systems. On the other hand, we focus on mobile communications networks with renewable energy base-stations (BSs) and we investigate communications and networking techniques that take into account both data traffic and energy profiles to support high quality-of-service (QoS). The objectives of each technical WP have been assigned in such a way as to ensure that the project's target is realized during the project's time period. The theoretical results derived from the WPs 3, 4 and 5 will be tested using the telecommunication network of MTN in Cyprus but also the state-of-the-art equipment of the CITI/Inria research lab in France. The outcome of this project will provide a theoretical framework for the optimal cooperation between communications networks and power networks in the context of smart micro-grids and renewable energy sources. This is in line with the objectives of the call's theme "Renewable Energy" and is of paramount importance for the Mediterranean area. The consortium of the project has the expertise and the infrastructure to implement the objectives set and to bring the project to a successful end.

### **8.2.2. Collaborations in European Programs, Except FP7 & H2020**

Socrate is very active in COST IRACON CA15104: Guillaume Villemaud is National Delegate (Alt.) and FIT/CorteXlab is identify as one of the COST platform: .

## **8.3. International Initiatives**

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

#### **8.3.1.1. CoWIN**

Title: Cognitive Wireless Networks from Theory to Implementation

International Partner (Institution - Laboratory - Researcher):

Princeton (United States) - electrical engineering departement - H. Vincent Poor

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 M. Perlaza has been appointed as Visiting Research Collaborator at the EE Department for the academic period 2016-2017. Scientific-Leaders at Inria: Samir M. Perlaza and Jean-Marie Gorce.
- **Technical University of Berlin**, Dept. of Electrical Engineering and Computer Science, Germany. This cooperation with Prof. Rafael Schaffer is on secrecy and covert communications. Scientific-Leaders at Inria: Samir M. Perlaza.

- **National University Singapore (NUS)**, Department of Electrical and Computer Engineering, Singapore. This collaboration with Prof. Vincent Y. F. Tan is on the study of finite block-length transmissions in multi-user channels and the derivation of asymptotic capacity results with non-vanishing error probabilities. Scientific-Leaders at Inria: Samir M. Perlaza
- **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 M. Perlaza.
- **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 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 M. 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 M. 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.
- **Bell Labs New Jersey, USA**, This cooperation with Prof. Antonia Tulino (affiliated to Bell Labs and to University of Napoli, Italy) is on caching in wireless networks. The objective is to demonstrate the efficiency of caching at the edge of wireless networks through experimentations on CorteXlab. This work will be published in 2017 in a special issue of IEEE Communication magazine (Yasser Fadlallah, Antonia M. Tulino, Dario Barone, Giuseppe Vettigli, Jaime Llorca and Jean-Marie Gorce: Coding for caching in 5G networks, IEEE Communication Magazine, 2017, accepted for publication). Scientific leader at Inria : Jean-Marie Gorce.
- **Technical University "Gh. Asachi" of Iasi, Romania**, Department of Electronics, Telecommunications and Information Technology. This recent collaboration has started on topics related on the theoretical aspects of the ultra-low power radio communications. Scientific-in-charge at Inria: Florin Hutu

## 8.4. International Research Visitors

- 2 month visit of Tarcisio F. Maciel (Federal University of Ceará, Brazil), working with Leonardo Sampaio-Cardoso on Radio Resource Allocation for Multi-User Communications: Background and Initial Perspectives for Joint Research on Resource Allocation & Massive MIMO.
- Visite and Talk of mme. Tarniceriu Technical University "Gh. Asachi" of Iasi in June.
- Visit and Talk of Mischa Dohler (King's College London) and Visa Koivunen (Aalto University, Finland) for HDR of Claire Goursaud.
- Visit and Talk of Gerhard Kramer (Technical University of Munich) for the PhD defense of Victor Quintero.

### 8.4.1. Visits to International Teams

#### 8.4.1.1. Sabbatical programme

Samir M. Perlaza is currently on Sabbatical year at Princeton University since July 2017.

**8.4.2. Internship**

- Clarissa Arraes Herculano, INSA Lyon, from Apr 2017 until Aug 2017.
- Romain Fontaine, Inria, from Jun 2017 until Jul 2017
- Fatimazhra Kninech, INSA Lyon, from Mar 2017 until Aug 2017
- Ivan Kolodziejczyk, INSA Lyon, from May 2017 until Jul 2017
- Daniel Krebs, INSA Lyon, from Apr 2017 until Sep 2017
- Thibaud Vial Nokia, from Apr 2017 until Aug 2017.

## CHROMA Project-Team

## 9. Partnerships and Cooperations

### 9.1. Regional Initiatives

#### 9.1.1. *COMODYS project, FIL (Federation d'Informatique de Lyon), 2017-19*

**Participants:** Laetitia Matignon, Olivier Simonin, Alessandro Renzaglia, Jilles Dibangoye.

Project of the Informatics Federation of Lyon (FIL) between two teams of two laboratories: CHROMA (CITI) and SMA (LIRIS), entitled "COoperative Multi-robot Observation of DYnamic human poSes", 2017-2019. Leader : L. Matignon & O. Simonin.

This project funds materials, missions and internships and its objectives are the on-line adaptation of a team of robots that observe and must recognize human activities.

#### 9.1.2. *CORDES ADT Inria project, 2017-18*

**Participants:** Olivier Simonin, Jilles Dibangoye, Alessandro Renzaglia, Vincent Le Doze.

The project CORDES (Coordination d'une Flotte de Drones Connectés pour la Cartographie 3D d'édifices) is an Inria ADT coordinated by Olivier Simonin. It funds an Inria expert engineer position in Chroma (Vincent Le Doze, 10/17-11/19) focusing on UAVs control and path-planning. The project aims to deploy a fleet of UAVs able to autonomously fly over an unknown infrastructure and to build a 3D map.

#### 9.1.3. *Regional AAP ARC6 project, 2015-18*

**Participants:** Olivier Simonin, Anne Spalanzani, Fabrice Valois [Insa de Lyon, Inria AGORA].

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".

#### 9.1.4. *Regional AAP ARC6 project 'TENSIVE', 2016-19*

**Participants:** Remi Cambuzat, Gérard Bailly [CNRS, GIPSA Lab. Grenoble], Olivier Simonin, Anne Spalanzani.

Regional project (Rhône-Alpes) "TENSIVE Robots de Téléprésence : Navigation Sociale et Interaction Verbale immersives" ARC6, 2016-2019. Leader : G. Bailly.

This project funds the PhD thesis of Remi Cambuzat who started on october 2016, and co-advized by G. Bailly (Dir.), O. Simonin and A. Spalanzani.

### 9.2. National Initiatives

#### 9.2.1. *ANR*

##### 9.2.1.1. *ANR "VIMAD" (2015-17)*

The VIMAD project, led by A. Martinelli, 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, [64]) 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 3.2.5 for a description of the results obtained during this 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. The PhD student (Pavan Vashista) recruited in this project focus on integrating models of human behaviors to evaluate and communicate a risk to pedestrians that may encounter the trajectory of the VALET vehicle. His PhD thesis started in february 2016 and is codirected by D. Vaufreydaz (Inria/PervasiveInteraction).

#### 9.2.1.3. ANR "HIANIC" (2017-20)

The HIANIC project, led by A. Spalanzani, proposes to endow autonomous vehicles with smart behaviors (cooperation, negotiation, socially acceptable movements) that better suit complex SharedSpace situations. It will integrate models of human behaviors (pedestrian, crowds and passengers), social rules, as well as smart navigation strategies that will manage interdependent behaviors of road users and of cybercars. The consortium is made of 3 academic partners: Inria (RITS, Chroma, Pervasive Interaction teams), Lig Laboratory (Magma team) and LS2N laboratory (ARMEN and PACCE teams). A. Spalanzani is the leader of this project.

#### 9.2.1.4. PIA Ademe "CAMPUS" (2017-20)

The CAMPUS project aims to identify, develop and deploy new functions for the autonomous cars in urban environments. In this project, Chroma will focus on finding solutions to navigate in complex situations such as crowded environments or dense traffic. The consortium is made of 1 academic partner: Inria (Rits and Chroma teams) and 3 companies: Safran electronics, Gemalto and Valeo.

## 9.3. European Initiatives

### 9.3.1. FP7 & H2020 Projects

Program: ECSEL

Project acronym: ENABLE-S3

Project title: European Initiative to Enable Validation for Highly Automated Safe and Secure Systems

Duration: June 2016 – May 2019

Coordinator: AVL List GesmbH

Other partners: Major European Organizations, including academic partners (such as Inria or KIT) and a Large number of industrial partners from various application domains such as automotive industry or Aeronautics or Train industry

Abstract: 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.

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 Renault and Inria Grenoble Rhône-Alpes. The Inria Tamis team (Rennes) is also involved in the project.

### 9.3.2. Collaborations with Major European Organizations

ETHZ, Zurich, Autonomous System laboratory, (Switzerland)

University of Zurich, Robotics and Perception Group (Switzerland)

Vision and IMU data Fusion for 3D navigation in GPS denied environment.

Karlsruhe Institut für Technologie (KIT, Germany)

Autonomous Driving (student exchanges and common project).

University of Babes-Bolyai, Cluj-Napoca (Romania).

Multi-robot patrolling and Machine Learning (PHC "DRONEM" 2017-18).

Vislab Parma (Italy)

Embedded Perception & Autonomous Driving (visits, projects submissions, and book chapter in the new edition of the Handbook of Robotics).

## 9.4. International Initiatives

### 9.4.1. Inria International Labs

Program: International Center of Excellence

Duration: 2012 – 2017

Coordinator: C. Laugier

Other partners: UPMC & CNRS (France), NTU (Taiwan)

The iCeIRA<sup>0</sup> international robotics laboratory led by Prof. Ren Luo from NTU (Taiwan) and strongly supported by the Taiwanese government, has been launched in 2012 for 5 years. Christian Laugier (Inria) and Raja Chatila (UPMC & CNRS) have actively participated to the starting of this laboratory in 2012 and are external Principal Investigators. The addressed research is about the concept of Human centered robotics.

### 9.4.2. Inria International Partners

#### 9.4.2.1. Informal International Partners

- UC Berkeley & Stanford University (CA, USA)  
Subject: Autonomous Driving (postdoc in the scope of Inria@SV, common publications and patent).
- NUS Singapore & NTU Singapore.  
Subject: Autonomous Driving (visits, common ICT Asia project, common organization of workshops, review of PhD students).
- Massachusetts Institute of Technology (MIT), Cambridge, MA (USA)  
Subject: Decentralized Control of Markov Decision Processes.  
Subject: Autonomous Driving (visits and common organization of a workshop).

## 9.5. International Research Visitors

### 9.5.1. Visits of International Scientists

- Visits of researchers from University Babes-Bolyai, Cluj-Napoca (Romania). In the context of our PHC "DRONEM" (2017-18), some members from the MLYRE team visited CHROMA, at CITI lab. in Lyon, July 8-13. Prof. Gabriela Czibula, Dr. Istvan-Gergely Czibula, Dr. Marian Zsuzsanna-Edit and Diana Lucia-Miholca given some talks about Machine Learning.

<sup>0</sup>International Center of Excellence in Intelligent Robotics and Automation Research.

## IMAGINE Project-Team

## 8. Partnerships and Cooperations

### 8.1. Regional Initiatives

#### 8.1.1. *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 was advised by Jean-Claude Léon and Damien Rohmer at Imagine, Raphaëlle Chaine and Julie Digne in Geomod team. This project was cancelled after Pablo Coves decided to abandon his PhD thesis.

### 8.2. National Initiatives

#### 8.2.1. *InriaHub ADT ULTRAHD (January-December 2017)*

**Participants:** Rémi Ronfard, Frédéric Devernay, Alexandre Gauthier.

This one-year contract was funding Alexandre Gauthier as a research engineer, with the goal of re-writing the code from Vineet Gandhi's PhD thesis into a suite of NATRON plugins. The resulting software was entirely re-designed for supporting ultra high definition video. The suite of plugins is collectively known as "Kino AI". The software is being extensively tested on a large dataset of 4K video recordings of theatre rehearsals, in collaboration with the Litt&Arts team at Univ. Grenoble Alpes, theatre director Jean-Francois Peyret in Paris, Theatre de l'Hexagone in Meylan and Theatre de Vidy in Lausanne.

#### 8.2.2. *FUI LIVE360 (December 2015 - December 2018)*

**Participants:** Frédéric Devernay, Sandra Nabil.

This 3-year contract with industrial partner GoPRO is funding the PhD thesis of Sandra Nabil.

#### 8.2.3. *FUI Collodi 2 (December 2016 - December 2018)*

**Participants:** Remi Ronfard, Maguelonne Beaud de Brives, Julien Daval, Damien Rohmer, Marie-Paule Cani.

This 2-year contract with two industrial partners: TeamTo and Mercenaries Engineering (software for production rendering), is a follow-up and a generalization of Dynam'it and Collodi 1. 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. The project is funding 2 engineers for 2 years.

#### 8.2.4. *ANR E-ROMA (November 2017 - October 2020)*

**Participants:** Remi Ronfard, Stefanie Hahmann, Damien Rohmer, Marie-Paule Cani, Pierre Casati.

This 3-year contract is a joint project with GeoMod team at LIRIS and the musée gallo-romain in Lyon. The contract started in November 2017 and is funding the PhD thesis of Pierre Casati.

#### 8.2.5. *ANR FOLDYN (November 2017 - October 2020)*

**Participants:** Damien Rohmer, Marie-Paule Cani, Thomas Buffet.

This 3-year contract is a joint project with the University of Toulouse. The contract started in November 2018 and is funding the PhD thesis of Thomas Buffet.

## 8.3. European Initiatives

### 8.3.1. FP7 & H2020 Projects

#### 8.3.1.1. 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. The contract ended successfully in March 2017.

#### 8.3.1.2. 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 predictions 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 bio-mechanics, 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. This contract ended successfully in April 2017.

## MAVERICK Project-Team

# 8. Partnerships and Cooperations

## 8.1. Regional Initiatives

We have frequent exchanges and on-going collaborations with Cyril Crassin from nVIDIA-Research, and Eric Heitz, Laurent Belcour and Jonathan Dupuy from Unity-Research.

Maverick is part of the GPU Research Center labeled by nVIDIA at Inria Grenoble. Team contact: Fabrice Neyret.

## 8.2. National Initiatives

### 8.2.1. 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.

### 8.2.2. 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. This project is in cooperation with Océ Print Logic technologies, the Museum of Ethnography at the University of Bordeaux and the Manao team at Inria Bordeaux. The grant started in October 2015, for 48 months.

### 8.2.3. CDP: Patrimalp 2.0

**Participants:** Nicolas Holzschuch [contact], Romain Vergne.

The main objective and challenge of Patrimalp 2.0 is to develop a cross-disciplinary approach in order to get a better knowledge of the material cultural heritage in order to ensure its sustainability, valorization and diffusion in society. Carried out by members of UGA laboratories, combining skills in human sciences, geosciences, digital engineering, material sciences, in close connection with stakeholders of heritage and cultural life, curators and restorers, Patrimalp 2.0 intends to develop of a new interdisciplinary science: Cultural Heritage Science. The grant starts in January 2018, for a period of 48 months.

### 8.2.4. ANR: CaLiTrOp

**Participant:** Cyril Soler [contact].

Computing photorealistic images relies on the simulation of light transfer in a 3D scene, typically modeled using geometric primitives and a collection of reflectance properties that represent the way objects interact with light. Estimating the color of a pixel traditionally consists in integrating contributions from light paths connecting the light sources to the camera sensor at that pixel.

In this ANR we explore a transversal view of examining light transport operators from the point of view of infinite dimensional function spaces of light fields (imagine, e.g., reflectance as an operator that transforms a distribution of incident light into a distribution of reflected light). Not only are these operators all linear in these spaces but they are also very sparse. As a side effect, the sub-spaces of light distributions that are actually relevant during the computation of a solution always boil down to a low dimensional manifold embedded in the full space of light distributions.

Studying the structure of high dimensional objects from a low dimensional set of observables is a problem that becomes ubiquitous nowadays: Compressive sensing, Gaussian processes, harmonic analysis and differential analysis, are typical examples of mathematical tools which will be of great relevance to study the light transport operators.

Expected results of the fundamental-research project CALiTrOp, are a theoretical understanding of the dimensionality and structure of light transport operators, bringing new efficient lighting simulation methods, and efficient approximations of light transport with applications to real time global illumination for video games.

### 8.3. International Initiatives

#### 8.3.1. Inria International Partners

##### 8.3.1.1. Declared Inria International Partners

Title: “MAIS”: Mathematical Analysis of Image Synthesis

International Partner (Institution - Laboratory - Researcher):

University of Montreal (Canada) - Département d'Informatique et Recherche Opérationnelle - Derek Nowrouzezahrai

Duration: 2015 - 2019

Start year: 2015

See also: <http://diro.umontreal.ca/accueil/>

##### 8.3.1.2. Indo-French Center of Applied Mathematics

###### **Topology-driven Visualization of Scientific Data**

Title: Topology-driven Visualization of Scientific Data

International Partner (Institution - Laboratory - Researcher):

IISc Bangalore (India) - Department of Science and Automation - Vijay Natarajan

Duration: Sept 2016 - Sept 2017

One of the greatest scientific challenges of the 21st century is how to master, organize, and extract useful knowledge from the overwhelming flow of information made available by today's data acquisition systems and computing resources. Visualization is the premium means of taking up this challenge. Topological analysis has recently emerged as a powerful class of methods for visualizing data. From the input data, these methods derive combinatorial structures capturing the essential features of the data. The goal of this project is to design new topological structures, study their properties, and develop efficient algorithms to compute them. In order to solve this challenge, we will combine our expertise in Topology for the Indian partner and in Geometric Modeling for the French partner. We plan to develop new geometric models that accurately and intuitively depict the topological combinatorial structures.

### 8.4. International Research Visitors

#### 8.4.1. Visits to International Teams

##### 8.4.1.1. Research Stays Abroad

- Alexandre Bléron has made a 3 months internship to work with Hock Soon Seah on 3D stylization in the MAGIC group of Nanyang Technological University of Singapore.
- Alban Fichet is making a 12 months stay at Charles University in Prague, to work with Alexander Wilkie and Jaroslav Krivanek on material models.
- Guillaume Loubet has made a 3 months internship in the Hyperion group at Disney, Los Angeles.

## MOEX Project-Team

## 5. Partnerships and Cooperations

### 5.1. National Initiatives

#### 5.1.1. ANR Elker

Program: ANR-PRC

Project acronym: ELKER

Project title: Extending link keys: extraction and reasoning

Duration: October 2017 - September 2021

Coordinator: LIG/Manuel Atencia

Participants: Manuel Atencia Arcas, Jérôme David, Jérôme Euzenat

Other partners: Inria Lorraine, Université de Vincennes

Abstract: The goal of ELKER is to extend the foundations and algorithms of link keys (see §3.3 ) in two complementary ways: extracting link keys automatically from datasets and reasoning with link keys.

#### 5.1.2. Framework agreement Ministère de la culture et de la communication

Program: Framework agreement Inria-Ministère de la culture et de la communication

Project acronym: GINCO V3

Project title: Outil d'aide à l'alignement pour l'élaboration du graphe culture

Duration: November 2017 - December 2018

Coordinator: Jérôme David

Participants: Jérôme David, Jérôme Euzenat, Manuel Atencia Arcas

Abstract: The GINCO V3 project aims at extending the GINCO tool with ontology alignment capabilities.

Program: Framework agreement Inria-Ministère de la culture et de la communication

Project acronym: FNE

Project title: Algorithmes d'aide à la définition de clés de liage et d'alignement d'autorités

Duration: November 2017 - December 2018

Coordinator: Jérôme David

Participants: Jérôme David, Manuel Atencia Arcas, Jérôme Euzenat

Other partners: Bibliothèque nationale de France

Abstract: The goal of the FNE cooperation is to evaluate the suitability of link key extraction algorithms to matching authorities from BnF, ABES and the ministry of Culture and to improve such algorithms if necessary.

### 5.2. International Initiatives

#### 5.2.1. Participation in Other International Programs

Jérôme Euzenat has benefited 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 works with the team of Fernanda Baião and Kate Revoredo at the Universidade Federal do Estado do Rio de Janeiro (UNIRIO). Together, they investigate methods for evolving ontologies and alignments which involve users and agents. The goal of the project is to design methods and algorithms using theory revision to deal with knowledge evolution in a reliable manner and obtaining better quality alignments.

### **5.3. International Research Visitors**

#### ***5.3.1. Visits of International Scientists***

- Kate Revoredo (UNIRIO) visited mOeX in May 2017.

#### ***5.3.2. Visits to International Teams***

- Jérôme Euzenat visited the Universidade Federal do Estado do Rio de Janeiro (UNIRIO) for one month in November-December 2017 (see §[5.2.1](#) ).



## **MORPHEO Project-Team**

## **9. Partnerships and Cooperations**

### **9.1. National Initiatives**

#### **9.1.1. Persyval-Lab exploratory project Carambole**

The Carambole projects initiates a new collaboration between the Morpheo team and biophysicists from University Paris Diderot. The objectives are to develop hardware and software to help tracking feature points on a leaf of *Averrhoa Carambola* during its growth with a multi-camera system and to measure their 3D motion. *Averrhoa carambola* is of special interest because of the distinctive nutation balancing motion of a leaf during its growth.

This exploratory project was funded for 18 months in 2016 and 2017 by the Persyval-Lab LabEx.

#### **9.1.2. ANR**

##### **9.1.2.1. ANR PRCE CaMoPi – Capture and Modelling of the Shod Foot in Motion**

The main objective of the CaMoPi project is to capture and model dynamic aspects of the human foot with and without shoes. To this purpose, video and X-ray imagery will be combined to generate novel types of data from which major breakthroughs in foot motion modelling are expected. Given the complexity of the internal foot structure, little is known about the exact motion of its inner structure and the relationship with the shoe. Hence the current state-of-the art shoe conception process still relies largely on ad-hoc know-how. This project aims at better understanding the inner mechanisms of the shod foot in motion in order to rationalise and therefore speed up and improve shoe design in terms of comfort, performance, and cost. This requires the development of capture technologies that do not yet exist in order to provide full dense models of the foot in motion. To reach its goals, the CaMoPi consortium comprises complementary expertise from academic partners : Inria (combined video and X-ray capture and modeling) and Mines St Etienne (finite element modeling), as well as industrials : CTC Lyon (shoe conception and manufacturing) and Sporaltec (dissemination). The project has effectively started in October 2017 with Claude Goubet's recruitment as a PhD candidate.

##### **9.1.2.2. 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. 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 is currently ongoing with 2 PhDs on the Inria side: Vincent Leroy and Jinlong Yang.

#### **9.1.3. Competitivity Clusters**

##### **9.1.3.1. FUI project Creamove**

Creamove is a collaboration between the Morpheo team of the Inria Grenoble Rhône-Alpes, the 4D View Solution company specialized in multi-camera acquisition systems, the SIP company specialized 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>.

#### 9.1.3.2. FUI24 SPINE PDCA – SPINE Plan-Do-Check-Act

The goal of the SPINE PDCA project is to develop a unique medical platform that will streamline the medical procedure and achieve all the steps of a minimally invasive surgery intervention with great precision through a complete integration of two complementary systems for pre-operative planning (EOS platform from EOS IMAGING) and imaging/intra-operative navigation (SGV3D system from SURGIVISIO). Innovative low-dose tracking and reconstruction algorithms will be developed by Inria, and collaboration with two hospitals (APHP Trousseau and CHU Grenoble) will ensure clinical feasibility. The medical need is particularly strong in the field of spinal deformity surgery which can, in case of incorrect positioning of the implants, result in serious musculoskeletal a high repeat rate (10 to 40% of implants are poorly positioned in spine surgery) and important care costs. In paediatric surgery (e.g. idiopathic scoliosis), the rate of exposure to X-rays is an additional major consideration in choosing the surgical approach to engage. For these interventions, advanced linkage between planning, navigation and postoperative verification is essential to ensure accurate patient assessment, appropriate surgical procedure and outcome consistent with clinical objectives.

## PERCEPTION Project-Team

# 8. Partnerships and Cooperations

## 8.1. European Initiatives

### 8.1.1. FP7 & H2020 Projects

#### 8.1.1.1. VHIA

Title: Vision and Hearing in Action

EU framework: FP7

Type: ERC Advanced Grant

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.

Website: <https://team.inria.fr/perception/projects/erc-vhia/>

## 8.2. International Initiatives

### 8.2.1. Inria International Partners

#### 8.2.1.1. Informal International Partners

- Bar Ilan University, Israel (prof. Sharon Gannot and his team)
- University of Trento, Italy (prof. Nicu Sebe and prof. Elisa Ricci)
- Dr. Rafael Munoz-Salinas and prof. Manuel Marin-Jimenez, University of Cordoba, Spain,
- Dr. Christine Evers and prof. Patrick Naylor, Imperial College of Science and Medecine, UK.
- Dr. Miriam Redi, Wikimedia Foundation, UK.
- Prof. Shih-Fu Chang, Columbia University, USA.

## 8.3. International Research Visitors

### 8.3.1. Visits of International Scientists

- Prof. Sharon Gannot (Bar Ilan University)
- Oscar David Gomez Lopez (University of Granada)

## PERVASIVE INTERACTION Project-Team

# 8. Partnerships and Cooperations

## 8.1. National Initiatives

### 8.1.1. ANR Project Involved

Participants: Amr Alyafi, Patrick Reignier.

Other Partners: UMR G-SCOP, UMR LIG (Persuasive Interaction, IIHM, Getalp), CEA Liten, PACTE, Vesta Systems and Elithis.

Dates: Jan 2015 to Dec 2018

The ANR project Involved focuses on bringing solutions to building actors for upcoming challenges in energy management in residential buildings. The project explores a user centric energy management system, where user needs and tacit knowledge drive the search of solutions. These are calculated using 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.

The project will develop interactive energy consultants for all the actors, providing 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: Chess Expertise from Eye Gaze and Emotion

Participants: James Crowley, Dominique Vaufreydaz, Rafaellea Balzarini

Other Partners: Dept of NeuroCognition, CITEN, Bielefeld University

Dates: Jan 2016 to Dec 2019

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 Neuroscience. The aim of this project is to experimentally evaluate and compare current theories for mental modelling 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 provide a structured environment that we will use for experimental evaluation of current theories of mental modeling and emotional response during problem solving and social interaction.

The project is organized 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 that elicit particularly strong physiological reactions. In the final phase, we will use these recordings to evaluate the effectiveness of competing techniques for mental modeling 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, multimodal 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. CDP EcoSesa - Cross Disciplinary Project of the ComUE UGA**

Participants: James Crowley, Patrick Reignier, Rafaellea Balzarini Dates: Jan 2017 to Dec 2020

Cities and their energy systems are undergoing profound transformations. Electric Power networks are being transformed from centralized, high capacity, generating plants, dimensioned to meet peak loads to decentralized, local, production based on intermittent renewable sources. This transformation is made possible by integration of information and energy technologies, new energy materials and components, and the rapid spread of pervasive computing. The result is a change in the socio-economics of energy distribution, and a change in the role of users from passive consumers to active participants in a dynamically fluctuating energy market. Many cities worldwide have initiated research projects and experiments to accelerate the spread of clean technologies. However, these initiatives generally focus on a specific issue that depends on the priorities and preferences of the local decision makers and stakeholders. At the same time, academic research has generally been confined to specialized silos in energy materials and management systems, in Social Sciences as well as in Information and Communication Technologies (ICT), resulting in piecemeal knowledge.

The vision of Eco-SESA is to address the problems resulting from the transition to clean decentralized energy production based on renewable sources with a holistic integrated humansystem approach. The project will address the development of Safe, Efficient, Sustainable and Accessible energy systems, from the individual end-user to dynamic communities of stakeholders at the district and grid levels.

Pervasive is involved in two research front of the project :

- Interactive systems to involve occupants of buildings
- Emerging behaviors from individual to communities

### **8.1.4. LabEx Persyval - Project MicroBayes: Probabilistic Machines for Low-level Sensor Interpretation**

Participants: Emmanuel Mazer, Raphael Frisch Other Partners: Laurent Girin (TIMA), Laurent Girin (GIPSA Lab), Didier Piau (L'Institut Fourier)

Dates: Nov 2016 to Nov 2019

The project MicroBayes builds on results of the recently completed EC FET Open project BAMBI to explore a new technique for Blind source separation and acoustic signal location using a new form of Bayesian Computer. The techniques have recently been demonstrated using a software simulation. Current plans are to implement and demonstrate the Bayesian computer using an FPGA. By the end of the project we expect to produce a hardware implementation suitable for use in low-cost low-power applications.

#### **8.1.5. Competitivity Clusters**

James Crowley is on the scientific committee for the Minalogic Competitivity Cluster. Minalogic is the global innovation cluster for digital technologies serving France's Auvergne-Rhône-Alpes region. The Scientific Committee advises the pole of strategy, advises local industry in proposal preparation, reviews FUI project proposals, and makes recommendations about labelling and support of project proposals.

## THOTH Project-Team

## 9. Partnerships and Cooperations

### 9.1. Regional Initiatives

#### 9.1.1. *DeCore (Deep Convolutional and Recurrent networks for image, speech, and text)*

**Participants:** Jakob Verbeek, Maha Elbayad.

DeCore is a project-team funded by the Persyval Lab for 3.5 years (september 2016 - February 2020), coordinated by Jakob Verbeek. It unites experts from Grenoble's applied-math and computer science labs LJK, GIPSA-LAB and LIG in the areas of computer vision, machine learning, speech, natural language processing, and information retrieval. The purpose of DeCore is to stimulate collaborative interdisciplinary research on deep learning in the Grenoble area, which is likely to underpin future advances in machine perception (vision, speech, text) over the next decade. It provides funding for two full PhD students. Maha Elbayad is one of them, supervised by Jakob Verbeek and Laurant Besacier (UGA).

### 9.2. National Initiatives

#### 9.2.1. *ANR Project Macaron*

**Participants:** Julien Mairal, Zaid Harchaoui [University of Washington], Laurent Jacob [CNRS, LBBE Laboratory], Michael Blum [CNRS, TIMC Laboratory], Joseph Salmon [Telecom ParisTech], Mikita Dvornik, Thomas Dias-Alves, Daan Wymen.

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.

#### 9.2.2. *ANR Project DeepInFrance*

**Participant:** Jakob Verbeek.

DeepInFrance (Machine learning with deep neural networks) project also aims at bringing together complementary machine learning, computer vision and machine listening research groups working on deep learning with GPUs in order to provide the community with the knowledge, the visibility and the tools that brings France among the key players in deep learning. The long-term vision of Deep in France is to open new frontiers and foster research towards algorithms capable of discovering sense in data in an automatic manner, a stepping stone before the more ambitious far-end goal of machine reasoning. The project partners are: INSA Rouen, Univ. Caen, Inria, UPMC, Aix-Marseille Univ., Univ. Nice Sophia Antipolis.

### 9.3. European Initiatives

#### 9.3.1. *FP7 & H2020 Projects*

##### 9.3.1.1. *ERC Advanced grant Allegro*

**Participants:** Cordelia Schmid, Pavel Tokmakov, Nicolas Chesneau, Vasiliki Kalogeiton, Konstantin Shmelkov, Daan Wymen, Xiaojiang Peng.

The ERC advanced grant ALLEGRO started in April 2013 for a duration of five years extended in 2017 for one year. 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.

#### 9.3.1.2. ERC Starting grant Solaris

**Participants:** Julien Mairal, Ghislain Durif, Andrei Kulunchakov, Dexiong Chen, Alberto Bietti, Hongzhou Lin.

The project SOLARIS started in March 2017 for a duration of five years. The goal of the project is to set up methodological and theoretical foundations of deep learning models, in the context of large-scale data processing. The main applications of the tools developed in this project are for processing visual data, such as videos, but also structured data produced in experimental sciences, such as biological sequences.

The main paradigm used in the project is that of kernel methods and consist of building functional spaces where deep learning models live. By doing so, we want to derive theoretical properties of deep learning models that may explain their success, and also obtain new tools with better stability properties. Another work package of the project is focused on large-scale optimization, which is a key to obtain fast learning algorithms.

## 9.4. International Initiatives

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

#### 9.4.1.1. GAYA

Title: Semantic and Geometric Models for Video Interpretation

International Partner (Institution - Laboratory - Researcher):

Carnegie Mellon University (United States) - Robotics Institute - Deva Ramanan

Start year: 2016

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

The primary goal of the associate team GAYA is to interpret videos, in terms of recognizing actions, understanding the human-human and human-object interactions. Despite several years of research, it is yet unclear what is an efficient and robust video representation to attack this challenge. In order to address this, GAYA will focus on building semantic models, wherein we learn the video feature representation with limited supervision, and also geometric models, where we study the geometric properties of object shapes to better recognize them. The team consists of researchers from two Inria project-teams (Thoth and WILLOW) and a US university (Carnegie Mellon University [CMU]). It will allow the three teams to effectively combine their respective strengths in areas such as inference and machine learning approaches for vision tasks, feature representation, large-scale learning, geometric reasoning. The main expected outcomes of this collaboration are: effective learnt representations of video content, new machine learning algorithms for handling minimally annotated data, large-scale public datasets for benchmarking, theoretical analysis of objects shapes and contours. In 2017, Gunnar Sigurdsson (PhD student of Abhinav Gupta [CMU]) visited the Thoth team to develop a new dataset of first- and third-person videos and an approach for learning a joint representation of these two modalities.



### 9.4.2. Inria International Partners

#### 9.4.2.1. Informal International Partners

- **University of Edinburgh:** C. Schmid collaborates with V. Ferrari, full professor at university of Edinburgh. Vicky Kalogeiton started a co-supervised PhD in 2013 and graduated in 2017; she has been bi-localized between Uni. Edinburgh and Inria. Her subject is automatic learning of object representations in videos. The collaboration resulted in two joint publications in 2017 [19], [18].
- **MPI Tübingen:** C. Schmid collaborates with M. Black, a research director at MPI, starting in 2013. End of 2015 she was awarded a Humboldt research award funding a long-term research project with colleagues at MPI. She spent one month at MPI in May 2017. In 2017 the project resulted in the development of a large-scale synthetic human action dataset [12].
- **University of Washington:** Julien Mairal collaborates with Zaid Harchaoui, former member of the Lear team, on the topic of large-scale optimization. They co-advised one student, Hongzhou Lin, who defended his PhD in 2017.

### 9.4.3. Participation in Other International Programs

- **Indo-French project EVEREST** with IIIT Hyderabad, India, funded by CEFIPRA (Centre Franco-Indien pour la Promotion de la Recherche Avancée). The aim of this project between Cordelia Schmid, Karteek Alahari and C. V. Jawahar (IIIT Hyderabad) is to enable the use of rich, complex models that are required to address the challenges of high-level computer vision. The work plan for the project will follow three directions. First, we will develop a learning framework that can handle weak annotations. Second, we will build formulations to solve the non-convex optimization problem resulting from the learning framework. Third, we will develop efficient and accurate energy minimization algorithms, in order to make the optimization computationally feasible.

## 9.5. International Research Visitors

### 9.5.1. Visits to International Teams

#### 9.5.1.1. Research Stays Abroad

- A. Bietti visited Microsoft Research at New York from September to December 2017, as part of the MSR-Inria joint centre collaboration.

## TYREX Project-Team

## 8. Partnerships and Cooperations

### 8.1. Regional Initiatives

#### AGIR

Title: Data-CILE

Call: Appel à projet Grenoble Innovation Recherche (AGIR-Pole)

Duration: 2016-2018

Coordinator: Nabil Layaïda

Abstract: The goal of this project is to contribute to foundational and algorithmic challenges introduced by increasingly popular data-centric paradigms for programming on distributed architectures such as spark and the massive production of big linked open data. The focus of the project is on building robust and more efficient workflows of transformations of rich web data. We will investigate effective programming models and compilation techniques for producing specialised language runtimes. We will focus on high-level specifications of pipelines of data transformations and extraction for producing valuable knowledge from rich web data. We will study how to synthesise code which is correct and optimised for execution on distributed platforms. The overall expected outcome is to make the development of rich-data-intensive applications less error-prone and more efficient.

### 8.2. National Initiatives

#### 8.2.1. ANR

##### CLEAR

Title: Compilation of intermediate Languages into Efficient big dAta Runtimes

Call: Appel à projets générique 2016 défi 'Société de l'information et de la communication' – JCJC

Duration: October 2016 – September 2020

Coordinator: Pierre Genevès

See also: <http://tyrex.inria.fr/clear>

Abstract: This project addresses one fundamental challenge of our time: the construction of effective programming models and compilation techniques for the correct and efficient exploitation of big and linked data. We study high-level specifications of pipelines of data transformations and extraction for producing valuable knowledge from rich and heterogeneous data. We investigate how to synthesize code which is correct and optimized for execution on distributed infrastructures.

#### 8.2.2. PERSYVAL-lab LabEx

Title: Mobile Augmented Reality Applications for Smart Cities

Call: Persyval Labex ("Laboratoire d'excellence").

Duration: 2014 – 2017

Coordinators: Pierre Genevès and Nabil Layaïda

Others partners: NeCS team at GIPSA-Lab laboratory.

Abstract: The goal of this project is to increase the relevance and reliability of augmented reality (AR) applications, through three main objectives:

1. Finding and developing appropriate representations for describing the physical world (3D maps, indoor buildings, ways...), integrated advanced media types (3D, 3D audio, precisely geo-tagged pictures with lat., long. and orientation, video...)
2. Integrating the different abstraction levels of these data streams (ranging from sensors data to high level rich content such as 3D maps) and bridging the gap with Open Linked Data (the semantic World). This includes opening the way to query the environment (filtering), and adapt AR browsers to users' capabilities (e.g. blind people). The objective here is to provide an open and scalable platform for mobile-based AR systems (just like the web represents).
3. Increasing the reliability and accuracy of localization technologies. Robust and high-accuracy localization technologies play a key role in AR applications. Combined with geographical data, they can also be used to identify user-activity patterns, such as walking, running or being in an elevator. The interpretation of sensor values, coupled with different walking models, allows one to ensure the continuity of the localization, both indoor and outdoor. However, dead reckoning based on Inertial Navigation Systems (INS) or Step-and-Heading Systems (SHS) is subject to cumulative errors due to many factors (sensor drift (accelerometers, gyroscopes, etc.), missed steps, bad estimation of the length of each stride, etc.). One objective is to reduce such errors by merging and mixing these approaches with various external signals such as GPS and Wi-Fi or relying on the analyses of user trajectories with the help of a structured map of the environment. Some filtering methods (Kalman Filter, observer, etc.) will be useful to achieve this task.