



RESEARCH CENTER  
Rennes - Bretagne-Atlantique

FIELD

Activity Report 2014

# Section Partnerships and Cooperations

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## ALF Project-Team

# 8. Partnerships and Cooperations

## 8.1. National Initiatives

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

**Participants:** Damien Hardy, Isabelle Puaut.

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

### 8.1.2. *Inria Project Lab: Multicore 2013-2016*

**Participants:** Erven Rohou, Alain Ketterlin, Nabil Hallou.

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

### 8.1.3. *ADT IPBS 2013-2015*

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

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

### 8.1.4. *ADT Padrone 2012-2014*

**Participants:** Erven Rohou, Alain Ketterlin, Emmanuel Riou.

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

### 8.1.5. *ANR W-SEPT 2012-2015*

**Participants:** Hanbing Li, Isabelle Puaut, Erven Rohou.

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

## 8.2. European Initiatives

### 8.2.1. FP7 & H2020 Projects

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

Type: IDEAS

Instrument: ERC Advanced Grant

Duration: April 2011 - March 2016

Coordinator: André Seznec

Inria contact: André Seznec

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

For more information, see <http://www.irisa.fr/alf/dal>.

#### 8.2.1.2. HiPEAC3 NoE

**Participants:** Pierre Michaud, Erven Rohou, André Seznec.

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

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

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

**Participants:** Damien Hardy, Isabelle Puaut.

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

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

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

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

## 8.3. International Initiatives

### 8.3.1. Participation In International Programs

#### 8.3.1.1. UFGM Chair (Brasil)

Program: Cátedras Francesas UFGM

Title: Compiler Support for emerging parallel architectures

Inria principal investigator: Sylvain Collange

International Partner (Institution - Laboratory - Researcher):

Universidade Federal de Minas Gerais (UFGM) - Computer Science Department - Fernando Pereira

Duration: Sep 2014 - Dec 2014

We propose . The project develop compilation techniques for code optimization to speedup applications that run in Graphics Processing Units (GPUs). The objective is to enable developers code high-performance programs in high-level languages, while taking maximum benefit from the hardware. In particular, we seek to alleviate control and memory divergence, which are important performance limiters specific to GPU architectures. For instance, the call fusion optimization factors out a common function call invoked from multiple independent conditional branches to enable the hardware to execute the function in SIMD mode regardless of branch divergence.

#### 8.3.2. Informal collaborations

The ALF project-team has informal collaborations (visits, common publications) with University of Wisconsin at Madison (Pr Wood), University of Toronto (Pr Moshovos), University of Ghent (Dr Eyerman), University of Upsalla (Pr Hagersten), University of Cyprus (Pr Sazeides), the Egyptian-Japanese University of Science and Technology (Pr Ahmed El-Mahdy).

## 8.4. International Research Visitors

### 8.4.1. Visits of International Scientists

- Dr Stijn Eyerman from University of Ghent has been visiting the ALF project-team in April-May 2014.
- Pr Erik Hagerstern from Uppsala University has been visiting the ALF project-team in September-December 2014
- Pr Fernando Magno Quintão Pereira, from the Federal University of Minas Gerais visited the ALF project for 1 week in January 2014.

### 8.4.2. Visits to International Teams

Sylvain Collange has been invited on a professor chair at Universidade Federal de Minas Gerais, Brasil (September-December 2014). The subject of the collaboration is "Compiler Support for emerging parallel architectures".

## ASAP Project-Team

# 8. Partnerships and Cooperations

## 8.1. National initiatives

### 8.1.1. LABEX CominLabs

**Participants:** Anne-Marie Kermarrec, Davide Frey, Michel Raynal, François Taïani.

ASAP participates in the CominLabs initiative sponsored by the "Laboratoires d'Excellence" program. The initiative federates the best teams from Bretagne and Nantes regions in the broad area of telecommunications, from electronic devices to wide area distributed applications "over the top." These include, among the others, the Inria teams: ACES, ALF, ASAP, CELTIQUE, CIDRE, DISTRIBCOM, MYRIADS, TEMICS, TEXMEX, and Visages. The scope of CominLabs covers research, education, and innovation. While being hosted by academic institutions, CominLabs builds on a strong industrial ecosystem made of large companies and competitive SMEs. In this context, ASAP received funding for DeSeNt (a collaborative project with the Univ. Nantes / LINA).

### 8.1.2. ANR project SocioPlug

**Participants:** Davide Frey, Anne-Marie Kermarrec, Pierre-Louis Roman, François Taïani.

SocioPlug is a collaborative ANR project involving Inria (ASAP team), the Univ. Nantes, and LIRIS (INSA Lyon and Univ. Claude Bernard Lyon). The project emerges from the observation that the features offered by the Web 2.0 or by social media do not come for free. Rather they bring the implicit cost of privacy. Users are more or less consciously selling personal data for services. SocioPlug aims to provide an alternative for this model by proposing a novel architecture for large-scale, user centric applications. Instead of concentrating information of cloud platforms owned by a few economic players, we envision services made possible by cheap low-end plug computers available in every home or workplace. This will make it possible to provide a high amount of transparency to users, who will be able to decide their own optimal balance between data sharing and privacy.

### 8.1.3. DeSeNt CominLabs

**Participants:** Resmi Ariyattu Chandrasekharannair, Davide Frey, Michel Raynal, François Taïani.

The DeSeNt project aims to ease the writing of distributed programs on a federation of plug computers. Plug computers are a new generation of low-cost computers, such as Raspberry pi (25\$), VIA- APC (49\$), and ZERO Devices Z802 (75\$), which offer a cheap and readily available infrastructure to deploy domestic on-line software. Plug computers open the opportunity for everyone to create cheap nano-clusters of domestic servers, host data and services and federate these resources with their friends, colleagues, and families based on social links. More particularly we will seek in this project to develop novel decentralized protocols than can encapsulate the notion of privacy-preserving federation in plug-based infrastructures. The vision is to use these protocols to provide a programming toolkit that can support the convergent data types being developed by our partner GDD (Gestion de Données Distribuées) at Univ. Nantes.

### 8.1.4. ANR Blanc project Displexity

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

The Displexity project started in Oct 2011. The aim of this ANR project that also involves researchers from Paris and Bordeaux is to establish the scientific foundations for building up a consistent theory of computability and complexity for distributed computing. One difficulty to be faced by DISPLEXITY is to reconcile two non necessarily disjoint sub-communities, one focusing on the impact of temporal issues, while the other focusing on the impact of spatial issues on distributed algorithms.

## 8.2. European initiatives

### 8.2.1. FP7 & H2020 projects

#### 8.2.1.1. TOWARD THE ALLYOURS START-UP

Title: TOWARD THE ALLYOURS START-UP

Type: EIT-ICT Labs

Instrument: ACLD Computing in the Cloud

Duration: Jan - Dec 2014.

Coordinator: Inria (France)

Partners: Trento Rise, BDP EIT-ICT

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

Abstract: The goal of the Activity proposal is to turn the inventions from the ERC Starting Grant Project GOSSPLE to innovation by setting up a start-up (AllYours) targeting both Internet users as well as small to medium companies (SME) offering full-fledged personalization in notification systems. In this second year, the AllYours activity focused on the peer-to-peer and on the corporate version of AllYours through a collaborative initiative that involves the ASAP team, TrentoRise (Italy), and the Eindhoven EIT/ICT nodes. Our work consisted on refining and testing our implementations. For the p2p version, we ran a test with real users coordinated by TrentoRise from Sep to Nov 2014.

### 8.2.2. Collaborations with major European organizations

Ecole Polytechnique Federale de Lausanne EPFL Switzerland; collaboration on the Google Focused Award Web-Alter-Egos.

## 8.3. International Initiatives

### 8.3.1. Inria associate teams

#### 8.3.1.1. RADCON

Title: Randomized Algorithms for Distributed Computing and Networks

International Partner (Institution - Laboratory - Researcher):

Univ. of Calgary (CANADA)

Duration: 2013 - 2015

See also: <http://www.irisa.fr/asap/radcon>

Over recent years, computing systems have seen a massive increase in parallelism and interconnectivity. Peer-to-peer systems, ad-hoc networks, sensor networks, or the "cloud" are based on highly connected and volatile networks. Individual nodes such as cell phones, desktop computers or high performance computing systems rely on parallel processing power achieved through multiple processing units. To exploit the power of massive networks or multiple processors, algorithms must cope with the scale and asynchrony of these systems, and their inherent instability, e.g., due to node, link, or processor failures. In this research project we explore randomized algorithms for large-scale networks of distributed systems, and for shared memory multi-processor systems.

For large-scale networks, decentralized gossip protocols have emerged as a standard approach to achieving fault-tolerant communication between nodes with simple and scalable algorithms. We will devise new gossip protocols for various complex distributed tasks, and we will explore the power and limits of gossip protocols in various settings.

For shared memory systems, randomized algorithms have proved extremely useful to deal with asynchrony and failures. Sometimes probabilistic algorithms provide the only solution to a problem; sometimes they are more efficient; sometimes they are simply easier to implement. We will devise efficient algorithms for some of the fundamental problems of shared memory computing, such as mutual exclusion, renaming, and consensus.



### 8.3.2. Inria international partners

Univ. of Calgary  
Univ. Nacional Autonoma de Mexico  
Univ. of Glasgow

## 8.4. International Research Visitors

### 8.4.1. Visits of international scientists

Yahya Benkaouz, ENSIAS Rabat, Morocco, from Dec 1 2013 to Feb 28 2014  
Maryam Helmi Khomeirani, Univ. of Calgary, Canada, from Aug 15 to Oct 14 2014  
Frederik Mallmann-Trenn, Simon Fraser Univ., Canada, from Jan 15 to Apr 20 and from Jun 16 to Jul 22 2014  
Diogo Saraiva Lima, Univ. of Lisbon, Portugal, from Jul 1 to Aug 29 2014

### 8.4.2. Internships

Naman Goel; from Feb 1 to Apr 25 2014. *User profiles segmentation for efficient personalized recommendations*. Supervised by Anne-Marie Kermarrec and François Taiani.  
Frederik Mallmann-Trenn; until Jul 31 2014. *Bounds on the Voting Time in Terms of Conductance*. Supervised by George Giakkoupis (and Petra Berenbrink of Simon Frazer Univ., Canada).  
Mathieu Pasquet; from Feb 1 to Jun 30 2014. *Content-based orientation in decentralized recommenders*. Supervised by Davide Frey.  
Martin Sansoucy; from May 15 to Aug 31 2014. *Caractérisation d'un protocole décentralisé de construction de topologies informatiques réparties à mémoire de forme*. Supervised by François Taiani.

### 8.4.3. Visits to international teams

George Giakkoupis, Univ. of Calgary, Canada, Mar 23 to Apr 10, and Oct 22 to Nov 9 2014.  
Anne-Marie Kermarrec was a part-time visiting professor at EPFL, Switzerland, from Jan to Jul 2014.  
Anne-Marie Kermarrec, Univ. of Sydney and NICTA, Australia, two weeks in Jan 2014.  
Anne-Marie Kermarrec, Yandex, Moscow, Russia, one week in Jun 2014.  
Antoine Rault, EPFL, Switzerland, Sep 1 to Nov 29 Nov 2014

## ASCOLA Project-Team

# 8. Partnerships and Cooperations

## 8.1. Regional Initiatives

### 8.1.1. *Competitiveness cluster Images-et-Reseaux*

#### 8.1.1.1. *EcoCloud*

**Participant:** Jean-Marc Menaud.

The project EcoCloud is a cooperative research project running for 2 years. Three other partners collaborate within the project that is coordinated by the company EasyVirt: the Ascola team and another company Pentasonic. The partners aim at developing an economically-valid and ecologic cloud platform in the context of micro and mono-site data centers (all resources are in the same physical location). A high SLA level must be provided with a specific focus on high availability satisfying strong redundancy and placement constraints.

## 8.2. National Initiatives

### 8.2.1. *CominLabs laboratory of excellence*

#### 8.2.1.1. *EPOC*

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

The project EPOC (Energy Proportional and Opportunistic Computing system) is an (academic) Labex CominLabs project running for 4 years. Four other partners collaborate within the project that is coordinated by ASCOLA: Myriads team, and the three institutions ENIB, ENSTB and University of Nantes. In this project, the partners focus on energy-aware task execution from the hardware to application's components in the context of a *mono-site* data center (all resources are in the same physical location) which is connected to the *regular electric Grid and to renewable energy sources* (such as windmills or solar cells). Three major challenges are addressed in this context: Optimize the energy consumption of distributed infrastructures and service compositions in the presence of ever more dynamic service applications and ever more stringent availability requirements for services; Design a clever cloud's resource management which takes advantage of renewable energy availability to perform opportunistic tasks, then exploring the trade-off between energy saving and performance aspects in large-scale distributed system; Investigate energy-aware optical ultra high-speed interconnection networks to exchange large volumes of data (VM memory and storage) over very short periods of time.

One of the strengths of the project is to provide a systematic approach, and use a single model for the system (from hard to soft) by mixing constraint programming and behavioral models to manage energy consumption in data centers.

This year, we have proposed a Cloud energy broker [26], which can adjust the availability and price combination to buy Green energy dynamically from the market to make datacenter green.

#### 8.2.1.2. *SecCloud*

**Participants:** Jacques Noyé [coordinator], Florent Marchand de Kerchove de Denterghem, Mario Südholt.

The high-level objective of the 3-year SecCloud (Secure Scripting for the Cloud) project is to enhance the security of devices on which web applications can be downloaded, i.e. to enhance client-side security in the context of the Cloud. In order to do so, the project relies on a language-based approach, focusing on three related issues:

- The definition of security policies for web architectures, especially on the client-side.
- Formally-proven analyses of web programming languages.
- Multi-level enforcement mechanisms for the security policies (based on static and dynamic analysis encompassing application-level and system-level software).

ASCOLA members are mainly interested in JavaScript as a programming language as well as the use of aspects as a seamless path from the definition of security policies and their composition to their implementation.

This year we have investigated how to extend real-world Javascript environments, such as Narcissus in a modular way.

## 8.2.2. ANR

### 8.2.2.1. MyCloud (ANR/ARPEGE)

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

The MyCloud project is an ANR/ARPEGE project running for 42 months, starting in Nov. 2010. It was accepted in Jul. 2010 for funding amounting to 190 KEUR (ASCOLA only). MyCloud involves a consortium with three academic partners (Inria, LIP6, EMN) and one industrial partner (We Are Cloud).

Cloud Computing provides a convenient means of remote on-demand and pay-per-use access to computing resources. However, its ad-hoc management of quality-of-service (QoS) and SLA poses significant challenges to the performance, dependability and costs of online cloud services.

The objective of MyCloud (<http://mycloud.inrialpes.fr>) is to define and implement a novel cloud model: SLAaaS (SLA as a Service). The SLAaaS model enriches the general paradigm of Cloud Computing and enables systematic and transparent integration of SLA to the cloud. From the cloud provider's point of view, MyCloud proposes autonomic SLA management to handle performance, availability, energy and cost issues in the cloud. From the cloud customer's point of view, MyCloud provides SLA governance allowing cloud customers to be part of the loop and to be automatically notified about the state of the cloud, such as SLA violation and cloud energy consumption.

The project ended in April 2014. This year, our main contribution is a new system for the specification of service-level agreements in the Cloud presented at the IEEE/ACM CCGrid conference [27].

### 8.2.2.2. SONGS (ANR/INFRA)

**Participants:** Adrien Lebre [coordinator], Flavien Quesnel, Jonathan Pastor.

The SONGS project (Simulation of Next Generation Systems) is an ANR/INFRA project running for 48 months (starting in January 2012 with an allocated budget of 1.8MEuro, 95KEuro for ASCOLA).

The consortium is composed of 11 academic partners from Nancy (AlGorille, coordinator), Grenoble (MESCAL), Villeurbanne (IN2P3 Computing Center, GRAAL/Avalon - LIP), Bordeaux (CEPAGE, HiePACS, RUNTIME), Strasbourg (ICPS - LSIIT), Nantes (ASCOLA), Nice (MASCOTTE, MODALIS).

The goal of the SONGS project (<http://infra-songs.gforge.inria.fr>) is to extend the applicability of the SimGrid simulation framework from Grids and Peer-to-Peer systems to Clouds and High Performance Computation systems.

## 8.2.3. FSN

### 8.2.3.1. OpenCloudware (FSN)

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

The OpenCloudware project is coordinated by France Telecom, funded by the French Fonds National pour la Société Numérique (FSN, call Cloud n°1) and endorsed by competitiveness clusters Minalogic, Systematic and SCS. OpenCloudware is developed by a consortium of 18 partners bringing together industry and academic leaders, innovative technology start-ups and open source community expertise. Duration: 36 months - 2012–2014.

The OpenCloudware project aims at building an open software engineering platform, for the collaborative development of distributed applications to be deployed on multiple Cloud infrastructures. It will be available through a self-service portal. We target virtualized multi-tier applications such as JavaEE - OSGi. The results of OpenCloudware will contain a set of software components to manage the lifecycle of such applications, from modelling(Think), developing and building images (Build), to a multi-IaaS compliant PaaS platform (Run).

The ASCOLA project-team is mainly involved in the sub-projects "Think" (SLA model across Cloud layers) and "Run" (virtual machine manager for datacenters and placement constraints). In 2013, the team has developed btrCloudStack, a private cloud based on the OpenSource CloudStack and integrating the work on placement rules and energy optimization.

## 8.3. European Initiatives

### 8.3.1. FP7 & H2020 Projects

#### 8.3.1.1. ERC Starting Grant: The CoqHoTT project

**Participant:** Nicolas Tabareau [coordinator].

CoqHoTT stands for Coq for Homotopy Type Theory. The goal of this project is to go further in the correspondence between proofs and programs which has allowed in the last 20 years the development of useful proof assistants, such as Coq (developed by Inria). This project starts from the recent discovery by field medal Vladimir Voevodsky, of the strong link between homotopy theory (which studies the notion of continuous deformation in topology) and type theory (which is at the heart of the Coq proof assistant). The main goal of the CoqHoTT project is to provide a new generation of proof assistants based on this fascinating connection.

The CoqHoTT project should start on March 2015 with a budget of 1,5M€.

#### 8.3.1.2. A4Cloud (IP)

**Participants:** Mario Südholt [coordinator], Walid Benghabrit, Ronan-Alexandre Cherrueau, Rémi Douence, Hervé Grall, Jean-Claude Royer, Mohamed Sellami.

The integrated project "Accountability for the Cloud" (A4Cloud) is coordinated by HP Labs, UK, and fosters cooperation of a consortium of five industrial and eight academic partners. It has been started in Oct. 2012 for a duration of 42 months.

A4Cloud focuses on accountability properties for the cloud and other future internet services as the most critical prerequisite for effective governance and control of corporate and private data processed by cloud-based IT services. The research being conducted in the project will increase trust in cloud computing by devising methods and tools, through which cloud stakeholders can be made accountable for the privacy and confidentiality of information held in the cloud. These methods and tools will combine risk analysis, policy enforcement, monitoring and compliance auditing. They will contribute to the governance of cloud activities, providing transparency and assisting legal, regulatory and socio-economic policy enforcement. For further information, see <http://www.a4cloud.eu>. ASCOLA, whose financial support consists of 550 K€, is mainly involved in the sub-projects on the enforcement of accountability and security policies, as well as tool validation efforts.

This year we have proposed new logic-based and language-level means for the formal specification and implementation of accountability properties (see 6.3).

## 8.4. International Initiatives

### 8.4.1. Inria Associate Teams

#### 8.4.1.1. REAL

Title: Reasoning about Aspect-oriented Programs and security In Distributed Systems

International Partner (Institution - Laboratory - Researcher):

Universidad de Chile (CHILI)

Duration: 2010-2016

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

While Aspect-Oriented Programming offers promising mechanisms for enhancing the modularity of software, this increased modularity raises new challenges for systematic reasoning. This project studies means to address fundamental and practical issues in understanding distributed aspect-oriented programs by focusing on the issue of security. To this end, the project tackles three complementary lines of work: 1. Designing a core calculus to model distributed aspect-oriented programming languages and reason about programs written in these languages. 2. Studying how aspects can be used to enforce security properties in a distributed system, based upon guarantees provided by the underlying aspect infrastructure. 3. Designing and developing languages, analyses and runtime systems for distributed aspects based on the proposed calculus, therefore enabling systematic reasoning about security. These lines of work are interconnected and confluent. A concrete outcome of RAPIDS will be prototypes for two concrete distributed aspect-oriented extensions of languages increasingly used by current practitioners: Javascript and Java/Scala.

## **8.4.2. Inria International Partners**

### *8.4.2.1. Informal International Partners*

Apart from the Inria associate team rapids with the Pleiad group (Prof. Éric Tanter) at U. Chile, the Ascola team has formalized cooperations, notably in the context of co-financed and co-supervised PhD theses with the PROG group (Prof. Wolfgang de Meuter) at VU Brussel, Belgium, and the Software Technology group (Prof. Mira Mezini) at TU Darmstadt, Germany.

Furthermore, the Ascola team has long-term cooperations that resulted in common results in 2014, typically joint publications or common software artifacts, with partners from the AIST research institute (Dr. Takahiro Hirofuchi) and U. of Bogota, Colombia (Prof. Rubby Casallas).

## **8.5. International Research Visitors**

### *8.5.1. Visits of International Scientists*

#### *8.5.1.1. Internships*

Gustavo Soto Ridd has done an Inria master internship advised by Nicolas Tabareau from August to November 2014. The goal of the internship was to go beyond the work on aspectual session types 6.4.

#### *8.5.1.2. Researchers*

Dr. Takahiro Hirofuchi, Researcher at AIST (Japan) spent one week in June 2014 to prepare a journal submission related to the Virtualization extensions we made in 2013 in Simgrid. The article is under review.

## ASPI Project-Team

# 7. Partnerships and Cooperations

## 7.1. National Initiatives

### 7.1.1. *PDMP Inférence, Évolution, Contrôle et Ergodicité (PIECE) — ANR Jeunes Chercheuses et Jeunes Chercheurs*

**Participant:** Florent Malrieu.

*January 2013 to December 2016.*

Piecewise deterministic Markov processes (PDMP) are non-diffusive stochastic processes which naturally appear in many areas of applications as communication networks, neuron activities, biological populations or reliability of complex systems. Their mathematical study has been intensively carried out in the past two decades but many challenging problems remain completely open. This project aims at federating a group of experts with different backgrounds (probability, statistics, analysis, partial derivative equations, modelling) in order to pool everyone's knowledge and create new tools to study PDMPs. The main lines of the project relate to estimation, simulation and asymptotic behaviors (long time, large populations, multi-scale problems) in the various contexts of application.

### 7.1.2. *Advanced Geophysical Reduced-Order Model Construction from Image Observations (GERONIMO) — ANR Jeunes Chercheuses et Jeunes Chercheurs*

**Participant:** Patrick Héas.

*March 2014 to February 2018.*

The GERONIMO project aims at devising new efficient and effective techniques for the design of geophysical reduced-order models (ROMs) from image data. The project both arises from the crucial need of accurate low-order descriptions of highly-complex geophysical phenomena and the recent numerical revolution which has supplied the geophysical scientists with an unprecedented volume of image data. Our research activities are concerned by the exploitation of the huge amount of information contained in image data in order to reduce the uncertainty on the unknown parameters of the models and improve the reduced-model accuracy. In other words, the objective of our researches is to process the large amount of incomplete and noisy image data daily captured by satellites sensors to devise new advanced model reduction techniques. The construction of ROMs is placed into a probabilistic Bayesian inference context, allowing for the handling of uncertainties associated to image measurements and the characterization of parameters of the reduced dynamical system.

## 7.2. International Initiatives

### 7.2.1. *Inria International Partners*

Arnaud Guyader collaborates with the group of Nicolas Hengartner at Los Alamos National Laboratories, on the development of fast algorithms to simulate rare events, and on iterative bias reduction techniques in nonparametric estimation. This collaboration has a long record of bilateral visits.

## ATLANMOD Project-Team

# 7. Partnerships and Cooperations

## 7.1. Regional Initiatives

Program: **Pole Images et Reseaux - Appel Projets PME 2011**

Project title: StreamMaster

Duration: 2012 - 2014

Coordinator: Data Syscom

Other partners: Research and University (University of Nantes, Ecole de Design Nantes Atlantique, ESC Rennes) and Vendors and service providers (IMINFO)

Abstract: The purpose of the StreamMaster project is creating a universal software solution for the smart management of document streams, providing an added value over all the chain. StreamMaster will provide: an hybrid (local and remote) technological platform to allow user access, the possibility of connection to every information system and every input and output stream, the management of all the parameters of the document stream (cost, speed, delay, quality, environmental impact), security and reinforced document authentication mechanisms, non-falsifiable documents by means of invisible document tatooing, an innovative and multimodal HMI.

Program: **Pays de la Loire regional funding, Call: Creation of new teams**

Project title: AtlanMod New Team Creation

Duration: 2011 - 2014

Coordinator: AtlanMod

Other partners: None

Abstract: AtlanMod has been funded by the Pays de la Loire Regional Council new research teams program. This funding will mainly cover a PhD Student and two years of a postdoc to work on the quality of models research line.

## 7.2. National Initiatives

### 7.2.1. FUI

Program: **FUI - AAP 15**

Project acronym: MoNoGe

Project title: Atelier de Modélisation de Nouvelle Génération

Duration: 2013 - 2016

Coordinator: Softeam

Other partners: Industry (DCNS), Research and University (ARMINES AtlanMod, LIP6) and Vendors and service providers (Softeam, Soft-Maint, Mia-Software)

Abstract: There is currently in companies a wide diversity of models and modeling tools according to the application domains, services or contexts which are concerned. This implies different problems forbidding their plain exploitation: traceability, global coherence, continuity between works, knowledge management, etc. All are largely penalized by this situation that harms the mastering of the complexity of the related systems and software. The MoNoGe project has for objective to bring innovative solutions allowing to ensure the agility of the models and modeling tools. The term agility is here referring to the properties of interoperability, extensibility and evolution of models. The dynamic extension mechanism to be developed in MoNoGe, potentially inspiring from the OMG MEF

standard currently under definition, is intended to preserve the original metamodel which can be conserved, partially hidden or extended. Thus, the legacy data and models can stay operational with the extended metamodel. The user does not have to deal with heavy migration or conversion operations, and can this way focus on its modeling activities while continuously exploiting past models. Our focus within the project is on defining conceptually such a (meta)model extension solution and proposing an implementing prototype based on Eclipse/EMF. To this intent, we are already studying the potential reuse (and improvement) of our EMF Views prototype in this given context.

**Program: FUI - AAP 13**

Project acronym: TEAP

Project title: TOGAF Enterprise Architecture Platform

Duration: 2012 - 2014

Coordinator: Obeo

Other partners: Industry (DCNS), Research and University (Inria AtlanMod) and Vendors and service providers (Obeo, Capgemini)

Abstract: The fast evolution of technologies (SOA, Cloud, mobile environments), the systems complexity and the growing need for agility require to be able to represent information systems as a whole. The high-level approach promoted by Enterprise Architecture (EA) is a key element in this context and intends to address all the systems dimensions: software components, associated physical resources, relationships with the companies requirements and business processes, implied actors/roles/structures, etc. The objective of the TEAP project was to specify and implement an EA platform based on the Open Group international standard named TOGAF and on the SmartEA technical solution. In addition to its base modeling capabilities, this platform now allows data federation from different existing sources (e.g. for reverse engineering purposes such as retro-cartography) as well as the definition of possible transformation chains (for governance and modernization). As part of this project, we have been notably using in practice (and improving accordingly) some of our works and corresponding prototypes such as EMF Views, ATL or some MoDisco components.

**Program: FUI - AAP 13**

Project acronym: ITM Factory

Project title: Information Technology Modernisation Factory

Duration: 04/2012 - 10/2014

Coordinator: Soft-Maint (Groupe SODIFRANCE)

Other partners: Mia-Software (Groupe SODIFRANCE), ACAPNOS, MMA and Inria AtlanMod.

Abstract: Application maintenance represents about 80 per cent of the computer market (at the French and global level). The challenge of software maintenance is to keep running applications with technologies that are no longer required to be maintained and with changing development teams and whose skills are not always validated on ancient languages. The main goal of the ITM Factory is to propose a software modernization framework, based on the ModDisco project and including: (i) an integrated workbench for software modernization engineers and (ii) a set of ready to use modernization cartirdges, i.e., a solution brick that meets a business challenge level, as opposed to a technical bricks that provides technical solutions that are integrated into a business solution.

## **7.3. European Initiatives**

### **7.3.1. FP7 & H2020 Projects**

#### **7.3.1.1. ARTIST**

Type: COOPERATION



Defi: Cloud Computing, Internet of Services and Advanced Software engineering

Instrument: Integrated Project

Duration: October 2012 - September 2015

Coordinator: Clara Pezuela (ATOS Spain)

Partner: ATOS and TECNALIA (Spain), Inria AtlanMod (France), Fraunhofer (Germany), TU Wien and Sparks (Austria), ENGINEERING (Italy), Spikes (Belgium), ATC and ICCS (Greece)

Inria contact: Hugo Bruneliere

Abstract: Nowadays Cloud Computing is considered as the ideal environment for engineering, hosting and provisioning applications. A continuously increasing set of cloud-based solutions is available to application owners and developers to tailor their applications exploiting the advanced features of this paradigm for elasticity, high availability and performance. Even though these offerings provide many benefits to new applications, they often incorporate constraints to the modernization and migration of legacy applications by obliging the use of specific development technologies and explicit architectural design approaches. The modernization and adaptation of legacy applications to cloud environments is a great challenge for all involved stakeholders, not only from the technical perspective, but also in business level with the need to adapt the business processes and models of the modernized application that will be offered from now on, as a service. The purpose of the ARTIST project is to propose and develop a novel model-driven approach for the migration of legacy applications in modern cloud environments which covers all aspects and phases of the migration process, as well as an integrated framework that supports all migration process.

#### 7.3.1.2. MONDO

Title: Scalable Modelling and Model Management on the Cloud

Type: COOPERATION (ICT)

Defi: Cloud Computing, Internet of Services and Advanced Software engineering

Instrument: Small or medium-scale focused research project (STREP)

Duration: November 2013 - May 2016

Coordinator: The Open Group - X/Open Company

Partners: The Open Group - X/Open Company (United Kingdom), University of York (United Kingdom), Universidad Autonoma de Madrid (Spain), Budapest University of Technology and Economics (Hungary), IKERLAN (Spain), MIA Software (France), Cassidian (Germany)

Inria contact: Massimo Tisi

Abstract: As Model Driven Engineering (MDE) is increasingly applied to larger and more complex systems, the current generation of modelling and model management technologies are being pushed to their limits in terms of capacity and efficiency, and as such, additional research is imperative in order to enable MDE to remain relevant with industrial practice and continue delivering its widely recognised productivity, quality, and maintainability benefits. The aim of MONDO is to tackle the increasingly important challenge of scalability in MDE in a comprehensive manner. Achieving scalability in modelling and MDE involves being able to construct large models and domain specific languages in a systematic manner, enabling teams of modellers to construct and refine large models in a collaborative manner, advancing the state-of-the-art in model querying and transformations tools so that they can cope with large models (of the scale of millions of model elements), and providing an infrastructure for efficient storage, indexing and retrieval of large models. To address these challenges, MONDO brings together partners with a long track record in performing internationally-leading research on software modelling and MDE, and delivering research results in the form of robust, widely-used and sustainable open-source software, with industrial partners active in the fields of reverse engineering and systems integration, and a global consortium including more than 400 organisations from all sectors of IT.

#### 7.3.1.3. Automobile

Title: Automated Mobile App Development

Type: Research For SMEs

Duration: November 2013 - October 2015

Coordinator: WebRatio s.r.l.

Partners: WebRatio, Politecnico di Milano (Italy), AtlanMod-Armines, Moon Submarine (UK), ForwardSoftware (Romania).

Inria contact: Jordi Cabot

Abstract: The AutoMobile project aims at designing and bringing to the market innovative methodologies, software tools, and vertical applications for the cost-effective implementation of cross-platform, multi-device mobile applications, i.e. business applications that can be accessed by users on a variety of devices and operating systems, including PC, cellular / smart phones and tablets.

Cross-platform and multi-device design, implementation and deployment is a barrier for today's IT solution providers, especially SME providers, due to the high cost and technical complexity of targeting development to a wide spectrum of devices, which differ in format, interaction paradigm, and software architecture.

AutoMobile will exploit the modern paradigm of Model-Driven Engineering and code generation to dramatically simplify multi-device development, reducing substantially cost and development times, so as to increase the profit of SME solution providers and at the same time reduce the price and total cost of ownership for end-customers.

AutoMobile will rely on modeling languages such as IFML (Interaction Flow Modeling Languages) and on tools like WebRatio.

### **7.3.2. Collaborations in European Programs, except FP7 & H2020**

Program: CORE Multi-annual thematic research programme. Fonds National de la Recherche Luxembourg.

Project acronym: TOOM

Project title: Testing Orders of Magnitude

Duration: September 2013 - August 2015

Coordinator: SnT/University of Luxembourg

Other partners: the iTrust company, EBRC, Inria Rennes/University of Nantes and the UFPR (Brazil).

Abstract: Over the last decade, large-scale systems drew much attention due to scalability and resiliency features. Many popular large-scale data-oriented systems (i.e., BigData), including, Peer-to-peer (P2P) and MapReduce, reached millions of users and processed petabytes of data, such as: Hadoop, Skype, Bittorrent, and Gnutella. The main reason is due to a decentralized manner to remove potential performance bottlenecks and centralized points of failure. Recently, cloud computing is gathering all these BigData systems underneath its layers (e.g. Paas, Saas, Iaas) to free developers from large-scale issues, such as: deployment, distribution, resiliency, security, and performance. Several companies around the globe rely on cloud computing to build robust and reliable services for their business operations (e.g. eBay, Amazon, Skype) mainly to handle heavy load conditions (e.g. seasonal sales, Internet-scale malicious attacks). Testing robustness and reliability of cloud computing services is a hard activity, the state of the art shows that the existing testing techniques suffer to handle aspects, such as: the scale of the cloud, the dynamism of the nodes, and the amount of data and load. In general, these testing techniques rely on a combination of unit tests with some mocking approach that may hide the cloud aspects and may not be suited for large-scale testing. The TOOM project is planned to present a solution for testing robustness of cloud computing services built on top of P2P technology to address scalability and dynamism aspects. The main contributions lie on two main steps. The first one is to validate the overall resilience

and reliability of cloud services. The second one is to reproduce large-scale stress loads, such as Distributed Denial of Service (DDoS) and peak loads, either gathered from the real load traces or synthetically generated. We plan to leverage data warehouse technology to house real load traces and use them during testing. To generate synthetic loads, we plan to use known load patterns or adapt them to new load trends. To assess the effectiveness of the TOOM outcomes, we will reproduce stress loads submitted by P2P technology across the cloud infrastructure on top of step-stress testing methodologies. In this manner, we can progressively increase the load in orders of magnitude up to a peak load. Then, we will measure the effectiveness either by code coverage whether the SUT is open-source, by the quality of service (QoS) of the SUT, or by the coverage of network and computing components used by the cloud computing services.

## **7.4. International Initiatives**

### **7.4.1. Inria International Partners**

#### *7.4.1.1. Informal International Partners*

The four main research partners of the team are:

- Politecnico di Milano (Italy) - DB Group, specially with Marco Brambilla
- TU Wien (Austria) - BiG Group, specially Manuel Wimmer
- Politecnica de Catalunya (Spain) - GESSI Group, specially Xavier Franch
- Universitat Poliècnica de València (Spain) - ISSI Group, specially José H. Canós

## **7.5. International Research Visitors**

### **7.5.1. Visits of International Scientists**

Javier Criado (University of Almeria, Spain), June-July

#### *7.5.1.1. Internships*

Rolandi, María Belén

Subject: Democracy in Open Source projects

Date: from May 2014 until Oct 2014

Institution: Universidad Nacional del Centro de la Provincia de Buenos Aires (Argentina)

### **7.5.2. Visits to International Teams**

#### *7.5.2.1. Research stays abroad*

In March, M. Tisi visited the National Institute of Informatics (NII) of Tokyo, Japan, for one month, in the frame of a collaboration on bidirectionalization of model-transformation languages.

## CAIRN Project-Team

# 8. Partnerships and Cooperations

## 8.1. Regional Initiatives

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

**Participants:** Raphaël Bardoux, Arnaud Carer, Matthieu Gautier, Olivier Sentieys.

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

## 8.2. National Initiatives

The CAIRN team mainly collaborates with the following laboratories: CEA List, CEA Leti, LEAT Nice, Lab-Sticc (Lorient, Brest), LIRMM (Montpellier, Perpignan), LIP6 Paris, IETR Rennes, DTIM-ONERA Toulouse, LAAS Toulouse, IRIT Toulouse, Inria Socrate.

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

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

### 8.2.1. *ANR Blanc - PAVOIS (2012–2016)*

**Participants:** Arnaud Tisserand, Emmanuel Casseau, Philippe Quémerais, Jérémie Métairie, Nicolas Veyrat-Charvillon, Karim Bigou.

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

### 8.2.2. *ANR INFRA 2011 - FAON (2012-2015)*

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

The FAON (Frequency based Access Optical Networks) project objectives are to demonstrate the technology and feasibility of a new type of Passive Optical Network (PON) for broadband access which uses a Frequency based shared access technique known as Frequency Division Multiplexing (FDM). These goals completely fall into the line of the expected capacity increase in PON which is today forecasted to go from 100 Mbps per user to 1 Gbps. For more details, see [http://www.agence-nationale-recherche.fr/en/anr-funded-project/?tx\\_jwmsuivibilan\\_pi2\[CODE\]=ANR-11-INFR-0005](http://www.agence-nationale-recherche.fr/en/anr-funded-project/?tx_jwmsuivibilan_pi2[CODE]=ANR-11-INFR-0005). Faon involves Orange Labs, CEA-LETI, University of South Brittany (Lab-STICC laboratory) and Univ. Rennes I (Foton laboratory and CAIRNteam). CAIRNaims at developing a high-rate architecture at the receiver side. Specific receiver algorithms (synchronization and equalization) and FPGA implementation are the key issues that will be addressed.

### 8.2.3. Equipex FIT - Future Internet (of Things)

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

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

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

**Participants:** Arnaud Tisserand, Philippe Quémerais.

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

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

**Participants:** Emmanuel Casseau, Steven Derrien, Antoine Courtay, Mythri Alle, Yaset Oliva Venegas.

COMPA (model oriented design of embedded and adaptive multiprocessor) is a project which involves CAIRN, IETR (Rennes) and Lab-STICC (Lorient). The aim of the project is to design adaptive multiprocessor embedded systems for executing dataflow programs. The use case is the Reconfigurable Video Coding (RVC) standard. More specifically, we focus on the portable and platform-independent RVC-CAL language to describe the applications. We use transformations to refine, increase parallelism and translate the application model into software and hardware components. Specific scheduling and actor's mapping are also investigated for runtime execution. For more details see <http://www.compa-project.org>.

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

**Participants:** Olivier Sentieys, Romuald Rocher, Nicolas Simon.

DEFIS (Design of fixed-point embedded systems) is a project which involves CAIRN, LIP6 (University of Paris 6), LIRMM (University of Perpignan), CEA LIST, Thales, Inpixon. The main objectives of the project are to propose new approaches to improve the efficiency of the floating-point to fixed-point conversion process and to provide a complete design flow for fixed-point refinement of complex applications. This infrastructure will reduce the time-to-market by automating the fixed-point conversion and by mastering the trade-off between application quality and implementation cost. Moreover, this flow will guarantee and validate the numerical behavior of the resulting implementation. The proposed infrastructure will be validated on two real applications provided by the industrial partners. For more details see <http://defis.lip6.fr>.

### 8.2.7. Labex CominLabs - BoWI (2014-2018)

**Participants:** Olivier Sentieys, Antoine Courtay, Olivier Berder, Pascal Scalart, Arnaud Carer, Viet-Hoa Nguyen, Zhongwei Zheng.

The BoWi project (Body World Interactions) aims at designing an accurate gesture and body movement estimation using very-small and low-power wearable sensor nodes. It initially stems from a proposal of the CominLabs think tank focused on the society challenge called Digital Environment for the Citizen. It is also related to the social challenge ICT for Personalized Medicine and to the research track Energy Efficiency in ICT. The main objective of the project is to propose pioneer interfaces for an emerging interacting world based on smart environments (house, media, information and entertainment systems...). Basically the project relies on Wireless Body Areas Sensor Networks; the aim is the accurate Gesture and Body Movement estimation with extremely severe constraints in terms of footprint and power consumption according to on-body energy harvesting perspectives. The BoWi geolocation approach will combine radio communication distance measurement and inertial sensors and it will also strongly benefit from cooperative techniques based on multiple observations and distributed computation. Different types of applications, as health care, activity monitoring and environment control, will be considered and evaluated along with a human-machine interface expertise.

The scientific challenge is global and deals with the solution to be interactively invented by all partners: a short-range geolocation method based on distributed and cooperating devices processing multisource data issued from radio-communication distance estimation and integrated inertial sensors. It includes several specific contributions:

- Dynamic and cooperative communication coding and protocol for inter-nodes communications. This includes cooperative communications and protocols such as cooperative MIMO, relaying, error coding, network coding and MAC and wake-up radio protocols.
- Node hardware/software architecture design and self-adaptive distributed processing for geolocation with aggressive low-power run-time optimisation.
- Channel models and antennas for short-range communications. This study will be performed for various radio standards from upcoming BAN 802.15.6, 802.15.4a technologies to future UWB solutions.
- Channel models and antennas for WBASN at millimeter waves. This is a promising perspective for antenna miniaturization, however no front-ends are yet available.
- In depth and specific analysis of human-machine interactions to set system constraints and define user requirement according to various application perspectives.

In practice the BoWi partners aim to deliver the design of basic components, a prototype based on available radio front-ends and energy harvesting devices as well as a system simulator including mm-wave models. Results will also concern the specification of future radio-front ends. The BoWi involves CAIRN, IETR (Rennes), and Lab-STICC (Brest, Lorient, Vannes). For more details see <http://www.bowi.cominlabs.ueb.eu/fr>.

### 8.2.8. Labex CominLabs - 3DCORE (2014-2018)

**Participants:** Olivier Sentieys, Daniel Chillet, Cédric Killian, Jiating Luo, Van Dung Pham.

3DCORE (3D Many-Core Architectures based on Optical Network on Chip) is a project which involves CAIRN, FOTON (Rennes, Lannion) and Institut des Nanotechnologies de Lyon. 3D integration in the ultra deep submicron domain means the implementation of billions of transistors or of hundreds of cores on a single chip with the need to ensure a large number of exchanges between cores, and the obligation to limit the power consumption. Focusing on system integration rather than transistor density, allows for both functional and technological diversification in integrated systems. The functional diversification allows for non-digital functionalities to migrate from the board level into the (on-)chip level. This allows for integration of new technologies that enable high performance, low power, high reliability, low cost, and high design productivity. Use of Optical Network-on-Chip (ONoC) promises to deliver significantly increased bandwidth, increased immunity to electromagnetic noise, decreased latency, and decreased power consumption while wavelength routing and Wavelength Division Multiplexing (WDM) contributes to the valuable properties of optical interconnect by permitting low contention or even contention free routing. WDM allows for multiple signals to be transmitted simultaneously, facilitating higher throughput. Individual realization of CMOS compatible optical components, such as, waveguides, modulators, and detectors lets the community foresee that such integration may be possible in the next ten years. The aim of the project is therefore to investigate new optical interconnect solutions to enhance by 2 to 3 magnitude orders energy efficiency and data rate of on-chip interconnect in the context of a many-core architecture targeting both embedded and high-performance computing. Moreover, we envisage taking advantage of 3D technologies for designing a specific photonic layer suitable for a flexible and energy efficient high-speed optical network on chip (ONoC).

#### 8.2.9. *Labex CominLabs - RELIASIC (2014-2018)*

**Participants:** Emmanuel Casseau, Arnaud Tisserand, Huu Van Long Nguyen.

RELIASIC (Reliable Asic) is a project which involves CAIRN, Lab-STICC (University of Bretagne Sud) and IETR (Institut d'Electronique et de Télécommunications de Rennes). One of the most critical challenges of the next design technologies will be fault-tolerant computation. The increase in integration density and the requirement of low-energy consumption can only be sustained through low-powered components, with the drawback of a looser robustness against transient errors. In the near future, electronic gates to process information will be inherently unreliable. New techniques will be required to increase the reliability of operators and components. The aim of the project is to address this problem with a bottom-up approach, starting from an existing application as a use case (a GPS receiver) and adding some redundant mechanisms to allow the GPS receiver to be tolerant to transient errors due to low voltage supply.

#### 8.2.10. *Labex CominLabs & Lebesgue - H-A-H (2014-2017)*

**Participants:** Arnaud Tisserand, Nicolas Veyrat-Charvillon, Karim Bigou, Gabriel Gallin.

H-A-H for *Hardware and Arithmetic for Hyperelliptic Curves Cryptography* is a project on advanced arithmetic representation and algorithms for hyper-elliptic curve cryptography. It involves IRISA-CAIRN(Lannion) and IRMAR (Rennes).

Arithmetic has an important role to play in providing algorithms robust against physical attacks (e.g., analysis of the power consumption, electromagnetic radiations or computation timings). Currently, there are only a very few hardware implementations of HECC (without any open source availability). This project will provide novel implementations of HECC based cryptographic algorithms on custom hardware platforms. For more details see <http://h-a-h.inria.fr/>.

### 8.3. European Initiatives

#### 8.3.1. *FP7 FLEXILES*

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

Program: FP7-ICT-2011-7

Project acronym: Flexiles

Duration: Oct. 2011 - Mar. 2015

Coordinator: Thales

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

Project title: Self Adaptive Heterogeneous Manycore Based on Flexible Tiles

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

### 8.3.2. FP7 ALMA

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

Program: FP7-ICT-2011-7

Project acronym: Alma

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

Duration: Sep. 2011 - Nov. 2014

Coordinator: KIT

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

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



## 8.4. International Initiatives

### 8.4.1. Inria Associate Teams

#### 8.4.1.1. HARDIESSE

Title: Heterogeneous Accelerators for Reconfigurable Dynamic, Energy efficient, Secure Systems  
International Partner (Institution - Laboratory - Researcher):

University of Massachusetts at Amherst (USA)

Duration: 2014 - 2016

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

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

### 8.4.2. Inria International Partners

#### 8.4.2.1. Declared Inria International Partners

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

Department of Computer Science, Lund University (Sweden), Prof. Krzysztof Kuchcinski, Hardware accelerators modeling using constraint-based programming.

Tampere University of Technology (Finland), Prof. Jarmo Takala, From dataflow-based video applications to embedded multicore platforms.

University College Cork (Ireland), Prof. Liam Marnane and Prof. Emanuel Popovici, Arithmetic operators for cryptography, side channel attacks for security evaluation, energy-harvesting sensor networks, and sensor networks for health monitoring.

University of Massachusetts at Amherst (USA), Prof. Russel Tessier and Prof. Maciej Ciesielski, Methods and tools for automatic reconfigurable arithmetic circuit generation.

#### 8.4.2.2. Informal International Partners

Imec (Belgium), Optimization of embedded systems using fixed-point arithmetic.

Electrical Engineering Department, Indian Institute of Technology Delhi (India), Cooperative and MIMO wireless communications.

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

Technical University of Madrid - UPM (Spain),

Optimization of embedded systems using fixed-point arithmetic.

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

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

Department of Electrical and Computer Engineering, University of Patras (Greece), Wireless Sensor Networks, data merging, priority scheduling, loop transformations for memory optimizations.

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

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

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

### 8.4.3. Participation In other International Programs

#### 8.4.3.1. CNRS PICS - SPiNaCH (2012 - 2014)

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

Principal investigator: Arnaud Tisserand, Olivier Berder, Olivier Sentieys

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

Duration: 2012 - 2014

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

## 8.5. International Research Visitors

### 8.5.1. Visits of International Scientists

Prof. Liam Marnane (University College Cork, Ireland) for one week in November (funded by CNRS PICS SpiNaCH project).

Fiona Edwards-Murphy, PhD student, (University College Cork, Ireland) for two weeks in September (funded by CNRS PICS SpiNaCH project).

Prof. Sanjay Rajopadhye (Colorado State University, USA) for one week in June (visiting professor position from University Rennes 1).

#### 8.5.1.1. Internships

Singh Rajhans, B.Eng. student, Indian Institute of Technology Roorkee (Roorkee, India), Intrinsic Fault Tolerance of Hopfield Artificial Neural Network Model for task scheduling in RSoC, from May 2014 to July 2014 [63].

Jiating Luo, Master's student, École centrale de Pékin (Beijing, China), Design of a Wavelength Allocator for Optical Network-on-Chips, from May 2014 to Sep 2014.

### 8.5.2. Visits to International Teams

Viet Hoa Nguyen, PhD student, visited IIT Delhi for 3 months between October and December 2014.

Christophe Hurliaux, PhD student, visited UMASS for 3 months between May and July 2014.

Steven Derrien visited UMASS for 1 week in December 2014.

## CELIQUE Project-Team

# 6. Partnerships and Cooperations

## 6.1. National Initiatives

### 6.1.1. *The PiCoq ANR project*

**Participants:** Alan Schmitt, Petar Maksimovic.

Process calculi, Verification, Proof Assistants

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

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

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

### 6.1.2. *The ANR VERASCO project*

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

Static program analysis, Certified static analysis

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

### 6.1.3. *The ANR Binsec project*

**Participants:** Frédéric Besson, Sandrine Blazy, Pierre Wilke, Colas Le Guernic.

Binary code, Static program analysis

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

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

#### 6.1.4. *The ANR MALTHY project*

**Participant:** David Cachera.

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

#### 6.1.5. *The ANR AJACS project*

**Participants:** Martin Bodin, Thomas Jensen, Alan Schmitt.

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

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

#### 6.1.6. *The ANR DISCOVER project*

**Participants:** Sandrine Blazy, Delphine Demange, Thomas Jensen, David Pichardie.

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

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

The project runs from October 2014 to September 2018.

#### 6.1.7. *Labex COMIN Labs Seccloud project*

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

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

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

## 6.2. International Initiatives

### 6.2.1. Inria Associate Teams

#### 6.2.1.1. JCERT

Title: Verified Compilation of Concurrent Managed Languages

International Partner (Institution - Laboratory - Researcher):

Purdue University (ÉTATS-UNIS)

Duration: 2014 -

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

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

### 6.2.2. Inria International Partners

#### 6.2.2.1. Informal International Partners

Yann Salmon spent one month in Luke Ong's group at Oxford University (UK) between january and february. The objective of this stay was, on the one side, to promote Yann's work on strategy-dependant analysis of functional programs and, on the other side, to learn from Luke Ong's group on the analysis principles for higher-order functions.

##### 6.2.2.1.1. JSCert

The JSCert project is an informal collaboration between Inria (Celtique and Toccata teams) and Imperial College. Alan Schmitt (Celtique) and Arthur Charguéraud (Toccata) are external collaborators for the "Certified Verification of Client-Side Web Programs" EPSRC project, led by Imperial College. Sergio Maffei and Philippa Gardner are external collaborators for the "AJACS" ANR project, led by Inria.

## 6.3. International Research Visitors

### 6.3.1. Visits to International Teams

#### 6.3.1.1. Sabbatical programme

Jensen Thomas

Date: Sep 2014 - Aug 2015

Institution: [University of Copenhagen, Denmark](#)

Pichardie David

Date: Sep 2011 - Aug 2012

Institution: [Purdue University](#) (PAYS???)

#### 6.3.1.2. Explorer programme

Salmon Yann

Date: Jan 2014 - Feb 2014

Institution: [University of Oxford](#) (UK)

## CIDRE Project-Team

# 8. Partnerships and Cooperations

## 8.1. Regional Initiatives

- **Région Bretagne ARED grant:** the PhD of Regina Marin on privacy protection in distributed social networks is supported by a grant from the Région Bretagne.
- **Labex COMINLAB contract (2012-2015): “POSEIDON”** - <http://www.poseidon.cominlabs.ueb.eu/fr/>

POSEIDON deals with the protection of data in outsourced or shared systems such as cloud computing and peer-to-peer networks. While these approaches are very promising solutions to outsource storage space, contents, data and services, they also raise serious security and privacy issues since users lose their sovereignty on their own data, services and systems. Instead of trying to prevent the bad effects of the cloud and of peer-to-peer systems, the main objective of the POSEIDON project is to turn benefit from their main characteristics (distribution, decentralization, multiple authorities, etc.) to improve the security and the privacy of the users' data, contents and services.

This project is conducted in cooperation with Télécom Bretagne and Université de Rennes I. The PhD of Julien Lolive (co-supervised by Sébastien Gambs and Caroline Fontaine), which deals with the entwining of identification and privacy mechanisms, is funded by the POSEIDON project. The postdoctoral researcher of Wei Pan (co-supervised by Gouenou Coatrieux and Nicolas Prigent) that deals with a distributed system to ensure patients' privacy in the context of medical imaging is also funded by this project.

- **Labex COMINLAB contract (2012-2015): “SecCloud”** - <http://www.seccloud.cominlabs.ueb.eu>

Nowadays attacks targeting the end-user and especially its web browser constitute a major threat. Indeed web browsers complexity has been continuously increasing leading to a very large attack surface. Among all possible threats, we tackle in the context of the SecCloud project those induced by client-side code execution (for example javascript, flash or html5).

Existing security mechanisms such as os-level access control often only rely on users identity to enforce the security policy. Such mechanisms are not sufficient to prevent client-side browser attacks as the web browser is granted the same privileges as the user. Consequently, a malicious code can perform every actions that are allowed to the user. For instance, it can read and leak user private data (credit card numbers, registered passwords, email contacts, etc.) or download and install malware.

One possible approach to deal with such threats is to monitor information flows within the web browser in order to enforce a security information flow policy. Such a policy should allow to define fine-grained information flow rules between user data and distant web sites. This implies to propose an approach and to design and implement a mechanism that can handle both OS-level and browser-level information flows.

Dynamically monitoring information flow at the web browser level may dramatically impact runtime performances of executed codes. Consequently, an important aspect of this work will be to benefit as far as possible from static analysis of application code. This static-dynamic hybrid approach should reduce the number of verifications performed at run time.

This study is conducted in cooperation with other Inria Teams (Ascola and Celtique). Deepak Subramanian is doing his PhD in the context of this project.

- **Labex COMINLAB contract (2013-2016): “DeScENt”** - <http://www.descent.cominlabs.ueb.eu>

In DeScENt, we propose to investigate how decentralized home-based networks of plug computers can support personal clouds according to sound architectural principles, mechanisms, and programming abstractions. To fulfill this vision we see three core scientific challenges, which we think must be overcome. The first challenge, decentralized churn-poor design, arises from the nature of plug federations, which show much lower levels of churn than traditional peer-to-peer environments. The second challenge, quasi-causal consistency, is caused by the simultaneous needs to produce a highly scalable environment (potentially numbering millions of users), that also offers collaborative editing capabilities of mutable data-structures (to offer rich social interactions). The third and final challenge, intuitive data structures for plug programming, arises from the need by programmers for intuitive and readily reusable data-structures to rapidly construct rich and robust decentralized personal cloud applications.

This study is conducted in cooperation with other teams (GDD Team (University of Nantes), Inria team ASAP)

- **Labex COMINLAB contract (2014-2017): “Kharon-Security”** - <http://www.securite.cominlabs.ueb.eu/>

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

In the project we aim to imagine and develop a malware scanning service that will permit users to analyze their own applications. This service will be available on a online platform that will also deliver previously computed signatures of known malware.

Project members are from Celtique and Cidre Inria teams.

## 8.2. National Initiatives

### 8.2.1. ANR

- **ANR INS Project: AMORES (2011-2015)** - <http://amores-project.org/>

Situated in the ubiquitous context characterized by a high mobility of individuals, most of them wearing devices capable of geolocation (smartphones or GPS-equipped cars), the AMORES project is built around three use-cases related to mobility, namely (1) dynamic carpooling, (2) real-time computation of multi-modal transportation itineraries and (3) mobile social networking. For these three use cases, the main objective of the AMORES project is to define and develop geo-communication primitives at the middleware level that can offer the required geo-located services, while at the same time preserving the privacy of users, in particular with respect to their location (notion of geo-privacy). Within this context, we study in particular the problem of anonymous routing and the design of a key generation protocol tied to a particular geographical location. Each of these services can only work through cooperation of the different entities composing the mobile network. Therefore, we also work on the development of mechanisms encouraging entities to cooperate together in a privacy-preserving manner. The envisioned approach consists in the definition of generic primitives such as the management of trust and the incentive to cooperation.

This project is joint between the Université de Rennes I, Supélec, LAAS-CNRS, Mobigis and Tisséo. The research project AMORES received the Innovation Award at the Toulouse Space Show in June 2013. Simon Boche and Paul Lajoie-Mazenc are doing their PhD in the context of this project.

- **ANR INS Project: LYRICS (2011-2015) - <http://projet.lyrics.orange-labs.fr/>**

With the fast emergence of the contactless technology such as NFC, mobile phones will soon be able to play the role of e-tickets, credit cards, transit pass, loyalty cards, access control badges, e-voting tokens, e-cash wallets, etc. In such a context, protecting the privacy of an individual becomes a particularly challenging task, especially when this individual is engaged during her daily life in contactless services that may be associated with his identity. If an unauthorized entity is technically able to follow all the digital traces left behind during these interactions then that third party could efficiently build a complete profile of this individual, thus causing a privacy breach. Most importantly, this entity can freely use this information for some undesired or fraudulent purposes ranging from targeted spam to identity theft. The objective of LYRICS (ANR INS 2011) is to enable end users to securely access and operate contactless services in a privacy-preserving manner that is, without having to disclose their identity or any other unnecessary information related to personal data. Within this project, we work mainly on the privacy analysis of the risks incurred by users of mobile contactless services as well as on the development of the architecture enabling the development of privacy-preserving mobile contactless services. The project is joint between France Télécom, Atos Worldline, CryptoExperts, ENSI Bourges, ENSI Caen, MoDyCo, Oberthur Technologies, NEC Corporation, Microsoft and Université de Rennes I.

The project was originally suppose to end in 2014 but an extension was granted until May 2015. The project has finished to develop a first prototype that illustrates how can be used privacy preserving protocols for the transport use case. The prototype implements a transportation pass (similar to the Navigo pass) embedded in the SIM card. This transport pass can be interact with a gate at the entrance of the transportation network in order to check the validity of the pass and answers wirelessly, in less than 300ms, without revealing any information about the user. This result has been presented in "Salon Cartes 2012", in [21], and in several French newspapers. It will be published at the end of 2014 in [15]. During 2014, the partners of the LYRICS projects have also worked on two new use cases and their corresponding prototypes: digital surveys and e-cash solutions that respect the privacy of users.

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

SocioPlug is a collaborative ANR project involving Inria (ASAP and CIDRE teams), the Nantes University, and LIRIS (INSA Lyon and Université Claude Bernard Lyon). The project emerges from the observation that the features offered by the Web 2.0 or by social media do not come for free. Rather they bring the implicit cost of privacy. Users are more of less consciously selling personal data for services. SocioPlug aims to provide an alternative for this model by proposing a novel architecture for large-scale, user centric applications. Instead of concentrating information of cloud platforms owned by a few economic players, we envision services made possible by cheap low-end plug computers available in every home or workplace. This will make it possible to provide a high amount of transparency to users, who will be able to decide their own optimal balance between data sharing and privacy.

### 8.2.2. Inria Project Labs

- **CAPPRIS (2012-2016)**

CAPPRIS stands for "Collaborative Action on the Protection of Privacy Rights in the Information Society". The main objective of CAPPRIS is to tackle the privacy challenges raised by the most recent developments and usages of information technologies such as profiling, data mining, social networking, location-based services or pervasive computing by developing solutions to enhance the protection of privacy in the Information Society. To solve this generic objective, the project focuses in particular on the following four fundamental issues:



- The design of appropriate metrics to assess and quantify privacy, primarily by extending and integrating the various possible definitions existing for the generic privacy properties such as anonymity, pseudonymity, unlinkability and unobservability, as well as notions coming from information theory or databases such as the recent but promising concept of differential privacy;
- The definition and the understanding of the fundamental principles underlying “privacy by design”, with the hope of deriving practical guidelines to implement notions such as data minimization, proportionality, purpose specification, usage limitation, data sovereignty and accountability directly in the formal specifications of our information systems;
- The integration between the legal and social dimensions, intensely necessary since the developed privacy concepts, although they may rely on computational techniques, must be in adequacy with the applicable law (even in its heterogeneous and dynamic nature). In particular, privacy-preserving technologies cannot be considered efficient as long as they are not properly understood, accepted and trusted by the general public, an outcome which cannot be achieved by the means of a mathematical proof.

Three major application domains have been identified as interesting experimentation fields for this work: online social networks, location-based services and electronic health record systems. Each of these three domains brings specific privacy-related issues. The aim of the collaboration is to apply the techniques developed to the application domains in a way that promotes the notion of privacy by design, instead of simply considering them as a form of privacy add-ons on the top of already existing technologies. CAPPRIS is a joint project between Inria, LAAS-CNRS, Université de Rennes I, Supélec, Université de Namur, Eurecom, and Université de Versailles. The postdoctoral position of Cristina Onete since September 2014 is funded by CAPPRIS.

### **8.2.3. Research mission “Droit et Justice”**

- **Droit à l’oubli (2012-2014)** The “right to be forgotten” can be viewed as a consequence and an extension of the right to privacy and to personal data protection, emphasized by the inherent difficulty to erase any given information from the omnipresent digital world. The French ministry of Justice has launched two twin projects (one of which is the DAO project), in order to explore the possible legal definitions of a “right to be forgotten”. Even though there are no legal foundations for such a right in France at the moment, the concept is already known from the general public and is also present in courts. Furthermore, individuals expect to be protected by such a right, thus it is important to understand why, how, in which circumstances and to which extent this new right may apply before envisioning a legal notion defining it. The DAO project involves a major legal component, a sociological survey and a technical study. In a nutshell, the legal part explores the possible boundaries and requirements of a right to be forgotten with respect to labor law, civil statuses, personal data protection, legal prescription and IT law. The sociological survey aims at understanding the root causes making people build a desire for forgetfulness in others. Finally, the objective of the computer science part is to elaborate a state of the art of the techniques that could be used to enforce a right to be forgotten in practice in the digital world. The expected output of the project as a whole is a detailed recommendation about whether an independent legislation proposal for the right to be forgotten would be justified, and how it should be done. This final report summarizing the thinkings of the project will be published at the end of 2014 or the beginning of 2015. The project is joint between Université de Rennes I, Inria and Supélec.

### **8.2.4. Competitivity Clusters**

The AMORES project (ANR INS 2011, <http://www.images-et-reseaux.com/en/content/amores>) is recognized by the Images & Réseaux cluster.

## **8.3. European Initiatives**

### 8.3.1. FP7 & H2020 Projects

The PANOPTESSEC project (<http://www.panoptesec.eu>) started on the 1st of November 2013. It deals with the automated and assisted security management of IT and SCADA system. The main objective of PANOPTESSEC is to provide an integrated solution that will allow to efficiently monitor SCADA systems, detect intrusions and react to them. To that end, it encompasses many of the research topics that are addressed by the CIDRE team: alerts aggregation and correlation, policy-aware intrusion detection, architecture-aware intrusion detection, automated trust management, trust-based automated reaction and visualization.

The CIDRE team is involved in the project on all of these aspects. The partners are:

- REHA (BE),
- Alcatel-Lucent Bell Labs France (FR),
- Epistemica (IT),
- The University of Rome (IT),
- the University of Hamburg (GE),
- the Institut Mines-Telecom (FR),
- ACEA (IT),
- Supélec (FR).

This year, our work focused on requirements and design. CIDRE was the WP leader of *WP2 - Deficiency and Requirement Analysis* and was also particularly involved in *WP4 - Data Collection and Correlation*, *WP5 - Dynamic Risk Management* and *WP6 - Visual Analytics and Display*. In *WP2*, we produce an document presenting the state of the art and current limitations in the fields of security data collection and correlation, mission impact evaluation, threat assessment, automated and semi-automated reaction and visualization and interaction. We also produced an operational requirement analysis. In *WP4*, we produced a document presenting the system requirements for data collectin and low-level correlation. In *WP5*, we produced a document presenting the system requirements for risk evaluation and dynamic risk management. In *WP6*, we produced a document presenting visualization challenges and requirements in the context of PANOPTESSEC. More generally, we also contributed to the design and architecture of what will be the PANOPTESSEC system.

## 8.4. International Initiatives

### 8.4.1. Informal International Partners

Sébastien Gambis is collaborating with Jean-Marc Robert (ETS, Montréal, Canada) on the development of privacy-preserving and secure distance-bounding protocols and with Alain Tapp (Université de Montréal, Montréal, Canada) on the design of cryptographic architectures for privacy. He is also collaborating with Panagiotis Papadimitratos (KTH, Stockholm, Sweden) on privacy for location-based services.

## 8.5. International Research Visitors

### 8.5.1. Visits of International Scientists

Jean-Marc Robert

Date: June 2014

Institution: École de Technologie Supérieure (Canada).

#### 8.5.1.1. Internships

Sackmann Mario Julián

Date: Sep 2014 - Jan 2015

Institution: Universidad de Buenos Aires (Argentine)

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

### *8.5.2.1. Explorer programme*

Sébastien Gambs

Date: May 2014

Institution: Institute of Big Data Analytics, Dalhousie University (Halifax, Canada)

### *8.5.2.2. Research stays abroad*

We built a collaboration with Yvan Labiche of the Carleton University in Ottawa to supervise the PhD thesis of Mouna Hkimi. In the context of this collaboration and thanks to the support of SUPELEC and go the SUPELEC foundation, Eric Totel went in Carleton University for four months from March to June 2014, to work on the subject of the modeling of distributed applications.

In May 2014, Sébastien Gambs visited Stan Matwin at the Institute of Big Data Analytics located at Dalhousie university (Halifax, Canada). This visit has foster the beginning of a collaboration on the privacy-preserving analysis of large scale data. In particular, we have started to develop a novel method for sanitizing CDRs (Call Details Records) dataset based on differentially-private variants of sketches, which has been submitted to the D4D challenge. We will also prepare a submission for an associate Inria team for the 2015 call.

Thanks to the support of SUPELEC, Christophe Bidan has joined the ETS (École Supérieure de Technologie) of Montréal from July 2014 to July 2015 for working with Prof. Jean-Marc Robert. This stay results from a collaboration that has been initiated 2 years ago when Prof. Jean-Marc Robert has spent 4 months (from September to December 2012) in the CIDRE research group.

From September 2014 to May 2015, Antoine Guellier has joined the "Securing Cyberspace" team led by Prof. Batten, at Deakin University (Melbourne, Australia). This stay is possible thanks to the international outgoing fellowships of Rennes Métropole and of the UEB (Université Européenne de Bretagne).

## **DIONYSOS Project-Team**

# **7. Partnerships and Cooperations**

## **7.1. National Initiatives**

### **7.1.1. ANR**

- Adlen Ksentini is participating at 20% of his time to the IRT BCOM granted by the ANR.
- Yassine Hadjadj-Aoul is participating at 20% of his time to the IRT BCOM granted by the ANR.

## **7.2. European Initiatives**

### **7.2.1. Collaborations in European Programs, except FP7 & H2020**

#### *7.2.1.1. QuEEN project*

Program: CELTIC

Project acronym: QuEEN

Project title: Quality of Experience Estimators in Networks

Duration: October 2011 - January 2015

Coordinator: Orange Labs

Other partners: 24 partners in many European partners

Abstract: QuEEN is a large 3-year Celtic project going from end 2011 to January 2015. Its objectives are to develop automatic QoE measurement modules for Web services and applications, and to organize these measurement modules as a network of cooperative agents in order to allow each agent to take advantage of the measurements done by the others. Dionysos was involved in most of the activities of the project, and QuEEN partners have benefit from our experience in developing the PSQA technology. QuEEN involved many companies and academic institutions (24 European partners); the project leader was Orange Labs, in Sophia Antipolis.

For more details, visit <http://celtic-queen.inria.fr/dokuwiki/doku.php?id=start>

#### *7.2.1.2. DPDMI*

Program: IT for Knowledge Management, IT4 Innovations, National Supercomputing Center, Ostrava, Czech Republic

Project acronym: DPDMI

Project title: Database of Performance and Dependability Models 1

Duration: October 2014 – March 2015

Coordinator: Technical University of Ostrava

Other partners: Inria (G. Rubino, Dionysos)

Abstract: the project consists in using the supercomputing facilities at Ostrava to build very large models with known numerical solutions, that will serve as a benchmark to many types of techniques designed to compute numerically exact values, bounds, estimations, etc., under research efforts all over the world (areas: Markovian models, rare event problems, neural networks, etc.).

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

**Partner 1:** FTW, Vienna (Austria)

We work with FTW on network economics.

**Partner 2:** VTT, Oulu, Finland

We work with VTT on Quality of Experience estimation and use.

## 7.3. International Initiatives

### 7.3.1. Inria International Labs

#### 7.3.1.1. CIRIC

In the context of CIRIC, we cooperate with the team of Reinaldo Vallejos, professor at the UTFSM, Valparaíso, Chile, on different topics related to networking and modeling issues. Specifically, these activities are organized around two collaborative projects, 7.3.2.1 and 7.3.4.1, where one can find the scientific details. We start to work also with Javiera Barrera's team at the University Adolfo Ibañez, Santiago de Chile, on stochastic optimization problems.

### 7.3.2. Inria Associate Teams

#### 7.3.2.1. MANAP

Title: MANAP (Markovian ANalysis and APplications)

International Partner (Institution - Laboratory - Researcher):

Universidad Técnica Federico Santa María (Valparaíso, Chile)

Duration: 2013 - . . .

See also: <http://people.rennes.inria.fr/Gerardo.Rubino/RESEARCH/MANAP/manap.html>

This project has two goals. The main one is to develop techniques allowing to accelerate solving techniques for Markov models, both in equilibrium and in their transient phases. The applications behind these efforts are the evaluation of performance, dependability and performability properties of complex communication systems. The second goal is to apply these solving techniques to specific problems in networking, concerning optical and wireless infrastructures. On both cases there is some emphasis on dependability aspects: fault tolerance routing schemes in the first case, complex dependability characteristics and their analysis in the second one. A third explicit objective is to produce a software tool implementing the techniques coming from the main research direction of the project, designed to be used both by engineers and researchers.

### 7.3.3. Inria International Partners

#### 7.3.3.1. MOCQUASIN

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

International Partner (Institution - Laboratory - Researcher):

University of Montreal (Canada)

Duration: 2013 - . . .

See also: [http://www.irisa.fr/dionysos/pages\\_perso/tuffin/MOCQUASIN/](http://www.irisa.fr/dionysos/pages_perso/tuffin/MOCQUASIN/)

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

### 7.3.4. Participation In other International Programs

#### 7.3.4.1. Siic AmSud with UDELAR, Uruguay, and UTFSM, Chile

Program: Stic AmSud

Title: Accelerating Markov Models for analysis and design of dynamic WDM optical networks (AMMA)

Inria principal investigator: Gerardo Rubino

International Partners (Institution - Laboratory - Researcher):

University of the Republic (UDELAR), Montevideo, Uruguay – Computer Science at the Engineering Faculty – prof. Héctor Cancela

Technical University Federico Santa María (UTFSM), Valparaíso, Chile – Electronics Department – Prof. Reinaldo Vallejos

Duration: 2 years, Jan. 2013 – Dec. 2014

This project has two main scientific goals: (i) to develop methods capable of solving Markov models faster than with state-of-the-art techniques, and (ii) to apply these techniques to the design of fault-tolerant optical networks. The rationale behind (i) is that the group has ideas and some preliminary promising unpublished results that makes it expect that its approach will be effective in producing new nice solving procedures. Concerning (ii), we have already produced results in simpler cases (without taking into account failures), and we also have results on all the associated areas (dependability analysis, combinatorial optimization, etc.). These main research lines are completed with other goals all concerned with the quantitative analysis of such complex communication systems.

#### 7.3.4.2. *Math AmSud with UDELAR, Uruguay, and UV, Chile*

Program: Math AmSud

Title: Stochastic Analysis, Statistics Inference, Numerical Analysis (SIN)

Inria principal investigator: Gerardo Rubino

Main International Partners (Institution - Laboratory - Researcher):

University of the Republic (UDELAR), Montevideo, Uruguay – Computer Science at the Engineering Faculty – prof. Paola Bermolen

University of Valparaíso, Chile — Prof. Soledad Torres

Duration: 2 years, Jan. 2013 – Dec. 2014

Stochastic calculus with respect to the standard Brownian motion or more generally with respect to semi-martingales is currently one of the most important components of international research in probability theory. The applications of this theory largely exceed the original probabilistic framework and have repercussions in various fields, including differential geometry, differential partial equations, theoretical physics, modeling in finance, hydrology, telecommunications and biology. Recently, many authors have been interested in developing a stochastic calculus with respect to Gaussian processes which are not necessarily semi-martingales, as for instance the well known fractional Brownian motion. This research project is articulated around the analysis and the applications of stochastic differential equations driven by long memory processes.

SIN is a large project with many partners. Our team participates in looking at differential equations and stochastic differential equations as limits of discrete Markov processes.

## 7.4. International Research Visitors

### 7.4.1. *Visits of International Scientists*

- Professor Héctor Cancela
  - Subject: network reliability (see [7.3.4.1](#) , [7.3.2.1](#) )
  - Institution: UDELAR, Montevideo, Uruguay
  - Duration: December 14 to December 31

- Professors Reinaldo Vallejos and Marta Barría  
Subject: network modeling and Markov chain analysis (see 7.3.4.1 , 7.3.2.1 , 7.3.1.1 )  
Institutions: UTFSM and UV, Valparaíso, Chile  
Duration: October 17 to October 27
- Leslie Murray  
Subject: Monte Carlo methods (see 5.6 )  
Institution: University of Rosario, Argentina  
Duration: November 21 to December 19
- Assistant Professor Pablo Romero  
Subject: network modeling and network reliability (see 7.3.4.1 , 7.3.2.1 )  
Institutions: UDELAR, Montevideo, Uruguay  
Duration: September 4 to November 14
- Luis Gutiérrez Begovich  
Subject: neural networks  
Institution: IPN (Instituto Politécnico Nacional), Mexico DF, Mexico  
Duration: December 6, 2013, to February 28, 2014
- Assistant Professor Jorge Graneri  
Subject: neural networks and human memory modeling (preparation for a future PhD work)  
Institutions: UDELAR, Montevideo, Uruguay  
Duration: October 1 to November 21

## **7.4.2. Visits to International Teams**

### *7.4.2.1. Research stays abroad*

Gerardo Rubino

Date: Jan 6 - Jan 10

Institution: Kaust, Saudi Arabia

G. Rubino visited the Center for Uncertainty Quantification in Computational Science and Engineering, Kaust, Saudi Arabia, one week in January, where he gave a seminar. He also served at the international Advisory Board of this Center

Gerardo Rubino

Date: Jun 25 - Jun 28

Institution: National Supercomputing Center, Technical University of Ostrava, Czech Republic

This was a research visit, which included a tutorial on rare event analysis using Monte Carlo techniques, and the preparation of a project

## **DIVERSE Project-Team**

# **8. Partnerships and Cooperations**

## **8.1. Regional Initiatives**

We obtained a grant from the Brittany region, within the plan of action SAD (for "Stratégie d'attractivité durable"). The VIP project (for "Visualisation Interactive de produits dans les configurateurs") aims to investigate software product line techniques. We have recruited Dr. Jin Kin (post-doc for a duration of 18 months, starting in december 2014) in collaboration with the ESTASYS team.

## **8.2. National Initiatives**

### **8.2.1. ANR**

#### *8.2.1.1. ANR GEMOC*

- Coordinator: Inria (DIVERSE)
- Other partners: ENSTA Bretagne, Inria, IRIT, I3S, Obeo, Thales
- Dates: 2012-2016
- Abstract: GEMOC focuses on a generic framework for heterogeneous software model execution and dynamic analysis. This work has the ambition to propose an innovative environment for the design of complex software-intensive systems by providing: a formal framework that integrates state-of-the-art in model-driven engineering (MDE) to build domain-specific modeling languages (DSMLs), and models of computation (MoC) to reason over the composition of heterogeneous concerns; an open-source design and modeling environment associated to a well-defined method for the definition of DSMLs, MoCs and rigorous composition of all concerns for execution and analysis purposes.

This requires addressing two major scientific issues: the design and verification of a formal framework to combine several different DSMLs relying on distinct MoCs; the design and validation of a methodology for DSMLs and MoC development. GEMOC aims at participating in the development of next generation MDE environments through a rigorous, tool-supported process for the definition of executable DSMLs and the simulation of heterogeneous models.

#### *8.2.1.2. ANR INFRA-JVM*

- Coordinator: Université Paris 6
- Other partners: Université Bordeaux 1, Université Rennes 1 (DIVERSE), Ecole des Mines de Nantes
- Dates: 2012-2015
- Abstract: INFRA-JVM is an ANR project whose goal is to design and provide a new Java Virtual Machine dedicated to pervasive environments. This project focuses on designing a Java Virtual Machine for embedded computing platform offering dynamic reconfiguration capabilities. In this context, DIVERSE addresses the problem of efficiently identifying faulty software components running simultaneously in a virtual machine without isolation. Current solutions that perform permanent and extensive monitoring to detect anomalies induce very high overhead on the system, and can, by themselves, make the system unstable. Our main objective is to investigate an optimistic adaptive monitoring system using models@runtime to determine the faulty components of an application.

#### *8.2.1.3. SOPRANO*

- Coordinator: CEA
- CEA, University of Paris-Sud, Inria Rennes, OcamlPro, Adacore



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

## **8.2.2. BGLE / LEOC**

### *8.2.2.1. BGLE2 CONNEXION*

- Coordinator: EDF
- Other partners: Atos WorldGrid, Rolls-Royce Civil Nuclear, Corys TESS, Esterel Technologies, All4Tec, Predict, CEA, Inria, CNRS / CRAN, ENS Cachan, LIG, Telecom ParisTech
- Dates: 2012-2016
- Abstract: The cluster CONNEXION (*digital command CONNtrol for Nuclear EXport and renova-tION*) aims to propose and validate an innovative architecture platforms suitable control systems for nuclear power plants in France and abroad. In this project the Triskell team investigates methods and tools to (i) automatically analyze and compare regulatory requirements evolutions and geographical differences; (ii) automatically generate test cases for critical interactive systems.

### *8.2.2.2. LEOC CLARITY*

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

### *8.2.2.3. Occiware*

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

## **8.2.3. DGA**

### *8.2.3.1. DGA-RAPID MOTIV*

- Coordinator: InPixal
- Other partners: Bertin, DGA, Inria
- Dates: 2012-2014

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

#### 8.2.3.2. *DGA FPML*

- Coordinator: DGA
- Partners: DGA MI, Inria
- Dates: 2014-2016
- Abstract: in the context of this project, DGA-MI and the Inria team DiverSE explore the existing approaches to ease the development of formal specifications of domain-Specific Languages (DSLs) dedicated to paquet filtering, while guaranteeing expressiveness, precision and safety. In the long term, this work is part of the trend to provide to DGA-MI and its partners a tooling to design and develop formal DSLs which ease the use while ensuring a high level of reasoning.

### 8.3. European Initiatives

#### 8.3.1. *FP7 & H2020 Projects*

##### 8.3.1.1. *FP7 FET STREP DIVERSIFY*

- Coordinator: Inria (DIVERSE)
- Other partners: SINTEF, Université de Rennes 1, Trinity College Dublin
- Dates: 2013-2016
- Abstract: DIVERSIFY explores diversity as the foundation for a novel software design principle and increased adaptive capacities in CASSs. Higher levels of diversity in the system provide a pool of software solutions that can eventually be used to adapt to unforeseen situations at design time. The scientific development of DIVERSIFY is based on a strong analogy with ecological systems, biodiversity, and evolutionary ecology. DIVERSIFY brings together researchers from the domains of software-intensive distributed systems and ecology in order to translate ecological concepts and processes into software design principles.

##### 8.3.1.2. *FP7 NoE NESSoS*

- Coordinator: CNR - Consiglio Nazionale delle Ricerche (Italy)
- Others partners: ATOS (Spain), ETH (Switzerland), Katholieke Universiteit Leuven (Belgium), Ludwig-Maximilians-Universitaet Muenchen (Germany), IMDEA (Spain), Inria (France), University of Duisburg-Essen (Germany), University of Malaga (Spain), University of Trento (Italy), SIEMENS (Germany), SINTEF (Norway)
- Dates: 2010-2014
- Abstract: The Network of Excellence on Engineering Secure Future Internet Software Services and Systems (NESSoS) aims at constituting and integrating a long lasting research community on engineering secure software-based services and systems. In light of the unique security requirements the Future Internet will expose, new results will be achieved by means of an integrated research, as to improve the necessary assurance level and to address risk and cost during the software development cycle in order to prioritize and manage investments. NESSoS will also impact training and education activities in Europe to grow a new generation of skilled researchers and practitioners in the area. NESSoS will collaborate with industrial stakeholders to improve the industry best practices and support a rapid growth of software-based service systems in the Future Internet.

Three Inria EPIs are involved in NeSSoS: ARLES, CASSIS and Triskell. Triskell leads the research workpackage on design and architecture for secured future internet applications.

##### 8.3.1.3. *FP7 Marie-Curie Relate*

- Coordinator: Karlsruhe Institute of Technology
- Other partners: Université de Rennes, IRISA (France); King's College (UK); South East European Research Center, SEERC (Greece); Charles University (Czech Republic); CAS Software (Germany); Singular Logic (Greece)
- Dates: 2011-2015
- Abstract: The RELATE Initial Training Network aims to establish a network of international academic and industrial partners for a joint research training effort in the area of engineering and provisioning service-based cloud applications. The training is intended to not only shape high-level academic researchers, but also educate next generation experts and innovators in the European software industry. Through an integrative and multidisciplinary research approach, RELATE aims to promote the advancement of the state of the art in the related areas of model-driven engineering and formal methods, service-based mash-ups and application integration, security, performance, and trust in service-based cloud applications, and quality management and business model innovation.

#### 8.3.1.4. *FP7 STREP HEADS*

- Coordinator: SINTEF
- Other partners: Inria, Software AG, ATC, Tellu, eZmonitoring
- Dates: 2013-2016
- Abstract: The idea of the HEADS project is to leverage model-driven software engineering and generative programming techniques to provide a new integrated software engineering approach which allow advanced exploitation the full range of diversity and specificity of the future computing continuum. The goal is to empower the software and services industry to better take advantage of the opportunities of the future computing continuum and to effectively provide new innovative services that are seamlessly integrated to the physical world making them more pervasive, more robust, more reactive and closer (physically, socially, emotionally, etc.) to their users. We denote such services HD-services. HD-services (Heterogeneous and Distributed services) characterize the class of services or applications within the Future Internet whose logic and value emerges from a set of communicating software components distributed on a heterogeneous computing continuum from clouds to mobile devices, sensors and/or smart-objects.

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

#### 8.3.2.1. *ICT COST Action MPM4CPS (IC1404)*

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

### 8.3.3. *Industry-driven EU projects*

#### 8.3.3.1. *ITEA MERGE*

- Coordinator: Thales Research and Technology

- Other partners: Thales Global Services, Thales Communications and Security, OBEO, ALL4TEC, Onera, Inria, Université Paris VI, Codenomicon, STUK - Radiation and Nuclear Safety Authority, POHTOnSense Oy, University of Oulu, University of Jyväskylä, Space Applications Services NV, Melexis, E2S, Katholieke Universiteit Leuven
- Dates: 2012-2015
- Abstract: MERgE stands for "Multi-Concerns Interactions System Engineering". Within the "Engineering support" theme of ITEA2 roadmap, the purpose of this project is to develop and demonstrate innovative concepts and design tools addressing in combination the "Safety" and "Security" concerns, targeting the elaboration of effective architectural solutions. MERgE will provide tools and solutions for combining safety and security concerns in systems development in a holistic way. It will provide academically solid and practice proven solutions and models for system developers and system owners to tackle the challenges of designing seamless optimal cost effective safe and secure solutions conformant to the model driven engineering paradigm. This will be done by tightly integrating the following paradigms: requirement engineering, safety, security and risk management in an over-all design process which is supported by adequate tools and methods. MERgE aims to bring a system engineering solution for Combined Safe & Secure system design. The main technical innovation of the project is the application of state of the art design tools tailors capabilities and "multi concern engineering" core technologies to the issue of interactions of "Safety" and "Security" concerns as well as other concerns like "Performance" or "Timing" in the design process.

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

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

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

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

### **8.4. International Initiatives**

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

##### *8.4.1.1. Declared Inria International Partners*

###### *8.4.1.1.1. Inria International Chair*

Prof. Robert B. France<sup>0</sup> was granted by an Inria international chair for the period 2013-2017. Prof. France collaborate intensively with many members of DIVERSE on various joint work, e.g., the Familiar project and the GEMOC initiative. The Inria International Chair allows Prof. France to visit once a year the team along the period.

##### *8.4.1.2. Informal International Partners*

- Université de Montréal (Canada)
- McGill University (Canada)
- University of Alabama (USA)

#### **8.4.2. International initiative GEMOC**

The GEMOC initiative (cf. <http://www.gemoc.org>) is an open and international initiative launched in 2013 that coordinate research partners worldwide to develop breakthrough software language engineering (SLE) approaches that support global software engineering through the use of multiple domain-specific languages. GEMOC members aim to provide effective SLE solutions to problems associated with the design and implementation of collaborative, interoperable and composable modeling languages.

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<sup>0</sup>Colorado State University, USA. See. <http://www.cs.colostate.edu/~france/>

The GEMOC initiative aims to provide a framework that facilitates collaborative work on the challenges of using of multiple domain-specific languages in software development projects. The framework consists of mechanisms for coordinating the work of members, and for disseminating research results and other related information on GEMOC activities. The framework also provides the required infrastructure for sharing artifacts produced by members, including publications, case studies, and tools.

The governance of the GEMOC initiative is ensured by the Advisory Board. The role of the Advisory Board is to coordinate the GEMOC work and to ensure proper dissemination of work products and information about GEMOC events (e.g., meetings, workshops).

Benoit Combemale is the co-founder and currently acts as principal coordinator of the GEMOC initiative. Benoit Combemale and Jean-Marc Jézéquel are part of the Advisory Board, and 9 DIVERSE members are part of the GEMOC initiative.

## **8.5. International Research Visitors**

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

#### *8.5.1.1. Internships*

- Victor Vranceanu: Inria, Intern, from Mar 2014 until Jul 2014
- Eric Manzi: Inria, Intern, from Jun 2014 until Aug 2014

## **DREAM Project-Team**

# **8. Partnerships and Cooperations**

## **8.1. National Initiatives**

### **8.1.1. PEPS: Pharmacology-epidemiology for Health Products**

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

The PEPS project (Pharmacology-epidemiology des Produits de Santé) is funded by ANSM (national agency for health security). The project leader is E. Oger from the clinical investigation center CIC-1414 INSERM/CHU Rennes. The other partners located in Rennes are the Institute of Research and Technology (IRT) B<>Com, EHESP and the LTSI. The project will start in January 2015 and is funded for 4 years (3.6M€).

The PEPS project has two parts: the clinical studies and a research program dedicated to the development of innovative tools for pharmacology-epidemiological studies with medico-administrative databases. The pharmacology-epidemiology is the study of the uses, the effectiveness and the effects of health products (especially drugs) for the patients in a real live context, on a large population. Using medico-administrative databases – that contains information about the reimbursement of the medication, the medical visits and the cares – is a recent approach to enable studies on large cohorts and to reduce the response time to a pharmacology-epidemiology question.

Our contribution to this project will be the proposal of pattern mining algorithms and reasoning techniques to analyze typical care pathways of specific groups of insured patients.

## **8.2. International Initiatives**

### **8.2.1. Inria International Partners**

#### *8.2.1.1. Informal International Partners*

##### 8.2.1.1.1. Monitoring cattle in big herds with multiple sensors

**Participant:** René Quiniou.

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

## DYLISS Project-Team

# 7. Partnerships and Cooperations

## 7.1. Regional Initiatives

### 7.1.1. *Regional partnership with computer science laboratories in Nantes*

**Participants:** Anne Siegel, Jérémie Bourdon, Damien Eveillard, François Coste, Jacques Nicolas, Vincent Picard, Santiago Videla.

Methodologies are developed in close collaboration with university of Nantes (LINA) and Ecole centrale Nantes (Ircsyn). This is acted through the Biotempo and Idealg ANR projects and co-development of common software toolboxes within the Renabi-GO platform process. The Ph-D students V. Picard and J. Laniau are also co-supervised with members of the LINA laboratory.

### 7.1.2. *Regional partnership in Marine Biology*

**Participants:** Catherine Belleannée, Jérémie Bourdon, Jeanne Cambefort, Guillaume Collet, Jean Coquet, François Coste, Damien Eveillard, Olivier Dameron, Clovis Galiez, Gaëlle Garet, Yann Guitton, Julie Laniau, Jacques Nicolas, Vincent Picard, Sylvain Prigent, Anne Siegel.

A strong application domain of the Dyliss project is marine Biology. This application domain is co-developped with the station biologique de Roscoff and their three UMR and involves several contracts. The IDEALG consortium is a long term project (10 years, ANR Investissement avenir) aiming at the development of macro-algae biotechnology. Among the research activities, we are particularly interested in the analysis and reconstruction of metabolism and the characterization of key enzymes. Other research contracts concern the modeling of the initiation of sea-urchin translation (former PEPS program Quantoursin, Ligue contre le cancer and ANR Biotempo), the analysis of extremophile archbacteria genomes and their PPI networks (former ANR MODULOME and PhD thesis of P.-F. Pluchon) and the identification of key actors implied in competition for light in the ocean (PELICAN ANR project). In addition, the team participates to a collaboration program with the Biocore and Ange teams, together with Ifremer-Nantes, focused on the understanding on micro-algae (thesis of Julie Laniau).

### 7.1.3. *Regional partnership in agriculture and bio-medical domains*

**Participants:** Aymeric Antoine-Lorquin, Catherine Belleannée, Charles Bettembourg, François Coste, Jean Coquet, Olivier Dameron, Victorien Delannée, Jacques Nicolas, Anne Siegel, Valentin Wucher, Nathalie Théret.

We have a strong and long term collaboration with biologists of INRA in Rennes : PEGASE and IGEEP units. This partnership is acted by the co-supervision of one post-doctorant and the co-supervision of several PhD students. The Ph-D thesis of V. Wucher [13] was supported by collaborations with the IGEEP laboratory. The post-doc of Charles Bettembourg nows strengthens these collaborations. This collaboration is also reinforced by collaboration within ANR contracts (MirNadapt, FatInteger).

We also have a strong and long term collaboration in the bio-medical domain, namely with the IRSET laboratory at Univ. Rennes 1/Irset, acted by the co-supervised Ph-D theses of V. Delannée (Metagenotox project, funded by Anses) and J. Coquet. This partnership was reinforced in the former years by the ANR contract Biotempo ended at the end of 2014.

## 7.2. National Initiatives

### 7.2.1. *Long-term contracts*

#### 7.2.1.1. *"Omics"-Line of the Chilean CIRIC-Inria Center*

**Participants:** Anne Siegel, Jérémie Bourdon, François Coste, Marie Chevallier, Damien Eveillard, Gaëlle Garet, Jacques Nicolas, Santiago Videla.

Cooperation with Univ. of Chile (MATHomics, A. Maass) on methods for the identification of biomarkers and software for biochip design. It aims at combining automatic reasoning on biological sequences and networks with probabilistic approaches to manage, explore and integrate large sets of heterogeneous omics data into networks of interactions allowing to produce biomarkers, with a main application to biomining bacteria. The program is co-funded by Inria and CORFO-chile from 2012 to 2022. In this context, IntegrativeBioChile is an Associate Team between Dyliss and the Laboratory of Bioinformatics and Mathematics of the Genome hosted at Univ. of Chile funded from 2011 to 2016.

#### 7.2.1.2. ANR *Idealg*

**Participants:** Anne Siegel, Catherine Belleannée, Jérémie Bourdon, Jeanne Cambefort, François Coste, Olivier Dameron, Damien Eveillard, Jacques Nicolas, Guillaume Collet, Clovis Galiez, Gaëlle Garet, Yann Guitton, Sylvain Prigent.

IDEALG is one of the five laureates from the national call 2010 for Biotechnology and Bioresource and will run until 2020. It gathers 18 different partners from the academic field (CNRS, IFREMER, UEB, UBO, UBS, ENSCR, University of Nantes, INRA, AgroCampus), the industrial field (C-WEED, Bezhin Rosko, Aleor, France Haliotis, DuPont) as well as a technical center specialized in seaweeds (CEVA) in order to foster biotechnology applications within the seaweed field. It is organized in ten workpackages. We are participating to workpackages 1 (establishment of a virtual platform for integrating omics studies on seaweed) and 4 (Integrative analysis of seaweed metabolism) in cooperation with SBR Roscoff. Major objectives are the building of brown algae metabolic maps, flux analysis and the selection extraction of important parameters for the production of targeted compounds. We will also contribute to the prediction of specific enzymes (sulfatases) within workpackage 5 .[\[details\]](#)

#### 7.2.2. **Methodology: ANR *Biotempo***

**Participants:** Anne Siegel, Jérémie Bourdon, François Coste, Damien Eveillard, Jacques Nicolas, Olivier Dameron, Vincent Picard, Sylvain Prigent, Nathalie Théret, Santiago Videla.

The BioTempo projects aims at developing some original methods for studying biological systems. The goal is to introduce partial quantitative information either on time or on component observations to gain in the analysis and interpretation of biological data. Three biological applications are considered regulation systems used by biomining bacteria, TGF-*beta* signaling and initiation of sea-urchin translation. It is funded by ANR Blanc (SIMI2) and coordinated by A. Siegel from 2011 to Nov. 2014. Teams involved include LINA (Nantes), I3S (Nice), DIMPP (Montpellier), Contraintes/Lifeware project team (Inria), IRSET (Rennes) and Station biologique de Roscoff [\[details\]](#)

#### 7.2.3. **Proof-of-concept on dedicated applications**

##### 7.2.3.1. ANR *Fatinteger*

**Participants:** Aymeric Antoine-Lorquin, Catherine Belleannée, Jacques Nicolas, Anne Siegel.

This project (ANR Blanc SVE7 "biodiversité, évolution, écologie et agronomie" from 2012 to 2015) is led by INRA UMR1348 PEGASE (F. Gondret). Its goal is the identification of key regulators of fatty acid plasticity in two lines of pigs and chickens. To reach these objectives, this project has for ambition to test some combination of statistics, bioinformatics and phylogenetics approaches to better analyze transcriptional data of high dimension. Data and methods integration is a key issue in this context. We work on the recognition of specific common cis-regulatory elements in a set of differentially expressed genes and on the regulation network associated to fatty acid metabolism with the aim of extracting some key regulators.

##### 7.2.3.2. ANR *Mirnadapt*

**Participants:** Jacques Nicolas, Catherine Belleannée, Anne Siegel, Olivier Dameron, Valentin Wucher, Charles Bettembourg.



This ANR project is coordinated by UMR IGEPP, INRA Le Rheu (D. Tagu) and funded by ANR SVSE 6 "Génomique, génétique, bioinformatique, biologie systémique" from 2012 to 2014. This cooperation was strengthened by a co-tutored PhD thesis (V. Wucher) defended in Nov. 2014 [13]. It proposes an integrative study between bioinformatics, genomics and mathematical modeling focused on the transcriptional basis of the plasticity of the aphid reproduction mode in response to the modification of environment. An important set of differentially expressed mRNAs and microRNAs are available for the two modes, asexual parthenogenesis and sexual reproduction. Our work is to combine prediction methods for the detection of putative microRNA/mRNA interactions as well as transcription factor binding sites from the knowledge of genomic sequences and annotations available on this and other insects. The results will be integrated within a coherent putative interaction network and serve as a filter for the design of new targeted experiments with the hope to improve functional annotations of implied genes.

#### 7.2.3.3. ANR Samosa

**Participants:** Jacques Nicolas, Catherine Belleannée, Anne Siegel, Aymeric Antoine-Lorquin, Jérémie Bourdon, François Coste.

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

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

### 7.2.4. Programs funded by research institutions

#### 7.2.4.1. ADT Complex-biomarkers

**Participants:** Jeanne Cambefort, Guillaume Collet, Marie Chevallier, Anne Siegel.

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

#### 7.2.4.2. ANSES Mecagenotox

**Participants:** Victorien Delannée, Anne Siegel, Nathalie Théret.

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

#### 7.2.4.3. PEPS VAG

**Participants:** François Coste, Jacques Nicolas, Clovis Galiez.

PEPS VAG started a collaboration between IMPMC UMR 7590, Institut de biologie de l'École Normale Supérieure (IBENS) UMR8197, Atelier de Bioinformatique UPMC and Dyliss. It aims at defining the needs and means for a larger project about viruses in marine ecosystems. Indeed, we aim at developing new methods based on both sequential and structural information of proteins to improve the detection of viral sequences in marine metagenomes, to identify new viruses and to compare the viral populations specifically associated with different environment parameters (temperature, acidity, nutrients...) and ultimately to connect them with the potential hosts identified by population sequencing.

### 7.3. European Initiatives

#### 7.3.1. Collaborations with Major European Organizations

Partner: EBI (Great-Britain)

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

Partner: Potsdam university (Germany)

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

### 7.4. International Initiatives

#### 7.4.1. Inria Associate Teams

##### 7.4.1.1. INTEGRATIVEBIOCHILE

Title: Bioinformatics and mathematical methods for heterogeneous omics data

Inria principal investigator: Anne Siegel

International Partner (Institution - Laboratory - Researcher):

University of Chile (Chile) - Center for Mathematical Modeling - Alejandro Maass

Duration: 2011 - 2016

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

IntegrativeBioChile is an Associate Team between Inria project-team "Dyliss" and the "Laboratory of Bioinformatics and Mathematics of the Genome" hosted at CMM at University of Chile. The Associated team is funded from 2011 to 2016. The project aims at developing bioinformatics and mathematical methods for heterogeneous omics data. Within this program, we funded long and short stay visitings in France.

#### 7.4.2. Inria International Labs

The Dyliss team is strongly involved in the Inria CIRIC center, and the research line "Omics integrative center": the associated team "IntegrativeBioChile", the post-doc of S. Thiele (2012) and the co-supervised of A. Aravena (2010-2013) contributed to reinforce the complementarity of both Chilean and French teams. In 2013, a workshop was organized in Chile to develop new French-Chilean collaboration within the framework of the CIRIC center. In 2014, Marie Chevallier joined the team as an engineer to reinforce software resulting from common collaborations.

### 7.4.3. Participation in other International Programs

#### 7.4.3.1. International joint supervision of PhD

Title: Applying logic programming to the construction of robust predictive and multi-scale models of bioleaching bacteria [S. Videla]

Inria principal investigator: Anne Siegel

International Partner (Institution - Laboratory - Researcher):

University of Postdam (Germany). Department of computer science. T. Schaub.

Duration: October 2011 - September 2014

## 7.5. International Research Visitors

### 7.5.1. Visits of International Scientists

- **Algeria.** Badji Mokhtar - Annaba University [M. Zekri]
- **Austria.** Graz university [M. Weltzer]
- **Chile.** Centro de Modelimiento Matematico, Santiago [A. Maass, P. Bordron, M.P. Cortez]
- **Germany.** Department of Computer Science, Potsdam [T. Schaub]
- **Germany.** Frei Universitat Berlin [A. Bockmayr]

#### 7.5.1.1. Internships

Francisco Dorr

Date: Mar 2014 - Aug 2014

Institution: Universidad de Buenos Aires (Argentina)

### 7.5.2. Visits to International Teams

#### 7.5.2.1. Shorts visits

- **Chile.** Centro de Modelimiento Matematico, Santiago. *Applications of ASP*. Nov. 2014 (1 to 2 weeks) [J. Bourdon, M. Chevallier, D. Eveillard, A. Siegel]

#### 7.5.2.2. Explorer programme

Prigent Sylvain

Date: Mar 2014 - Apr 2014

Institution: **FUB** (Germany)

Videla Santiago

Date: Mar 2014 - May 2014

Institution: **University of Potsdam** (Germany)

Picard Vincent

Date: Sep 2014 - Nov 2014

Institution: **The University of Tokyo, Japanese-French Laboratory for Informatics**(Japan)

## ESTASYS Exploratory Action

# 7. Partnerships and Cooperations

## 7.1. Regional Initiatives

### 7.1.1. *ESTASE*

**Participants:** Axel Legay, Sean Sedwards.

ESTASE is a create project whose main objective was to initiate the creation of the plasma toolset as well as to propose new model checking algorithms for rare events.

### 7.1.2. *Privacy*

**Participants:** Axel Legay, Fabrizio Biondi, Jean Quilbeuf.

Privacy is a regional project whose objective is to quantify privacy of data. This includes, e.g., quantifying the anonymity of a voting protocol.

### 7.1.3. *Variability*

**Participants:** Axel Legay, Jin Hyun Kim, Louis-Marie Traonouez.

Variability is a regional project whose objective is to lift scheduling techniques to connected-objects. The main application of the project is Systems of Systems.

## 7.2. National Initiatives

### 7.2.1. *ANR Malthy*

**Participants:** Axel Legay, Rudolf Fahrenberg, Louis-Marie Traonouez.

The objective of this project is to study new models and techniques to reason on quantitative systems. We mainly focus on the composition of timed components in a dynamic setting.

### 7.2.2. *BGLE Sys2Soft*

**Participants:** Axel Legay, Thomas Given-Wilson, Cyrille Jegourel.

This national project studies various languages and techniques for quantitative systems.

## 7.3. European Initiatives

### 7.3.1. *Danse*

Program: FP7

Project acronym: DANSE

Project title: Designing for Adaptability and evolution in System of systems Engineering

Duration: mois année début - mois année fin

Coordinator: Offis

Abstract: Design and verification of Systems of Systems. We contributed by proposing the first verification engine for Heterogeneous SoS. For doing so, we have combined Plasma with Desyre that is a simulator for SoS described via the standardised FMI/FMU approach.

### 7.3.2. *Meals*

Program: Marie Curie

Project acronym: Meals

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

Duration: Octobre 2012 – Octobre 2016

Coordinator: Germany (Saarbrücken) and Argentina ()

Abstract: Colaborative action on the topic of quantitative systems

### **7.3.3. Sensation**

Program: Fet ProActif

Project acronym: Sensation

Project title: Self Energy-Supporting Autonomous Computation

Duration: Octobre 2012 – Octobre 2015

Coordinator: Aalborg University

Abstract: Development of new results for energy-centric systems. We contributed by proposing new algorithms for rare-event simulation.

### **7.3.4. DALI**

Program: FP7

Project acronym: DALI

Project title: Devices for assisted living

Duration: Octobre 2011 - Octobre 2014

Coordinator: Trento University

Abstract: Development of a machine to guide a lady in a commercial center. We contributed by designing the cognitive algorithm. The machine is one example of a component of a large SoS that has its own objective but whose global behavior depends on those of other components. This is also a good illustration that our tool can be miniaturized to work in a small robot.

### **7.3.5. EMC2**

Program: ARTEMIS

Project acronym: EMC2

Project title: Embedded Multi-Core systems for Mixed Criticality applications in dynamic and changeable real-time environments

Duration: mars 2014 – mars 2017

Coordinator: Infineon

Abstract: Large initiative on embedded systems and SoS. We will contribute with our expertise from DANSE and Sensation projects.

## **7.4. International Initiatives**

Our team has strong collaboration with University of Namur, Carnegie Mellon University, University of Aalborg, Verimag Grenoble, and University of Waterloo. So far, those activities have not yet been funded.

## **7.5. International Research Visitors**

### **7.5.1. Visits of International Scientists**

#### *7.5.1.1. Internships*

- Jan Kretinsky, PostDoc at IST Austria
- Karin Quaas, PostDoc at Leipzig University
- Kim Larsen, Professor at Aalborg University
- Zoltan Esik, Professor at University of Szeged

## FLUMINANCE Project-Team

# 8. Partnerships and Cooperations

## 8.1. National Initiatives

### 8.1.1. ANR SYSCOMM *GeoFluids: Analyse et simulation d'écoulements fluides à partir de séquences d'images : application à l'étude d'écoulements géophysiques*

**Participants:** Dominique Heitz, Etienne Mémin.

*duration 48 months.*

The project Geo-FLUIDS focuses on the specification of tools to analyze geophysical fluid flows from image sequences. Geo-FLUIDS aims at providing image-based methods using physically consistent models to extract meaningful features describing the observed flow and to unveil the dynamical properties of this flow. The main targeted application domains concern Oceanography and Meteorology. The project consortium gathers the Inria research groups: FLUMINANCE (leader), CLIME and MOISE. The group of the "Laboratoire de Météorologie Dynamique" located at the ENS Paris, the IFREMER-CERSAT group located at Brest and the METEOFRANCE GMAP group in Toulouse.

### 8.1.2. ANR JCJC *GERONIMO : Advanced GEophysical Reduced-Order Model construction from IMAge Observations*

**Participant:** Cédric Herzet.

*duration 48 months.* The GERONIMO project which starts in March 2014 aims at devising new efficient and effective techniques for the design of geophysical reduced-order models from image data. The project both arises from the crucial need of accurate low-order descriptions of highly-complex geophysical phenomena and the recent numerical revolution which has supplied the geophysical scientists with an unprecedented volume of image data. The project is placed at the intersection of several fields of expertise (Bayesian inference, matrix factorization, sparse representations, etc.) which will be combined to handle the uncertainties associated to image measurements and to characterize the accurate reduced dynamical systems.

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

**Participant:** Cédric Herzet.

*duration 36 months.* This project tackles the problem of deriving a precise submesoscale characterization of ocean currents from satellite data. The targeted methodologies should in particular enable the exploitation of data of different nature (for example sea surface temperature or height) and/or resolutions. This 36-month project benefits from a collaboration with the Laboratoire de Météorologie Dynamique, Ecole Normale Supérieure, Paris.

### 8.1.4. INSU-LEFE: *MODELER*

**Participant:** Etienne Mémin.

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

## 8.2. International Initiatives

### 8.2.1. Inria International Partners

#### 8.2.1.1. Informal International Partners

**Universidad de Buenos Aires (ARGENTINA)** We have maintained academic exchanges with the group of Guillermo Artana.

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

### 8.2.2. Participation In other International Programs

SticAMSUD project Voiceproduction leded by Denisse Sciamarella (CNRS, LIMSI)

## GENSCALE Project-Team

# 8. Partnerships and Cooperations

## 8.1. Regional Initiatives

### 8.1.1. *DGASP: Discrete Geometry Problem solve with ASP*

**Participants:** Douglas Goncalves, Antonio Mucherino.

This project was funded by Région Bretagne in the framework of the SAD call (Stratégie Attractivité Durable), from April 2013 to March 2014 and coordinated by A. Mucherino. It enabled to hire Douglas Goncalves as a postdoctoral student for 12 months for working on a discretizable class of distance geometry problems. The project is in collaboration with Carlile Lavor (IMECC-UNICAMP, Brazil) and Jacques Nicolas (Dyliss team, IRISA).

### 8.1.2. *KoriKlast2: Intensive Sequence comparison*

**Participants:** Sébastien Brillet, Erwan Drezen, Dominique Lavenier, Ivaylo Petrov.

This is a collaborative project funded by Région Bretagne (18 months, from June 2014) with 3 partners: the Korilog Company, the bioinformatics computing center of Roscoff and the GenScale team. The purpose is (1) to improve the KLAST software with new alignment methods developed by GenScale; (2) to extend the capabilities of KLAST toward metagenomic processing; (3) to develop a cloud version targeting huge sequence comparison processing.

### 8.1.3. *Collaboration with IGDR (Insitute of Genetic and Development of Rennes)*

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

We collaborate with several teams of the IGDR: Genetics of dog (detection of long non coding RNAs in collaboration with Thomas Derrien and Christophe Hitte) and Integrated Functional Genomics and Biomarkers (NGS analyses of glioblastoma cancer, project funded by INCa in collaboration with Marie de Tayrac and Jean Mosser).

### 8.1.4. *Partnership with INRA*

**Participants:** Susete Alves Carvalho, Anaïs Gouin, Dominique Lavenier, Fabrice Legeai, Claire Lemaitre, Pierre Peterlongo, François Moreews.

The GenScale team has a strong and long term collaboration with biologists of INRA in Rennes: IGEPP and PEGASE units. This partnership concerns both service and research activities and is acted by the hosting three INRA engineers (F. Legeai, F. Moreews, S. Alves Carvalho). In particular, the collaboration with the IGEPP team includes several research projects in which Genscale is a formal partner: PEAPOL and SPECIAPHID projects.

## 8.2. National Initiatives

### 8.2.1. ANR

#### 8.2.1.1. *Project FATINTEGER*

**Participants:** Dominique Lavenier, François Moreews.

Coordinateur: F. Gondret

Duration: 36 months (Mar. 2012 - feb. 2015)

Partners: PEGASE Inra Rennes, CNRS IRISA Rennes, AgroCampus Ouest LMA-IRMAR Rennes



The FatInteger project aims to identify some of the transcriptional key players of animal lipid metabolism plasticity, combining high throughput data with statistical approaches, bioinformatics and phylogenetic. GenScale is involved in the design of the workflow for processing the genomic data.

#### 8.2.1.2. *Project SPECIAPHID: Speciation of pea aphids*

**Participants:** Claire Lemaitre, Anaïs Gouin, Fabrice Legeai.

Coordinator: J-C. Simon (Inra)

Duration: 36 months (Jan. 2012 – Dec 2014)

Partners: IGEPP Inra Rennes, CBGP Inra Montpellier, BF2I Inra Lyon.

The SPECIAPHID project aims to understand the adaptation and speciation of pea aphids by re-sequencing and comparing the genomes of numerous aphid individuals. The role of Genscale is to apply and develop new methods to detect variation between re-sequenced genomes, and in particular complex variants such as structural ones.

#### 8.2.1.3. *Project ADA-SPODO: Genetic variation of Spodoptera Frugiperda*

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

Coordinator: E. D'Alençon (Inra, Montpellier)

Duration: 39 months (Oct. 2012 – Dec 2015)

Partners: DGIMI Inra Montpellier, CBGP Inra Montpellier, URGI Inra Versailles, Genscale Inria/IRISA Rennes.

The ADA-SPODO project aims at identifying all sources of genetic variation between two strains of an insect pest: Lepidoptera Spodoptera Frugiperda in order to correlate them with host-plant adaptation and speciation. GenScale's task is to develop new efficient methods to compare complete genomes along with their postgenomic and regulatory data.

#### 8.2.1.4. *Project COLIB'READ: Advanced algorithms for NGS data*

**Participants:** Pierre Peterlongo, Claire Lemaitre, Dominique Lavenier, Fabrice Legeai, Guillaume Rizk, Chloé Riou.

Coordinator: P. Peterlongo (Inria, GenScale, Rennes)

Duration: 36 months (Mar. 2013 – Feb. 2016)

Partners: LIRMM Montpellier, Bamboo Inria Lyon, Genscale Inria/IRISA Rennes.

The main goal of the Colib'Read project is to design new algorithms dedicated to the extraction of biological knowledge from raw data produced by High Throughput Sequencers (HTS). The project proposes an original way of extracting information from such data. The goal is to avoid the assembly step that often leads to a significant loss of information, or generates chimerical results due to complex heuristics. Instead, the strategy proposes a set of innovative approaches that bypass the assembly phase, and that does not require the availability of a reference genome. <https://colibread.inria.fr/>

#### 8.2.1.5. *Project GATB: Genome Analysis Tool Box*

**Participants:** Dominique Lavenier, Erwan Drezen, Pierre Peterlongo, Claire Lemaitre, Guillaume Rizk, Charles Deltel.

Coordinator: D. Lavenier (Inria/Irisa, GenScale, Rennes)

Duration: 24 months (Feb. 2013 – Jan. 2015)

Partners: GenScale Inria/IRISA, Rennes – DTI Inria, Rennes.

This project aims to develop algorithms and tools for genome analysis based on a compact data structure having a very low memory footprint allowing end-users to process huge volume of genomic data on a simple desktop computer. The GATB is structured around a C++ library from which many efficient NGS tools can be developed. GATB has been published and used outside Genscale (LIRMM, Inria Bamboo team). <http://gatb.inria.fr>

#### 8.2.1.6. *Project HydroGen: Metagenomic applied to ocean life study*

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

Coordinator: D. Lavenier (Inria/Irisa, GenScale, Rennes)

Duration: 42 months (Nov. 2014 – Apr. 2018)

Partners: CEA (GenosScope, Evry), INRA (AgroParisTech, Paris – MIG, Jouy-en-Jossas).

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

### 8.2.2. *PIA: Programme Investissement d’Avenir*

#### 8.2.2.1. *RAPSODYN: Optimization of the rapeseed oil content and yield under low nitrogen*

**Participants:** Dominique Lavenier, Claire Lemaitre, Pierre Peterlongo.

Coordinator: N. Nessi (Inra, IGEPP, Rennes)

The objective of the Rapsodyn project is the optimization of the rapeseed oil content and yield under low nitrogen input. GenScale is involved in the bioinformatics work package to elaborate advanced tools dedicated to polymorphism and application to the rapeseed plant.

#### 8.2.2.2. *France Génomique: Bio-informatics and Genomic Analysis*

**Participants:** Laurent Bourri, Dominique Lavenier.

Coordinator: J. Weissenbach (Genoscope, Evry)

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

### 8.2.3. *Programs from research institutions*

#### 8.2.3.1. *Inria ADT Mapsembler*

**Participants:** Alexan Andrieux, Dominique Lavenier, Claire Lemaitre, Pierre Peterlongo.

The Mapsembler project aims at finalizing and at distributing the Mapsembler tool. It is funded by Inria ADT call (2012) and coordinated by P. Peterlongo from oct. 2012 to sept. 2014. <http://alcovna.genouest.org/mapsembler/>

#### 8.2.3.2. *Mastodons CNRS Program SéPhHaDé: Computational Challenge of High Throughput Sequencing and Phenotyping in Life Science*

**Participants:** Dominique Lavenier, Erwan Drenzen, Ba Diep Nguyen.

Coordinator: E. Rivals (Lirmm, Montpellier)

Duration: 3 years (2012-2014)

Partners: Lirmm et Inria Montpellier, GenScale IRISA/Inria Rennes, Bamboo LIFL, Lille, INRA Montpellier, ISEM, IPMC Nice, CIRAD Montpellier, LSIS Aix Marseille, Tela Botanica Montpellier, UPMC Banyuls/Mer, CEA Evry, LITIS Rouen

This project deals with the management of huge volume of data generated (1) by the new sequencing technologies (2) by the collection of information for phenotyping living organisms. In 2014, GenScale has developed a methodology to compare metagenomic datasets to protein databanks.

## 8.3. International Initiatives

### 8.3.1. Inria International Partners

#### 8.3.1.1. Informal International Partners

- Brazil
  - IMECC, UNICAMP, Campinas
  - COPPE, Federal University of Rio de Janeiro
  - University federal of Minas Gerais
- USA
  - Information Sciences Group (CCS-3), Los Alamos National Laboratory (LANL), Los Alamos.
  - Baylor College of Medicine, Houston
- China
  - StateKey Laboratory of Silkworm Genome Biology at the SouthWest University, Chongqing, China
- Vietnam
  - University of Cantho
- Europe
  - Bulgarian Academy of Science (BAS), Sofia, Bulgaria
  - The Genome Analysis Center, Norwich, UK
  - University of Sheffield, UK
  - University of York, UK

## 8.4. International Research Visitors

### 8.4.1. Visits of International Scientists

- Stephen Richards, Assistant Professor, Baylor College of Medicine, Houston, USA, June 2014. Stephen Richards is responsible for the sequencing and bioinformatics analysis of the genomes of arthropods. During his visit, he worked on the improvement of the pea aphid genome assembly.
- Ba Diep Nguyen, Assistant Professor, Cantho University, Vietnam Nov. 2014 to Jan. 2015 During his visit, Ba Diep Nguyen worked on the design of a new methodology for comparing metagenomic samples to protein databank.

### 8.4.2. Visits to International Teams

#### 8.4.2.1. Research stays abroad

- Rumén Andonov, Professor, Information Sciences Group (CCS-3) from Los Alamos National Laboratory (LANL), Los Alamos, USA. Jan. 2014 to Aug. 2014. R. Andonov collaborates with LANL on various research projects related to solving hard combinatorial optimization problems on very large graphs and their applications in Bioinformatics. Two applications were on the focus of this cooperation during 2014: the scaffolding problem in NGS and structural classification of proteins.

## HYBRID Project-Team

# 8. Partnerships and Cooperations

## 8.1. Regional Initiatives

### 8.1.1. Labex S3PM

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

S3PM is a 3-year project (2013-2016) funded by Labex CominLabs. It involves 3 academic research teams: Medicis (LTSI/Inserm), S4 and Hybrid (IRISA/Inria). S3PM aims at providing specific models, tools and software to create a collaborative virtual environment dedicated to neurosurgery processes using observations of real processes.

### 8.1.2. Labex HEMISFER

**Participant:** Anatole Lécuyer [contact].

HEMISFER is a 3-year project (2013-2016) funded by Labex CominLabs. It involves 4 Inria/IRISA teams (Hybrid, Visages (lead), Panama, Athena) and 2 medical centers: the Rennes Psychiatric Hospital (CHGR) and the Reeducation Department of Rennes Hospital (CHU Pontchaillou). The goal of HEMISFER is to make full use of neurofeedback paradigm in the context of rehabilitation and psychiatric disorders. The major breakthrough will come from the use of a coupling model associating functional and metabolic information from Magnetic Resonance Imaging (fMRI) to Electro-encephalography (EEG) to “enhance” the neurofeedback protocol. Clinical applications concern motor, neurological and psychiatric disorders (stroke, attention-deficit disorder, treatment-resistant mood disorders, etc).

### 8.1.3. Labex SABRE

**Participants:** Anatole Lécuyer [contact], Jussi Lindgren.

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

### 8.1.4. CNPAO Project

**Participants:** Valérie Gouranton [contact], Jean-Baptiste Barreau, Quentin Petit.

CNPAO ("Conservatoire Numérique du Patrimoine Archéologique de l'Ouest") is an on-going research project partially funded by the Université Européenne de Bretagne (UEB). It involves IRISA/Hybrid and CReAAH. The main objectives are: (i) a sustainable and centralized archiving of 2D/3D data produced by the archaeological community, (ii) a free access to metadata, (iii) a secure access to data for the different actors involved in scientific projects, and (iv) the support and advice for these actors in the 3D data production and exploration through the latest digital technologies, modeling tools and virtual reality systems.

### 8.1.5. IRT b<>com

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

b<>com is a French Institute of Research and Technology (IRT). The main goal of this IRT is to fasten the development and marketing of tools, products and services in the field of digital technologies. Our team collaborate with b<>com within two 3-year projects: ImData (on "Immersive Interaction") and GestChir (on "Augmented Healthcare").

## 8.2. National Initiatives

### 8.2.1. ANR CORVETTE

**Participants:** Bruno Arnaldi [contact], Valérie Gouranton [contact], Florian Nouviale, Thomas Lopez, Rozenn Bouville Berthelot, Thomas Boggini, Quentin Petit.

**CORVETTE** (COLlaboRative Virtual Environment Technical Training and Experiment) is a 4-year ANR project (2011-2014) led by Bruno Arnaldi. It involves 3 Academic partners (INSA Rennes, ENIB, CEA-List) and 4 Industrial partners (AFPA, Nexter Training, Virtualys, Golaem). CORVETTE aims at designing novel approaches for industrial training (maintenance, complex procedures, security, diagnosis, etc) exploiting virtual reality technologies. The project has three main research axes: collaborative work, virtual human, communication and evaluation. The project seeks to put in synergy: 1) Virtual Human for its ability to embody the user as an avatar and acting as a collaborator during training; 2) Natural communication between users and virtual humans for task-oriented dialogues; and 3) Methodologies in cognitive psychology for the assessment of the effectiveness of the collaboration of users and virtual humans to perform complex cooperative tasks in VR. All these components have been integrated into a unified environment based on an industrial scenario. Several evaluations regarding the different technologies developed in the project have also been achieved.

### 8.2.2. ANR MANDARIN

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

**MANDARIN** ("MANipulation Dextre hAptique pour opéRations INdustrielles en RV") is a 4-year ANR project (2012-2015). MANDARIN partners are CEA-List (coordinator), Inria/Hybrid, UTC, Haption and Renault. It aims at designing new hardware and software solutions to achieve natural and intuitive mono and bi-manual dextrous interactions, suitable for virtual environments. The objective of Hybrid in MANDARIN is to design novel multimodal 3D interaction techniques and metaphors allowing to deal with haptic gloves limitations (portability, under-actuation) and to assist the user in virtual reality applications requiring dexterous manipulation. The results will be evaluated with a representative industrial application which is not feasible with currently existing technologies: the bi-manual manipulation of complex rigid objects and cables bundles.

### 8.2.3. ANR HOMO-TEXTILUS

**Participants:** Anatole Lécuyer [contact], Maud Marchal, Jonathan Mercier-Ganady.

**HOMO-TEXTILUS** is a 4-year ANR project (2012-2015). Partners of the project are : Inria/Hybrid, CHART, LIP6, TOMORROW LAND, RCP and potential end-user is Hussein Chalayan fashion designer. The objective of HOMO TEXTILUS is to study what could be the next generation of smart and augmented clothes, and their influence and potential impact on behavior and habits of their users. The project is strongly oriented towards human science, with both user studies and sociological studies. The involvement of Hybrid team in the project consists in studying the design of next-gen prototypes of clothes embedding novel kinds of sensors and actuators. Envisionned sensors relate to physiological measurements such as with EEG (electroencephalography and Brain-Computer Interfaces), EMG (muscular activity), GSR (galvanic skin response) or Heart Rate (HR). Envisionned actuators relate to new sensory stimulations such as vibrotactile displays or novel visual (eg LED) displays. These prototypes will thus be used in the various experiments planned in the project.

### 8.2.4. FUI SIFORAS

**Participants:** Bruno Arnaldi [contact], Valérie Gouranton [contact], Thomas Lopez.

SIFORAS (Simulation for training and assistance) is a 3-year project (2011-2014) funded by the competitive cluster "Images et Réseaux". SIFORAS involves 4 academic partners (INSA Rennes, ENIB, CEA-List, ENISE) and 9 Industrial partners (Nexter Training, Delta CAD, Virtualys, DAF Conseils, Nexter Systems, DCNS, Renault, SNCF, Alstom). This project consists in developing a pedagogical system for technical training in industrial procedures. It aims at proposing Instructional Systems Design to answer the new objectives of training (Intelligent Tutorial System, mobility, augmented reality, high productivity). The Hybrid implication in the project shares some common means and goals with the Corvette project, in particular concerning its global architecture based on STORM and LORA models, and exploiting GVT software.

### 8.2.5. *FUI Previz*

**Participants:** Bruno Arnaldi [contact], Valérie Gouranton [contact], Rozenn Bouville Berthelot, Emmanuel Badier, Thomas Boggini.

Previz is a 3-year project (2013-2016) funded by the competitive cluster "Images et Réseaux". Previz involves 4 Academic partners (Hybrid/INSA Rennes, ENS Louis-Lumière, LIRIS, Gipsa-Lab) and 9 Industrial partners (Technicolor, Ubisoft, SolidAnim, Ioumasystem, Polymorph). Previz aims at proposing new previsualization tools for movie directors. The goal of Hybrid in Previz is to introduce new interactions between real and virtual actors so that the actor's actions, no matter his/her real or virtual nature, impact both the real and the virtual environment. The project will end up with a new production pipeline in order to automatically adapt and synchronize the visual effects (VFX), in space and time, to the real performance of an actor.

### 8.2.6. *ADT MAN-IP*

**Participant:** Valérie Gouranton [contact].

The ADT MAN-IP is a 2-year project (2013-2015) funded by Inria for software support and development. MAN-IP involves two Inria teams: Hybrid and MimeTIC. MAN-IP aims at proposing a common software pipeline for both teams to facilitate the production of populated virtual environments. The resulting software should include functionalities for motion capture, automatic acquisition and modification, and high-level authoring tools.

### 8.2.7. *ADT OpenViBE-NT*

**Participants:** Anatole Lécuyer [contact], Jussi Lindgren [contact], Jozef Legény.

The ADT OpenViBE-NT is a 3-year project (2012-2015) funded by Inria for support and development of the OpenViBE software (section 5.1). OpenViBE-NT involves four Inria teams: Hybrid, Potioc, Athena, Neurosys - all being extensive users of OpenViBE. OpenViBE-NT aims at improving the current functionalities of OpenViBE platform, and helping in supporting its active and ever growing community of users.

## 8.3. European Initiatives

### 8.3.1. *FP7 & H2020 Projects*

#### 8.3.1.1. *FP7 VISIONAIR*

**Participants:** Valérie Gouranton, Thierry Duval.

- Program: FP7-INFRA
- Project acronym: VISIONAIR
- Project title: VISION Advanced Infrastructure for Research
- Duration: Feb 2011 - Feb 2015
- Coordinator: INPG
- Other partners: INPG France, University Patras Greece, Cranfield University United Kingdom, Universiteit Twente Netherlands, Universitaet Stuttgart Germany, ICBPP Poland, Univ. Méditerranée France, CNR Italy, Inria France, KTH Sweden, Technion Israel, RWTH Germany, PUT Poland, AMPT France, TUK Germany, University Salford United Kingdom, Fraunhofer Germany, I2CAT Spain, University Essex United Kingdom, MTASEAKI Hungary, ECN France, UCL United Kingdom, Polimi Italy, European Manufacturing and Innovation Research Association
- Abstract: Visionair calls for the creation of a European infrastructure for high level visualisation facilities that are open to research communities across Europe and around the world. By integrating existing facilities, Visionair aims to create a world-class research infrastructure for conducting state-of-the-art research in visualisation, thus significantly enhancing the attractiveness and visibility of the European Research Area. Hybrid team is mainly involved in Work Package 9 (Advanced methods for interaction and collaboration) led and supervised by Prof. Georges Dumont (MimeTIC Inria team).

## 8.4. International Initiatives

### 8.4.1. Inria Associate Teams

#### 8.4.1.1. Associate Team SIMS

**Participant:** Maud Marchal [contact].

SIMS is an Inria Associate Team involving Mimetic and Hybrid Inria teams in Rennes and the GAMMA Research Group of the University of North Carolina in the United States. SIMS focuses on realistic and effective simulation of highly complex systems based on human movement and interaction. The Associate Team has three main axes of research: crowd simulation, movement planning for autonomous virtual humans and real-time physical simulation for interactive environments. The latter axis is supervised by Maud Marchal. In this context, one Master student spent 8 months in the GAMMA Research Group, starting in November 2013.

## 8.5. International Research Visitors

### 8.5.1. Visits of International Scientists

- Dr. Gerd Bruder, Postdoc at the Universität Hamburg, Germany, spent a half month stay in our group in Rennes in February 2014 to work on locomotion and distance perception in virtual environments, in the frame of EU FP7 "VISIONAIR" project.
- Mr. Michael Pereira, PhD student at EPFL, Switzerland, spent a half month stay in our group in Rennes in October 2014 to work on BCI and virtual environments, in the frame of EU FP7 "VISIONAIR" project.

### 8.5.2. Visits to International Teams

#### 8.5.2.1. Explorer programme

Merwan Achibet

Date: Sep 2014 - Dec 2014

Institution: School of Electro-Communication Tokyo, (UEC), Pr. Kajimoto, Japan

## HYCOMES Team

# 7. Partnerships and Cooperations

## 7.1. Regional Initiatives

- Ayman Aljarbouh's PhD is partially funded by an ARED grant of the Brittany Regional Council. His doctoral work takes place in the context of the Modrio and Sys2Soft projects on hybrid systems modeling — see sections 7.3.1 and 7.2 . Ayman Aljarbouh is working on accelerated simulation techniques for hybrid systems. In particular, he is focusing on the regularisation, at runtime, of chattering behaviour and the approximation of Zeno behaviour.
- Benoît Caillaud is participating to the S3PM project of the CominLabs excellence laboratory <sup>0</sup>. This project focuses on the computation of surgical procedural knowledge models from recordings of individual procedures, and their execution [24]. The objective is to develop an enabling technology for procedural knowledge based computer assistance of surgery. In this project, we demonstrate its potential added value in nurse and surgeon training.

## 7.2. National Initiatives

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

Project acronym: Sys2soft

Project title: Physics Aware Software

Duration: June 2012 – April 2016

Coordinator: Dassault Systèmes (France)

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

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

## 7.3. European Initiatives

### 7.3.1. Collaborations in European Programs, except FP7 & H2020

Program: ITEA2

Project acronym: Modrio

Project title: Model Driven Physical Systems Operation

Duration: September 2012 – November 2015

Coordinator: EDF (France)

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<sup>0</sup><http://www.cominlabs.ueb.eu/themes/project/>



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

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

## **7.4. International Initiatives**

### **7.4.1. Inria International Partners**

#### *7.4.1.1. Informal International Partners*

Extending beyond the context of the Modrio project (see section 7.3.1), the Hycomes team is collaborating with the team of Dassault Systems, located in Lund (Sweden), in charge of developing Dymola, one of the major software tools in the Modelica community.

## I4S Project-Team

# 8. Partnerships and Cooperations

## 8.1. Regional Initiatives

### 8.1.1. FONDEOL2

**Participants:** Dominique Siegert, Ivan Guéguen.

Type: Region

Objectif: wind turbines SHM

Duration: June 2011 to June 2014

Coordinator: STX France

Partners: IFSTTAR, Central School of Nantes and EGIS

Inria contact: Ivan Guéguen

Abstract: The project involves innovation supports and foundations for offshore wind around 5 lots representing the issues of the project:

- Lot 1: The design methodology
- Lot 2: Design, calculation, execution and control of offshore foundations
- Lot 3: Structural supports remote monitoring of wind
- Lot 4: Eco-design of supports and foundations for wind jacket and gravity
- Lot 5: Integration of noise reduction during pile installation in foundation design jacket

We are interested in the problem of Lot 3, structural monitoring of wind turbine supports. This lot covers an area of research in full expansion, commonly known as Structural Health Monitoring (SHM).

### 8.1.2. MAG2C-Pont Tabarly

**Participant:** Ivan Guéguen.

Type: GIS

Objectif: bridge instrumentation

Duration: Since 2014

Coordinator : LIRGEC

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

Inria contact: Ivan Guéguen

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

The instrumentation auscultates globally the structure, a structural defect in a given location changes its modal parameters and thus the vibration behavior. Then it can be detected on any part of the structure with an accelerometer. These measures coupled with a wireless data transmission system type or wifi 3g will allow remote monitoring of the evolution of the structure. And where appropriate, to deploy when necessary, for maintenance. The different objectives are

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

The instrument proposed is based on an accelerometer-based distributed network on the structure. This assembly is connected to a data acquisition system and a modem 3g for continuous measurements and remotely. The vibration will be collectable on the internet.

## 8.2. National Initiatives

### 8.2.1. High speed rail track Instrumentation

**Participant:** Ivan Guéguen.

Type: IRT

Objectif: bridge SHM

Duration: 11/2014 to 11/2018

Coordinator: RAILENIUM

Partners : IFSTTAR, EIFFAGE, RFF, LGCgE

Inria contact: Ivan Guéguen

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

The instrumentation will include: A Weather station measures environmental conditions (temperature, precipitation on the site). Accelerometers, to monitor the dynamic behavior of the track, with measures at several levels: the hammer beams on top of the grave-bitumen layer, on top of the soil. These measures will include acceleration compare the dynamic response of a section with and without GB. Instrumentation of severe bitumen strain gauges for measuring the longitudinal and transverse tensile strains at the base of the UK, and temperature probes (top and bottom layer). This instrumentation will estimate the fatigue life of the GB, temperature changes in this layer, and will calculate a temperature equivalent to the layer of GB. Instrumentation subgrade by means of measurement gauges at the top of the vertical deformation of the soil, and TDR probes to measure changes in water content. Its objective is to measure the levels of distortion in the upper part of the soil, and their variations, in conjunction with the seasonal variations in water content. An anchored sensor, measuring the total deflection between the top of the GB and a reference point that is 4 m deep. This sensor will measure the total displacement of the structure beneath the ballast (GB + layer of granular soil leveling + support). These will also serve as a reference for comparison with the movements deducted from accelerometer measurements. Continuous optical fiber, to measure static permanent deformation in the transverse direction over the entire width of the structure at the base of the sub-layer. These optical fibers used to monitor deformation obtained following the transverse profile in the game with underlay in the UK (in ballast) and the part with underlay GNT (Differential settlement, appearance of a crack ...).

### 8.2.2. REPTILES

**Participant:** Jean Dumoulin.

Type: FUI

Objectif: Innovation for rehabilitation of potable water tubes

Duration: Since 11/2012

Coordinator: FREYSSINET

Inria contact: J. Dumoulin

Since 2012, within FUI Reptiles, J. Dumoulin was coordinator of the conception, study and development of a thermoplastic composite assembly system for water tubes reinforcement. Moreover, infrared thermography was used for active control.

### 8.2.3. SIPRIS

**Participants:** Laurent Mevel, Dominique Siegert, Ivan Guéguen, Vincent Le Cam, Mathieu Le Pen, Michael Doehler.

contract 6841.

Type: FUI

Objectif: Systèmes d'Instrumentation pour la prévention des risques

Duration: June 2013 to June 2014

Coordinator: ADVITAM

Inria contact: L. Mevel

**Abstract:** The project concerns the behavior of a prestressed concrete beam, a series of vibration and displacement measurement was carried out in line with internal stresses due to the cables. This followed an experimental modal analysis and study of the variations of modal parameters on the beam. As part of the project, the laboratory signaling gantry of IFSTTAR Nantes was instrumented to perform an experimental system for automatic damage detection based on monitoring the natural modes of vibration. The gantry was also modeled by the finite element method to predict the variations of the first natural frequencies of vibration for a damage event catalog. The gantry is a metallic structure of 8x12 m, formed by the assembly of profiled aluminum alloy welded. This portico was installed there thirty years on the site. Each pillar is fixed in a massive concrete anchor with threaded rods 10, which are critical for the stability of the gantry. CAD geometric model made with Solidworks that was used for the mesh structure with shell elements. The FE mesh consists of 59231 triangular elements at 6 knots, the model has a total of 143,831 nodes. The thicknesses of the shells of the parts constituting the structure are between 3 and 25 mm. The mechanical properties of the aluminum alloy are reported in the table below. The boundary conditions applied to the model consisted of blocking the degrees of freedom of movement and rotation on the edges of holes arranged to pass the threaded rods. The mesh is refined in the vicinity of the holes. The results give an excellent correlation between simulation and experiment on the relative value for the third mode. The correlation is smaller for the first and the second mode. An update of the numerical model can refine the correlation between simulation and experiment, especially the absolute value of frequencies. As shown in the simulation and experimentation, modes with greater frequency of changes generally important in their relative value.

Tests were performed on laboratory test slabs SII Nantes

Very good progresses has also been validated compared to the problems encountered on PEGASE 1 due to memory limitations (few memory, no MMU, reduced Linux...). A global method is currently tested: transcoding SSI algorithms from Matlab sources to C codes using the Matlab-coder toolbox. Thus code execution is compared to the results got from Matlab from a common benchmark of data files

### 8.2.4. Collaboration with ISAE

**Participants:** Laurent Mevel, Ahmed Jhinaoui.

Ahmed Jhinaoui has finished his thesis on helicopter instability. This thesis was co-directed by professor Morlier from ISAE, France. This thesis is funded by FP7-NMP Large Scale Integrated Project IRIS.

### 8.2.5. Collaboration with GEM

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

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

## 8.3. European Initiatives

### 8.3.1. FP7 & H2020 Projects

#### 8.3.1.1. ISMS

**Participants:** Michael Doehler, Laurent Mevel.

Type: FP7

Defi: Internet-Based Structural Monitoring System

Instrument: Industry-Academia Partnerships and Pathway

Objectif: Develop damage detection framework for SHM

Duration: September 2010 - August 2014

Coordinator: Palle Andersen

Partner: Structural Vibration Solutions (Denmark), University of British Columbia (Canada)

Inria contact: Laurent Mevel

Abstract:

ISMS aimed to address the significant commercial opportunity and rapidly emerging technological potential of improved Damage Detection or Structural Health Monitoring (SHM) technologies for large-scale civil infrastructure by challenging significant and non-trivial, inter-disciplinary and intersectoral barriers currently preventing industrial application and take-up of these technologies. The principal strategic objective of ISMS was joint design and development of a fully automated internet-based damage detection procedure robust to environmental changes with application to fully instrumented large-scale civil infrastructures, primarily bridges [50].

### 8.3.2. Collaborations in European Programs, except FP7 & H2020

#### 8.3.2.1. European Research Network on System Identification (ERNSI)

**Participants:** Qinghua Zhang, Michael Doehler, Laurent Mevel.

The I4S project-team is involved in the activities of the European Research Network on System Identification (ERNSI) federating major European research teams on system identification, currently teams from 8 countries. Modeling of dynamical systems is fundamental in almost all disciplines of science and engineering, ranging from life science to process control. System identification concerns the construction, estimation and validation of mathematical models of dynamical physical or engineering phenomena from experimental data.

#### 8.3.2.2. MODRIO

**Participants:** Qinghua Zhang, Liangquan Zhang.

Type: ITEA2

Defi: Model Driven Physical Systems Operation

Objectif: To meet the evermore stringent safety and environmental regulations for power plants and transportation vehicles, system operators need new techniques to improve system diagnosis and operation.

Duration: June 2012 to November 2015

Coordinator: Daniel Bouskela (EDF)

Inria teams PARKAS, HYCOMS, I4S

Inria contact: B. Caillaud

Abstract: Open standards are necessary for different teams to cooperate by sharing compatible information and data. The objective of the MODRIO project is to extend modeling and simulation tools based on open standards from system design to system diagnosis and operation. This project joined by partners from Austria, Belgium, Finland, France, Germany, Italy and Sweden has been selected by the board of Information Technology for European Advancement (ITEA 2).

### 8.3.2.3. COST Action TU 1402

**Participants:** Michael Doehler, Laurent Mevel.

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

M. Doehler is co-leader of working group 2 "SHM technologies and structural performance".

Type: COST

Objectif: Quantifying the value of structural health monitoring

Duration: 11/2014 - 11/2018

Coordinator: S. Thoens (DTU Denmark)

Partner: 23 countries, see [http://www.cost.eu/COST\\_Actions/tud/Actions/TU1402](http://www.cost.eu/COST_Actions/tud/Actions/TU1402)

Inria contact: Laurent Mevel

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

### 8.3.2.4. EBONSI

**Participant:** Qinghua Zhang.

Type: ANR-NSFC

Objectif: Extended Block-Oriented Nonlinear System Identification

Duration: from April 2011 to March 2014.

Coordinator: Qinghua Zhang

Partner: CRAN, Laboratory of Industrial Process Monitoring and Optimization of Peking University.

Inria contact: Qinghua Zhang

Abstract: The main idea of block-oriented nonlinear system identification is to model a complex system with interconnected simple blocks. Such models can cover a large number of industrial applications, and are yet simple enough for theoretic studies. The objectives of the EBONSI project are to extend classical block-oriented nonlinear models to new model structures motivated by industrial applications, and to relax some traditional restrictions on experimental conditions. This is an international project jointly funded by the French Agence Nationale de la Recherche (ANR) and the Chinese National Natural Science Foundation (NSFC).

## IPSO Project-Team

## 6. Partnerships and Cooperations

### 6.1. National Initiatives

#### 6.1.1. ANR Programme blanc international (BLAN) LODIQUAS 2012-2015

**Participants:** Philippe Chartier, Florian Méhats, Francois Castella, Mohammed Lemou.

The project, entitled "LODIQUAS" (for: Low DIMensional QUANTum Systems), received fundings for 4 postdocs (48 months) and one pre-doc (36 months). The whole project involves the following researchers : Norbert Mauser (Vienna), Erich Gornik (Vienna), Mechthild Thalhammer (Innsbruck), Christoph Naegerl (Innsbruck), Jörg Schmiedmayer (Vienna), Hans-Peter Stimming (Vienna), Francis Nier (Rennes), Raymond El Hajj (Rennes), Claudia Negulescu (Toulouse), Fanny Delebecque (Toulouse), Stéphane Descombes (Nice), Christophe Besse (Lille).

Quantum technology as the application of quantum effects in macroscopic devices has an increasing importance, not only for far future goals like the quantum computer, but already now or in the near future. The present project is mainly concerned with the mathematical and numerical analysis of these objects, in conjunction with experimental physicists.

#### 6.1.2. ANR MOONRISE: 2015-2019

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

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

#### 6.1.3. ANR Programme blanc GYPSI: 2010-2014

**Participant:** Nicolas Crouseilles.

Leader: Ph. Gendrih.

The full description is available at <https://sites.google.com/site/anrgypsi/>

#### 6.1.4. ANR Programme blanc E2T2: 2010-2014

**Participant:** Nicolas Crouseilles.

Leader: P. Beyer

## 6.2. European Initiatives

### 6.2.1. FP7 & H2020 Projects

#### 6.2.1.1. Geopardi

Type: FP7

Defi: NC

Instrument: ERC Starting Grant

Objectif: NC

Duration: September 2011 - August 2016

Coordinator: E. Faou

Inria contact: E. Faou

### **6.2.2. Collaborations in European Programs, except FP7 & H2020**

#### *6.2.2.1. Verification of global gyrokinetic codes and development of new algorithms for gyrokinetic and kinetic codes*

Project acronym: EUROFusion CFP-WP14-ER-01/IPP-03: 2014

Project title: verification of global gyrokinetic codes and development of new algorithms for gyrokinetic and kinetic codes

Duration: 2013-2014

Participants: N. Crouseilles and M. Lemou

Coordinator: E. Sonnendrücker

#### *6.2.2.2. Enabling Research Project for the implementation of the fusion roadmap*

Project acronym: EUROFusion

Project title: Enabling Research Project for the implementation of the fusion roadmap

Duration: 2015-2017

Participants: N. Crouseilles and M. Lemou

Coordinator: E. Sonnendrücker

## **6.3. International Research Visitors**

### **6.3.1. Visits of International Scientists**

- L. Einkemmer, University of Innsbruck, two weeks, november 2014.
- Y. Zhang, WPI, Vienna, 3 months.

### **6.3.2. Visits to International Teams**

#### *6.3.2.1. Research stays abroad*

- N. Crouseilles visited the group of P. Coelho (Universitat tecnico de Lisboa, Portugal), one week (november 2014).
- M. Lemou and N. Crouseilles visited the India Institute of Science at Bangalore (India): from december 2d to december 17th, 2013. Visited team: around Raghurama Rao.
- M. Lemou visited the Wisconsin university, Madison (USA): from February 1st to February 16th, 2014. Visited team: around Shi Jin.
- P. Chartier, M. Lemou and F. Méhats visited the university of San Sebastien, Pays Basque (Spain): from June 8th to June 13th 2014.



## KerData Project-Team

# 8. Partnerships and Cooperations

## 8.1. National Initiatives

### 8.1.1. ANR

MapReduce (2010–2014). An ANR project (ARPEGE 2010) with international partners, which focuses on optimized Map-Reduce data processing on cloud platforms. This project started in October 2010 in collaboration with Argonne National Lab, the University of Illinois at Urbana Champaign, the UIUC/Inria Joint Lab on Petascale Computing, IBM, IBCP, MEDIT and the GRAAL Inria Project-Team. URL: <http://mapreduce.inria.fr/>.

### 8.1.2. ADT

ADT BlobSeer (2013–2014). To support the development of the BlobSeer software for ongoing cooperations, Inria provided support for a research engineer. Loïc Cloatre has been hired as a senior engineer for the second year of this project, starting in February 2014.

### 8.1.3. Other National projects

HEMERA (2010–2014). An Inria Large Wingspan Project, started in 2010. Within Hemera, G. Antoniu (KerData Inria Team) and Gilles Fedak (GRAAL Inria Project-Team) co-lead the Map-Reduce scientific challenge.

KerData also co-initiated a working group called *Efficient management of very large volumes of information for data-intensive applications*, co-led by G. Antoniu and Jean-Marc Pierson (IRIT, Toulouse).

Grid'5000. We are members of the Grid'5000 community: we make experiments on the Grid'5000 platform on a daily basis.

## 8.2. European Initiatives

### 8.2.1. FP7 and H2020 Projects

BigStorage (2015–2018)

Program: European Training Network (ETN).

Coordinator: María S. Pérez.

Partners: Universidad Politécnica de Madrid (UPM), Barcelona Supercomputing Center (PSC), Johannes Gutenberg Universität Mainz, Foundation for Research and Technology - Hellas (FORTH), Xyratex Technology Limited, Deutsches Klimarechenzentrum, CA Technologies, Fujitsu Technology Solutions GmbH, French Atomic Agency CEA, IBM Research Ireland, Bull SAS, and Informatica El Corte Ingles.

Abstract: The consortium of this Marie-Curie Innovative Training Networks (ITN) *BigStorage: Storage-based Convergence between HPC and Cloud to handle Big Data* aims at training future data scientists in order to enable them and us to apply holistic and interdisciplinary approaches for taking advantage of a data-overwhelmed world, which requires HPC and Cloud infrastructures with a redefinition of storage architectures underpinning them — focusing on meeting highly ambitious performance and energy usage objectives. KerData mainly collaborates with UPM and PSC 2 co-advised PhD theses).

### 8.2.2. Collaborations in European Programs, except FP7 and H2020

Program: EIT ICT Labs.

Project acronym: EUROPA Activity - Future Cloud Action Line.

Project title: Big Data Analytics with Apache Flink for Real Business Use-Cases.

Duration: May 2014–December 2014.

Coordinator: Gabriel Antoniu, Alexandru Costan.

Participants: Anirvan Basu, Camelia Ciolac.

Other partners: TU Berlin (Germany), VTT (Finland), F-Secure (Finland).

Abstract: In this project, we study the requirements with respect to Big Data analytics today, following several interviews with representative companies from various domains ranging from online mobile gaming to security and logistics. The goal is to identify those requirements that could be addressed by the Apache Flink (formerly known as Stratosphere) platform and apply them in some real-life business scenarios. We first present the state-of-the-art in the field of Big Data analytics, then validate the novel features of Flink. Finally we study how some of the requirements needed by the industry could be addressed by the latter, and illustrate them with 2 real use-cases. To this end, Camelia Ciolac and Anirvan Basu were hired and implemented two demos showing the use of Flink to solve Big Data problems from 2 companies: a mobile games developer (Tribeflame) and a security company (F-Secure), respectively.

## 8.3. International Initiatives

### 8.3.1. Inria International Labs

JLESC: Joint Laboratory on Extreme-Scale Computing. This laboratory is jointly run by Inria, UIUC, ANL and BSC. It has been created in 2014 as a follow-up of the Inria-UIUC JLPC to collaborate on concurrency-optimized I/O for Extreme-scale platforms (see details in Section 4.3). This project is an extension of the Joint Inria-UIUC Laboratory for Petascale Computing (JLPC) which was used as the basis of the Data@Exascale Associate Team with ANL and UIUC (2013–2015).

### 8.3.2. Inria Associate Teams

Data@Exascale

Title: Ultra-scalable I/O and storage for Exascale systems

Inria principal investigator: Gabriel Antoniu

International Partners:

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

University of Illinois at Urbana Champaign (United States) - Marc Snir

Duration: 2013–2015

See also: <http://www.irisa.fr/kerdata/data-at-Exascale/>

Description: as the computational power used by large-scale scientific applications increases, the amount of data manipulated for subsequent analysis increases as well. Rapidly storing this data, protecting it from loss and analyzing it to understand the results are significant challenges, made more difficult by decades of improvements in computation capabilities that have been unmatched in storage. For many applications, the overall performance and scalability becomes clearly driven by the performance of the I/O subsystem. As we anticipate Exascale systems in 2020, there is a growing consensus in the scientific community that revolutionary new approaches are needed in computational science storage. These challenges are at the center of the activities of the Joint Inria-UIUC Lab for Petascale Computing, recently extended to Argonne National Lab. This project gathers researchers from Inria, Argonne National Lab and the University of Illinois at Urbana Champaign to address 3 goals: 1) investigate new storage architectures for Exascale systems; 2) investigate new approaches to the design of I/O middleware for Exascale systems to optimize data processing and visualization, leveraging dedicated I/O cores and I/O forwarding techniques; 3) explore techniques enabling adaptive cloud data services for HPC.

### 8.3.3. Participation In other International Programs

FP3C ANR-JST project (2010–2014). This project co-funded by ANR and by JST (Japan Science and Technology Agency) started in October 2010 for 42 months. It focuses on programming issues for Post-Petascale architectures. In this framework, KerData collaborates with the University of Tsukuba on data management issues. Rohit Saxena was hired as an engineer until February 2014.

### 8.3.4. Inria International Partners

#### 8.3.4.1. Declared Inria International Partners

Politehnica University of Bucharest. This status was established since January 2013, right after the end of our former DataCloud@work Associate Team.

#### 8.3.4.2. Informal International Partners

Huazhong University of Science and Technology (HUST), China. We collaborate on optimizing Map-Reduce in virtualized environments.

Nanyang Technological University (NTU). We collaborate on optimizing Big Data applications in the Cloud and HPC systems.

## 8.4. International Research Visitors

### 8.4.1. Visits of International Scientists

Robert Ross (Argonne National Lab) visited the KerData team for one week (June 2014) within the framework of the Data@Exascale Associate Team, as an Invited Professor funded by the University of Rennes 1.

### 8.4.2. Internships

Stefan Ene

Subject: Overlapping cloud data transfers and computation for incremental Map-Reduce.

Date: April–September 2014.

Institution: Master student from Politehnica University of Bucharest (Romania). Co-funded by the Inria Internships Program.

Andreea Pintilie

Subject: Bio-informatics inspired algorithms for fast cloud data transfers.

Date: April–September 2014.

Institution: Master student from Politehnica University of Bucharest (Romania). Co-funded by the Inria Internships Program.

Anh-Phuong Tran

Subject: Failure-aware job scheduling in Hadoop cloud data centers.

Date: February–June 2014.

Institution: Master student enrolled in the European Master in Distributed Computing (EMDC) program, a joint program between KTH Royal Institute of Technology in Sweden and Instituto Superior Tecnico in Portugal.

Tien Dat Phan

Subject: A simulation approach to evaluate Map-Reduce performance under failure.

Date: February 2014–June 2014.

Institution: Master student from University Rennes 1, Rennes (France)

Orçun Yildiz

Subject: (In-)Efficiency in energy consumption of data management on Petascale super-computers.

Date: February–July 2014.

Institution: Master student enrolled in the European Master in Distributed Computing (EMDC) program, a joint program between KTH Royal Institute of Technology in Sweden and Instituto Superior Tecnico in Portugal.

Thomas Bouguet

Subject: Development of a web platform for the analysis of Darshan I/O log files.

Date: May–July 2014.

Institution: Master student from University Rennes 1, Rennes (France).

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

Lokman Rahmani visited ANL (Rob Ross, Tom Peterka) for 2 months, funded by the PUF NextGen project in the context of the Joint Laboratory for Extreme-Scale Computing (JLESC).

## LAGADIC Project-Team

# 8. Partnerships and Cooperations

## 8.1. Regional Initiatives

### 8.1.1. Oseo Apash project

**Participants:** François Pasteau, Marie Babel.

*no Insa Rennes 2012-230, duration: 24 months.*

Started in September 2012 and finished in July 2014, the Apash project was supported by the Images & Réseaux cluster. It involved three laboratories connected to INSA Rennes, namely Irisa/Inria, IETR and LGCGM. One industrial partner took part into this project: Ergovie. This project aimed at designing a driving assistance for electrical wheelchair towards the autonomy and security of disabled people. The work realized within this project is described in Section 6.2.1 .

### 8.1.2. HandiViz project - SATT Ouest Valorisation

**Participants:** François Pasteau, Marie Babel.

*duration: 12 months.*

This project started in June 2014. Thanks to a strong collaboration with Ergovie Company and the rehabilitation center Pôle Saint Hélier (Rennes), the semi-autonomous navigation solution designed for wheelchair systems (see Section 6.2.1 ) has been medically validated and tested by patients. The resulting technology is currently under transfer towards Ergovie (SATT/INSA funding). This technology, compliant with any off-the-shelf electrical wheelchair, is expected to be commercialized at mid 2015. We expect that this technology should be helpful for many handicapped people. In particular, clinical trials have shown that such a system can lift the medical interdiction to drive wheelchairs for people who suffer from severe handicap such as hemispatial neglect or cerebral palsy.

### 8.1.3. ARED NavRob

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

*no Inria Rennes 8033, duration: 36 months.*

This project funded by the Brittany council started in October 2013. It supports in part Suman Raj Bista's Ph.D. about visual navigation of a humanoid robot (see Section 8.2.4 ).

### 8.1.4. "Équipement mi-lourd Rennes Métropoles"

**Participant:** Paolo Robuffo Giordano.

*no Irisa CNRS Rennes 14C0481, duration: 36 months.*

A grant from "Rennes Métropole" has been obtained in June 2014 and will support the activities related to the use of drones (quadrotor UAVs). The platform described in Section 5.4.5 has been purchased thanks to this grant.

## 8.2. National Initiatives

### 8.2.1. ANR P2N Nanorobust

**Participants:** Le Cui, Eric Marchand.

*no. UR1 11FA310-06D, duration: 48 months.*

This project started in November 2011. It is composed of a consortium managed by Femto-ST in Besançon with LPN and Isir in Paris, Thalès and Lagadic group through the “Université de Rennes 1”. Nanorobust deals with the development of micro- and nano-manipulation within SEM (Scanning Electron Microscope). Our goal is to provide visual servoing techniques for positioning and manipulation tasks with a nanometer precision.

### 8.2.2. ANR Contint Visioland

**Participants:** Noël Mériaux, Patrick Rives, François Chaumette.

*duration: 48 months.*

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

### 8.2.3. PEA Decsa

**Participants:** Aurélien Yol, Eric Marchand.

*no Inria Rennes 6630, duration: 36 months.*

This project started in November 2011. It is composed of a consortium managed by Astrium/Airbus with the Novadem, Sirehna, Spot Image and Magellium companies, and with the Inria Lagadic and Steep groups (Peter Sturm). It is devoted to the development of navigation and perception algorithms for small drones in urban environment.

### 8.2.4. Oseo Romeo 2

**Participants:** Nicolas Cazy, Suman Raj Bista, Fabien Spindler, Paolo Robuffo Giordano, François Chaumette.

*no Inria Rennes 7114, duration: 48 months.*

This project started in November 2012. It is composed of a large consortium managed by Aldebaran Robotics. It aims to develop advanced control and perception functionalities to a humanoid robot. It supports in part Suman Raj Bista’s Ph.D. about visual navigation of a humanoid robot, as well as Nicolas Cazy’s Ph.D. about model-based predictive control for visual servoing.

### 8.2.5. Equipex Robotex

**Participants:** Fabien Spindler, François Chaumette.

*no Inria Rennes 6388, duration: 10 years.*

Lagadic is one of the 15 French partners involved in the Equipex Robotex network. It is devoted to get significative equipments in the main robotics labs in France. In a near future, we plan to buy a humanoid robot, Romeo, by Aldebaran Robotics.

### 8.2.6. Inria large scale initiative action PAL

**Participants:** Panagiotis Papadakis, François Pasteau, Vishnu Karakkat Narayanan, Erwan Demairy, Marie Babel, Patrick Rives, François Chaumette.

Lagadic participates in the large-scale initiative action PAL (Personally Assisted Living) to develop technologies and services to improve the autonomy and quality of life for elderly and fragile persons. PAL started in September 2009 for 5 years. The purpose of PAL is to provide an experimental infrastructure, in order to facilitate the development of models, tools, technologies and concept demonstrations. Using the skills and objectives of the involved teams, four research themes have been defined: a) assessing the degree of frailty of the elderly, b) mobility of people, c) rehabilitation, transfer and assistance in walking, and d) social interaction. Lagadic is currently involved in the themes "mobility of people" and "assistance in walking" through collaborations with the EPI e-Motion (Grenoble), EPI Coprin (Sophia-Antipolis), and Handibio (Toulon). See Sections 6.2.1 , 6.2.2 and 6.1.4 , as well as [55].

## 8.3. European Initiatives

### 8.3.1. FP7 & H2020 Projects

#### 8.3.1.1. FP7 Space RemoveDEBRIS

**Participants:** Eric Marchand, Fabien Spindler, François Chaumette.

Instrument: Specific Targeted Research Project

Duration: from October 2013 till September 2016

Coordinator: University of Surrey (United Kingdom)

Partner: Surrey Satellite Technology (United Kingdom), Astrium (Toulouse, France and Bremen, Germany), Isis (Delft, The Netherlands), CSEM (Neuchâtel, Switzerland), Stellenbosch University (South Africa).

Inria contact: François Chaumette

Abstract: The goal of this project is to validate the model-based tracking algorithms developed during Antoine Petit's Ph.D. (see Section 6.3.1) on images acquired during an actual space debris removal mission.

#### 8.3.1.2. FP7 Regpot Across

**Participant:** François Chaumette.

Program: Regpot

Project acronym: Across

Project title: Center of Research Excellence for Advanced Cooperative Systems

Duration: from September 2011 till March 2015

Coordinator: Prof. Ivan Petrovic from University of Zagreb (Croatia)

Other partners: KTH (Sweden), ETHZ (Switzerland), TUM (Germany), University of Manchester (UK), Vienna University of Technology (Austria), Politecnico di Milano (Italy), University of Sevilla (Spain), Eindhoven University of Technology (The Netherlands), University of Athens (Greece), etc.

Abstract: the goal of this project is to enhance collaborations with the University of Zagreb.

## 8.4. International Initiatives

### 8.4.1. Inria Associate Teams

**Participant:** Marie Babel.

Sampen (Self Adaptive Mobile Perception and Navigation) is an Inria associated team with the Iceira Lab supervised by Prof Ren C. Luo at the National University of Taiwan. It has been accepted in 2014 for 2 years. The coordinator of the team for Inria is Anne Spalanzani from UPMF University at Grenoble. The other French participants are Marie Babel, Daney David (Phoenix group in Bordeaux) and Christian Laugier (e-Motion group in Grenoble).

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

#### *8.4.1.1. Informal International Partners*

- As a follow up to the long term collaboration with the “Centro de Tecnologia da Informação Renato Archer” (CTI) in Campinas (Brazil), a new Ph.D. student, Renato José Martins, joined the team in Sophia Antipolis thanks to a grant from the CNPq (2013-2017). He is co-directed by Patrick Rives and Samuel Siqueira Bueno from “Divisão de Robótica e Visão Computacional” at CTI.
- Alexandre Krupa has a collaboration with Nassir Navab from the Technische Universität München concerning the joint supervision of Pierre Chatelain’s Ph.D.
- Patrick Rives has a collaboration with Javier Gonzales-Jimenez from the University of Malaga (Spain). Eduardo Fernandez-Moral who received his PhD in Malaga by September 2014, is currently on a Postdoctoral position in Sophia Antipolis.

## **8.5. International Research Visitors**

### *8.5.1. Visits of International Scientists*

- Hideaki Uchiyama, associate professor at Kyushu University, Japan, visited the group in Rennes for 3 weeks in December 2014 to work on augmented reality.
- Ivan Markovic, postdoctoral researcher at the University of Zagreb, spent a three-month visit in Rennes in the scope of the FP7 Regpot Across project (see Section [8.3.1.2](#) and [6.2.4](#) ).

### *8.5.2. Visits to International Teams*

- Pierre Chatelain spent 2 one-week visits in Nassir Navab’s lab at TUM, Germany, in the scope of his Ph.D.



## LINKMEDIA Project-Team

# 8. Partnerships and Cooperations

## 8.1. Regional Initiatives

### 8.1.1. *CominLabs Project CominWeb*

**Participants:** Vincent Claveau, Sébastien Le Maguer.

*Duration:* 1 year

*Partners:* Univ. Nantes

*URL:* <http://www.cominweb.cominlabs.ueb.eu>

In the framework of the CominWeb projet, a 50k€ contract was granted by the Labex CominLabs to the team to carry a preliminary study about text similarity models in different contexts: information retrieval, content based recommendation, etc.

### 8.1.2. *CominLabs Project Linking Media in Acceptable Hypergraphs (LIMAH)*

**Participants:** Rémi Bois, Sébastien Campion, Vincent Claveau, Guillaume Gravier, Patrick Gros, Pascale Sébillot.

*Duration:* 4 years, started in April 2014

*Partners:* Telecom Bretagne (IODE), Univ. Rennes II (CRPCC, PREFics), Univ. Nantes (LINA/TAL)

*URL:* <http://limah.irisa.fr>

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

## 8.2. National Initiatives

### 8.2.1. *ANR Project FIRE-ID*

**Participants:** Sébastien Campion, Philippe-Henri Gosselin, Patrick Gros, Hervé Jégou.

*Duration:* 3 years, started in May 2012

*Partner:* Xerox Research Center Europe

The FIRE-ID project considers the semantic annotation of visual content, such as photos or videos shared on social networks, or images captured by video surveillance devices or scanned documents. More specifically, the project considers the fine-grained recognition problem, where the number of classes is large and where classes are visually similar, for instance animals, products, vehicles or document forms. We also assumed that the amount of annotated data available per class for the learning stage is limited.

### 8.2.2. *ANR Project Secular*

**Participants:** Laurent Amsaleg, Teddy Furon, Hervé Jégou, Ewa Kijak.

*Duration:* 3 years, started in September 2012

Partners: Morpho, Univ. Caen GREYC, Telecom ParisTech

Content-based retrieval systems (CBRS) are becoming the main multimedia security technology to enforce copyright laws or to spot illegal contents over the Internet. However, CBRS were not designed with privacy, confidentiality and security in mind. This comes in serious conflict with their use in these new security-oriented applications. Privacy is endangered due to information leaks when correlating users, queries and the contents stored-in-the-clear in the database. This is especially the case of images containing faces which are so popular in social networks. Biometrics systems have long relied on protection techniques and anonymization processes that have never been used in the context of CBRS. The project seeks to a better understanding of how biometrics related techniques can help increasing the security levels of CBRS while not degrading their performance.

## 8.3. European Initiatives

### 8.3.1. FP7 & H2020 Projects

#### 8.3.1.1. VIAMASS

Type: FP7

Instrument: ERC Starting Grant

Duration: 04/2014 – 03/2019

Coordinator: Hervé Jégou

Inria contact: Hervé Jégou

Abstract: VIAMASS is a ERC Starting grant project coordinated by Hervé Jégou and with Teddy Furon as co-investigator. The goal of the project is to automatically discover visual links within a very large collection of images. These “visual hyper-links” will connect the objects across the images of the collection. This raises a major obstacle with respect to scalability: cross matching all the images is of quadratic complexity when performed with a brute-force approach. To this end, VIAMASS addresses issues at the frontier of the current state of the art in computer vision and signal processing.

#### 8.3.1.2. Forensic Image Identifier and Analyzer

Program: Eurostars

Duration: 03/2011 – 07/2014

Coordinator: Videntifier Technologies

Other partners: Videntifier Technologies (Iceland), Forensic Pathways (UK)

Abstract: FIIA is an innovative software service for the Forensic market that automatically identifies and analyzes the content of images on web sites and seized computers. The service saves time and money, gathers better evidence, and builds stronger court cases. We are in charge of helping with the technology needed to identify the logos from terrorist organizations that are inserted in images or videos. Challenges are related to the poor resolution and small size of logos as well as to the very strict efficiency constraints that the logo detector must match.

## 8.4. International Initiatives

### 8.4.1. Inria Associate Teams

#### 8.4.1.1. MOTIF

Title: Unsupervised motif discovery in multimedia content

International Partner (Institution - Laboratory - Researcher):

Pontifícia Universidade Católica de Minas Gerais - VIPLAB - Silvio Jamil Guimãraes

Universidade Federal Minas Gerais - NPDI - Arnaldo Albuquerque de Araújo

Duration: 2014 - 2017

See also: <http://www.icei.pucminas.br/projetos/viplab/projects/associate-team/index.html>

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

## **8.4.2. Inria International Partners**

### *8.4.2.1. Informal International Partners*

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

## **8.4.3. Other International Programs**

- PICS CNRS MM-Analytics
  - Title: Fouille, visualisation et exploration multidimensionnelle de contenus multimédia ; Multi-Dimensional Multimedia Browsing, Mining, Analytics (num 6382).
  - International Partner (Institution - Laboratory - Researcher):  
Reykjavík University, Iceland - Björn Þór Jónsson
  - Jan. 2014 – Dec. 2016
- STIC AmSud MAXIMUM Unsupervised Multimedia Content Mining
  - International coordinator: Guillaume Gravier, CNRS – IRISA, France
  - Scientific coordinators : Arnaldo de Albuquerque Araújo (Universidade Federal de Minas Gerais, Computer Science Department, NPDI); Benjamin Bustos (Universidad de Chile, Department of Computer Science, PRISMA); Silvio Jamil F. Guimarães (Pontifícia Universidade Católica de Minas Gerais, VIPLAB)
  - Jan. 2014 - Dec. 2015

## **8.5. International Research Visitors**

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

Yannis Avrithis

Dates: October 2014 (2 weeks)

Institution: National Technical University of Athens (Greece)

### **8.5.2. Internships**

Miaoqing Shi

Dates: February 2014–January 2015 (1 year)

Subject: Large scale visual search

Institution: Pekin University (China)

### **8.5.3. Visits to International Teams**

#### *8.5.3.1. Research stays abroad*

Petra Bosilj

Date: Sep. – Nov., 2014

Institution: Johann Bernoulli institute, Groningen, The Netherlands

Anca-Roxana Simon

Date: Apr. – June, 2014

Institution: Katholieke Universiteit Leuven, Belgium

## MIMETIC Project-Team

# 8. Partnerships and Cooperations

## 8.1. National Initiatives

### 8.1.1. ANR

#### 8.1.1.1. ANR *iSpace&Time*

**Participants:** Fabrice Lamarche [contact], Carl Jorgensen, Julien Pettré, Marc Christie.

The *iSpace&Time* project is founded by the ANR and gathers six partners: IGN, Lamea, University of Rennes 1, LICIT (IFSSTAR), Telecom ParisTech and the SENSE laboratory (Orange). The goal of this project is the establishment of a demonstrator of a 4D Geographic Information System of the city on the web. This portal will integrate technologies such as web2.0, sensor networks, immersive visualization, animation and simulation. It will provide solutions ranging from simple 4D city visualization to tools for urban development. Main aspects of this project are:

- Creation of an immersive visualization based on panoramic acquired by a scanning vehicle using hybrid scanning (laser and image).
- Fusion of heterogeneous data issued by a network of sensor enabling to measure flows of pedestrians, vehicles and other mobile objects.
- Use of video cameras to measure, in real time, flows of pedestrians and vehicles.
- Study of the impact of a urban development on mobility by simulating vehicles and pedestrians.
- Integration of temporal information into the information system for visualization, data mining and simulation purpose.

The mimetic team is involved in the pedestrian simulation part of this project. This project started in 2011 and ended in november 2014.

#### 8.1.1.2. ANR *TecSan RePLiCA*

**Participants:** Armel Créteul [contact], Anthony Sorel, Richard Kulpa.

The goal of *RePLiCA* project is to build and test a new rehabilitation program for facial praxia in children with cerebral palsy using an interactive device.

In a classical rehabilitation program, the child tries to reproduce the motion of his/her therapist. The feedback he/she has lays on the comparison of different modalities: the gesture of the therapist he/she has seen few seconds ago (visual space) and his/her own motion (proprioceptive space). Unfortunately, besides motor troubles these children often have some cognitive troubles and among them a difficulty to convert the information from a mental space to another one.

The principle of our tool is that during a rehabilitation session the child will observe simultaneously on the same screen an avatar, the virtual therapist's one, performing the gesture to be done, and a second avatar animated from the motion he actually performs. To avoid the use of a too complex motion capture system, the child will be filmed by a simple video camera. One first challenge is thus to be able to capture the child's facial motion with enough accuracy. A second one is to be able to provide him/her an additional feedback upon the gesture quality comparing it to a database of healthy children of the same age.

*RePLiCA* did start in january 2012 and will end in July 2015.

#### 8.1.1.3. ANR *JCJC Cinecitta*

**Participants:** Marc Christie [contact], Cunka Sanokho.

Cinecitta is a 3-year young researcher project funded by the French Research Agency (ANR) lead by Marc Christie. The project started in October 2012 and will end in October 2015.

The main objective of Cinecitta is to propose and evaluate a novel workflow which mixes user interaction using motion-tracked cameras and automated computation aspects for interactive virtual cinematography that will better support user creativity. We propose a novel cinematographic workflow that features a dynamic collaboration of a creative human filmmaker with an automated virtual camera planner. We expect the process to enhance the filmmaker's creative potential by enabling very rapid exploration of a wide range of viewpoint suggestions. The process has the potential to enhance the quality and utility of the automated planner's suggestions by adapting and reacting to the creative choices made by the filmmaker. This requires three advances in the field. First, the ability to generate relevant viewpoint suggestions following classical cinematic conventions. The formalization of these conventions in a computationally efficient and expressive model is a challenging task in order to select and propose the user with a relevant subset of viewpoints among millions of possibilities. Second, the ability to analyze data from real movies in order to formalize some elements of cinematographic style and genre. Third, the integration of motion-tracked cameras in the workflow. Motion-tracked cameras represent a great potential for cinematographic content creation. However given that tracking spaces are of limited size, there is a need to provide novel interaction metaphors to ease the process of content creation with tracked cameras. Finally we will gather feedback on our prototype by involving professionals (during dedicated workshops) and will perform user evaluations with students from cinema schools.

#### *8.1.1.4. ANR Contint Entracte*

**Participants:** Charles Pontonnier, Georges Dumont, Steve Tonneau, Franck Multon, Julien Pettré [contact], Ana Lucia Cruz Ruiz, Antoine Muller, Anthony Sorel, Nicolas Bideau, Richard Kulpa.

The ANR project ENTRACTE is a collaboration between the Gepetto team in LAAS, Toulouse (head of the project) and the Inria/MimeTIC team. The project started in November 2013 and will end in August 2017. The purpose of the ENTRACTE project is to address the action planning problem, crucial for robots as well as for virtual human avatars, in analyzing human motion at a biomechanical level and by defining from this analysis bio-inspired motor control laws and bio-inspired paradigms for action planning. The project is launched since november 2013 and Ana-Lucia Cruz-Ruiz has been recruited as a PhD student since this date to begin to work on musculoskeletal-based methods for avatar animation. Moreover, Steve Tonneau, a PhD student currently in third year is also developing bio-inspired posture generators for avatar navigation in encumbered environments.

### **8.1.2. ADT**

#### *8.1.2.1. ADT Man IP*

**Participants:** Franck Multon [contact], Julian Joseph.

The ADT-MAN-IP aims at proposing a common production pipeline for both MimeTIC and Hybrid teams. This pipeline intends to facilitate the production of populated virtual reality environments.

The pipeline starts with the motion capture of an actor, using motion capture devices such as a Vicon (product of Oxford Metrics) system. To do so, we need to design new methods to automatically adapt all motion captures data to an internal skeleton that can be reused to retarget the motion to various types of skeletons and characters. The purpose is then to play this motion capture data on any type of virtual characters used in the demos, regardless their individual skeletons and morphology. The key point here is to make this process be as automatic as possible. During the first year, a software toolbox has been developed in Motion Builder (product of Autodesk) to automate this process. We also developed automatic following methods to make virtual humans locomote along a given path in the environment in Unity 3D.

The second step in the pipeline is to design a high level scenario framework to describe a virtual scene and the possible user's interactions with this scene so that he/she can interact with the story directly. This work will be performed in 2015.

In this ADT we also will have to connect these two opposite parts into a unique framework that can be used by non-experts in computer animation to design new immersive experiments involving autonomous virtual humans. The resulting framework could consequently be used in the Immersia immersive room for various types of application.

## 8.2. European Initiatives

### 8.2.1. FP7 & H2020 Projects

#### 8.2.1.1. VISIONAIR

**Participants:** Georges Dumont [contact], Charles Pontonnier, Thierry Duval, Valérie Gouranton, Ronan Gaugne.

Our actual Virtual Reality systems allowed us to be a key partner within the European Project VISIONAIR (<http://www.infra-visionair.eu/>) that began in February 2011 in the infrastructure call of FP7. Our Immersia (<http://www.irisa.fr/immersia>) Virtual Reality room is, in Europe, a key place for virtual reality. We are leading the Work Package 9 on Advanced methods for interaction and collaboration of this project and are deeply involved in the directory board and in the scientific piloting committee. The VISIONAIR project's goal is to create a European infrastructure that should be a unique, visible and attractive entry towards high level visualization facilities. These facilities will be open to the access of a wide set of research communities. By integrating our existing facilities, we will create a world-class research infrastructure enabling to conduct frontier research. This integration will provide a significant attractiveness and visibility of the European Research Area. The partners of this project have proposed to build a common infrastructure that would grant access to high level visualization and interaction facilities and resources to researchers. Indeed, researchers from Europe and from around the world will be welcome to carry out research projects using the visualization facilities provided by the infrastructure. Visibility and attractiveness will be increased by the invitation of external projects.

This project is built with the participation of 26 partners, INPG ENTREPRISE SA IESA France, Institut Polytechnique de Grenoble France, University of Patras LMS Greece, Cranfield University United Kingdom, Universiteit Twente Twente Netherlands, Universitaet Stuttgart Germany, Instytut Chemii Bioorganicznej Pan Pscn Poland, Université De La Méditerranée D'aix-Marseille II France, Consiglio Nazionale Delle Ricerche CNR Italy, Institut National de Recherche en Informatique et en Automatique Inria France, Kungliga Tekniska Hoegskolan Sweden, Technion - Israel Institute of Technology Israel, Rheinisch-Westfaelische Technische Hochschule Aachen RWTH Germany, Poznan University of Technology Poland, Arts et Métiers ParisTech AMPT France, Technische Universitaet Kaiserslautern Germany, The University of Salford United Kingdom, Fraunhofer-gesellschaft zur foerderung der Angewandten Forschung Germany, fundacio privada I2CAT Spain, University of Essex United Kingdom, Magyar Tudományok Akadémia Számítástechnikai Es Automatizálási Kutató Intézet Hungary, École Centrale de Nantes France, University College of London United Kingdom, Politecnico di Milano Polimi Italy, European Manufacturing and Innovation Research Association (cluster leading excellence).

We organized the General Assembly of VISIONAIR, in Rennes Bretagne Atlantique Inria Research centre from 2014, dec. second to dec. fourth. We hosted 60 participants and had very interesting scientific presentations.

## 8.3. International Initiatives

### 8.3.1. Inria Associate Teams

#### 8.3.1.1. FORMOSA

Title: Fostering Research on Models for Storytelling Applications

International Partner (Institution - Laboratory - Researcher):

National Cheng Chi University (TAIWAN)

Duration: 2013 - 2015

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

The application context targeted by this proposal is Interactive Virtual Storytelling. The growing importance of this form of media reveals the necessity to re-think and re-assess the way narratives are traditionally structured and authored. In turn, this requires from the research community to address complex scientific and technical challenges at the intersection of literature, robotics, artificial intelligence, and computer graphics. This joint collaboration addresses three key issues in virtual storytelling: (i) delivering better authoring tools for designing interactive narratives based on literary-founded narrative structures, (ii) establishing a bridge between the semantic level of the narrative and the geometric level of the final environment to enable the simulation of complex and realistic interactive scenarios in 3D, and (iii) providing a full integration of the cinematographic dimension through the control of high-level elements of filmic style (pacing, preferred viewpoints, camera motion). The project is founded on a past solid collaboration and will rely on the team's complementarity to achieve the tasks through the development of a joint research prototype.

#### 8.3.1.2. SIMS

Title: Toward realistic and efficient simulation of highly complex systems

International Partner (Institution - Laboratory - Researcher):

University of North Carolina at Chapel Hill (ÉTATS-UNIS)

Duration: 2012 - 2014

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

The general goal of SIMS is to make significant progress toward realistic and efficient simulation of highly complex systems which raise combinatory explosive problems. This proposal is focused on human motion and interaction, and covers 3 active topics with wide application range: 1. Crowd simulation: virtual human interacting with other virtual humans, 2. Autonomous virtual humans: who interact with their environment, 3. Physical Simulation: real humans interacting with virtual environments. SIMS is orthogonally structured by transversal questions: the evaluation of the level of realism reached by a simulation (which is a problem by itself in the considered topics), considering complex systems at various scales (micro, meso and macroscopic ones), and facing combinatory explosion of simulation algorithms.

## MYRIADS Project-Team

# 6. Partnerships and Cooperations

## 6.1. Regional Initiatives

### 6.1.1. CominLabs EPOC project (2013-2016)

**Participants:** Sabbir Hasan Rochi, Yunbo Li, Anne-Cécile Orgerie, Jean-Louis Pazat.

In this project, partners aim at focusing on energy-aware task execution from the hardware to application's components in the context of a mono-site data center (all resources are in the same physical location) which is connected to the regular electric Grid and to renewable energy sources (such as windmills or solar cells). In this context, we tackle three major challenges:

- Optimizing the energy consumption of distributed infrastructures and service compositions in the presence of ever more dynamic service applications and ever more stringent availability requirements for services.
- Designing a clever cloud's resource management which takes advantage of renewable energy availability to perform opportunistic tasks, then exploring the trade-off between energy saving and performance aspects in large-scale distributed systems.
- Investigating energy-aware optical ultra high-speed interconnection networks to exchange large volumes of data (VM memory and storage) over very short periods of time.

### 6.1.2. EcoPaaS, Brittany region SAD project(2014-2015)

**Participants:** Maria Del Mar Callau Zori, Anne-Cécile Orgerie, Guillaume Pierre, Lavinia Samoila.

Many research efforts have been dedicated to reducing cloud energy consumption, in particular by optimizing the Infrastructure-as-a-Service layer of the Cloud. Infrastructure-as-a-Service (IaaS) is the layer in charge of the virtualization of physical resources, and therefore has direct control over energy-related elements. However, the IaaS layer has no knowledge about the nature of applications which run over these resources, which limits the scope of decisions it can take.

The EcoPaaS project therefore aim at making the IaaS layer (in charge of resources) and the PaaS layer (in charge of applications) collaborate to further reduce the Cloud energy consumption. The idea is to define standard interfaces that allow both layers to exchange relevant information and to coordinate their actions. Exchanging information will for example allow the PaaS layer to estimate the energy consumption of each application it is running. Coordinating actions will in turn allow the system to avoid situations where both layers simultaneously take mutually-damaging actions. This project is funding Maria del Mar Callau-Zori's postdoc.

### 6.1.3. Monitoring for Cloud Security, collaboration with DGA-MI (2014-2017)

**Participants:** Anna Giannakou, Christine Morin, Jean-Louis Pazat, Louis Rilling.

Our study aims at designing a self-adaptable system for security supervision in clouds. The considered system should cope with the dynamic nature of clouds and have a minimal impact on performance. The funding from DGA funds a PhD student, Anna Giannakou, who joined Myriads team in March 2014. Anna Giannakou is co-advised by Christine Morin (Inria), Jean-Louis Pazat (INSA Rennes) and Louis Rilling (DGA-MI). Louis Rilling was formally appointed as external collaborator in Myriads team effective from March 1st 2014.

### 6.1.4. IRT B-Com

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



Yvon Jégou and Jean-Louis Pazat are at IRT B-Com<sup>0</sup> one day per week. With Édouard Outin, B-com PhD student, they contribute to the B-Com *Indeed* project, which aims at developing a distributed cloud software stack with a high degree of adaptability.

## 6.2. National Initiatives

### 6.2.1. Inria ADT GinFlow (2014-2016)

**Participants:** Christine Morin, Javier Rojas Balderrama, Matthieu Simonin, Cédric Tedeschi.

The GinFlow technological development action funded by INRIA targets the development of a fully-operational workflow management system based on the HOCL-TS software prototype developed during the PhD thesis of Héctor Fernandez between 2009 and 2012. Also, it allows the integration of this software with the TIGRES workflow engine developed at the Lawrence Berkeley National Lab so as to make the workflows submitted using the TIGRES programming model run in a decentralized fashion.

### 6.2.2. Inria ADT Snooze (2012-2014)

**Participants:** Eugen Feller, Yvon Jégou, David Margery, Christine Morin, Anne-Cécile Orgerie, Matthieu Simonin.

The Snooze technological development action funded by INRIA aims at developing an IaaS cloud environment based on the Snooze virtual machine framework developed by the team (<http://snooze.inria.fr>) and to make this new environment available to a wide community. In 2014, we refactored some parts of the code to enable the use of plugins. We also developed the Cloud Agnostic Checkpointing Service (CACS) service on top of Snooze to enable application recovery in the event of the failure of servers hosting virtual machines [31].

### 6.2.3. HEMERA Inria AEN (2010-2014)

**Participants:** Bogdan Florin Cornea, Yvon Jégou, Anne-Cécile Orgerie.

The Myriads team is involved in the HEMERA large wingspan project funded by INRIA (<http://www.grid5000.fr/mediawiki/index.php/Hemera>). This project aims at demonstrating ambitious up-scaling techniques for large scale distributed computing by carrying out several dimensioning experiments on the Grid'5000 infrastructure, at animating the scientific community around Grid'5000 and at enlarging the Grid'5000 community by helping newcomers to make use of Grid'5000. Yvon Jégou is co-chair of the "Bring Grids Power to Internet-Users thanks to Virtualization Technologies" working group. Anne-Cécile Orgerie is involved in the "Energy" working group which is currently looking at making energy-aware experiments on Grid'5000 easier for the users. This project funded Bogdan Florin Cornea's postdoc supervised by Anne-Cécile Orgerie and Laurent Lefèvre (Inria, LIP, Lyon).

### 6.2.4. Inria IPL CityLab (under submission) (2014-2018)

**Participants:** Roberto-Gioacchino Cascella, Christine Morin.

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

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

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<sup>0</sup><http://b-com.org/wp/>

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

**Participants:** Yvon Jégou, Christine Morin.

The MIMHES project (<http://www.inra.fr/mihmes>) led by INRA/BioEpAR aims at producing scientific knowledge and methods for the management of endemic infectious animal diseases and veterinary public health risks. Myriads team will provide software tools to efficiently manage and ease the use of a distributed computing infrastructure for the execution of different simulation applications.

In 2014, we interacted with the INRA/BioEpAR research team in order to improve the initial software prototype and to make it ready for parallelisation. A first parallel version of the code was delivered by Inria during summer 2014. This first version uses the OpenMP standard to exploit multiple processor cores of the same server. A speed-up approaching 20 has been observed on a 24-cores Dell server for a single run. A whole simulation necessitates multiple runs (a few hundreds) to reach precise results. During the next steps, the presence of these runs will be exploited both to increase the volume of the internal computations (increase the efficiency of multi-core computation) and to exploit multiple servers.

### 6.2.6. CNRS GDS EcoInfo

**Participant:** Anne-Cécile Orgerie.

The EcoInfo group deals with reducing environmental and societal impacts of Information and Communications Technologies from hardware to software aspects. This group aims at providing critical studies, lifecycle analyses and best practices in order to improve the energy efficiency of printers, servers, data centers, and any ICT equipment in use in public research organizations.

## 6.3. European Initiatives

### 6.3.1. FP7 & H2020 Projects

#### 6.3.1.1. CONTRAIL

**Participants:** Roberto-Gioacchino Cascella, Stefania Costache, Florian Dudouet, Filippo Gaudenzi, Yvon Jégou, Christine Morin.

Type: COOPERATION

Defi: Internet of Services, Software & Virtualisation

Instrument: Integrated Project

Objectif: Internet of Services, Software and Virtualisation

Duration: October 2010 - January 2014

Coordinator: Inria

Partner: XLAB Razvoj Programske Opreme In Svetovanje d.o.o., Slovenia; Italian National Research Council, ISTI-CNR & IIT-CNR, Italy; Vrije Universiteit Amsterdam, The Netherlands; Science and Technology Facilities Council, STFC, UK; Genias Benelux bv, The Netherlands; Tiscali Italia SpA, Italy; Konrad-Zuse-Zentrum für Informationstechnik Berlin, ZIB, Germany; Hewlett Packard Italiana S.r.l - Italy Innovation Center, Italy; Country Constellation Technologies Ltd, UK; Linagora, France.

Inria contact: Christine Morin

Abstract: The goal of the Contrail project is to design, implement, evaluate and promote an open source system for Cloud Federations. Resources that belong to different operators will be integrated into a single homogeneous federated Cloud that users can access seamlessly. The Contrail project has built a complete Cloud platform which integrates Infrastructure-as-a-Service (IaaS) and Platform-as-a-Service (PaaS) offerings [2].

### 6.3.1.2. *ECO<sub>2</sub>Clouds*

**Participants:** Maxence Dunnewind, Nicolas Lebreton, Julien Lefeuvre, David Margery, Eric Poupart.

Type: FP7

Defi: Future internet experimental facility and experimentally-driven research

Instrument: Specific Targeted Research Project

Objectif: Future Internet Research and Experimentation (FIRE)

Duration: October 2012 - September 2014

Coordinator: Atos Spain SA (ATOS, Spain)

Partner: Atos Spain SA (ATOS, Spain) The University of Manchester (UNIMAN, United Kingdom) The University of Edinburgh (UEDIN, United Kingdom) Universitaet Stuttgart (USTUTT, Germany) Politecnico di Milano (POLIMI, Italy)

Inria contact: David Margery

Abstract: In *ECO<sub>2</sub>Clouds*, we add to *BonFIRE* energy probes to be able to measure power consumption of the infrastructure, combine it with information about energy sources used to produce the power so as to be able to bill CO<sub>2</sub> usage to experimenters running VMs. To allow for scheduling and adaptation of running applications, CO<sub>2</sub> usage is not only billed after the fact but also quoted in advance for a given period for according to resource usage units.

### 6.3.1.3. *Fed4FIRE*

**Participants:** Maxence Dunnewind, Julien Lefeuvre, David Margery.

Type: FP7

Defi: Future internet experimental facility and experimentally-driven research

Instrument: Integrated Project

Objectif: ICT-2011.1.6 Future Internet Research and Experimentation (FIRE) with a specific focus on b) FIRE Federation

Duration: October 2012 - September 2016

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

Partner: Interdisciplinary institute for broadband technology (iMinds, Belgium), University of Southampton (It Innovation, United Kingdom) Universite Pierre et Marie Curie - paris 6 (UPMC, France) Fraunhofer-Gesellschaft zur Foerderung der Angewandten Forschung e.v (Fraunhofer, Germany) Technische Universitat Berlin (TUB, Germany) The University of Edinburgh (UEDIN, United Kingdom) National Ict Australia Limited (NICTA, Australia) Atos Spain SA (Atos, Spain) Panepistimio Thessalias (University of Thessaly) (UTH, Greece) National Technical University of Athens (NTUA, Greece) University of Bristol (UNIVBRIS, United Kingdom) Fundacio Privada i2cat, Internet I Innovacio Digital a Catalunya (i2cat, Spain) Eurescom-European Institute for Research and Strategic Studies in Telecommunications (EUR, GmbH Germany) Delivery of Advanced Network Technology to Europe limited (DANTE limited, United Kingdom) Universidad de Cantabria (UC, Spain) National Information Society agency (NIA, Korea (republic of))

Inria contact: David Margery

Abstract: In *Fed4FIRE*, we investigate the means by which our experimental platforms (*BonFIRE*, and in a secondary way *Grid'5000*) could be made interoperable with a wider eco-system of experimental platforms in Europe and beyond. The baseline architectural choice for this project is to use the key concepts of the Slice Federation Architecture (SFA) to provision resources on experimental platforms, a Control and Management Framework for Networking Testbeds named OMF for experiment control and OML, the OMF Measurement library for data collection. We investigate whether these can be used to run experiments on *BonFIRE* and how they need to be extended to support the operating model of *BonFIRE*.

#### 6.3.1.4. HARNESS

**Participants:** Eliya Buyukkaya, Georgios Ioannidis, Ancuta Iordache, Guillaume Pierre, Genc Tato.

Type: COOPERATION

Defi: Pervasive and Trusted Network and Service Infrastructures

Instrument: Small or medium-scale focused research project

Objectif: ICT-2011.1.2 Cloud Computing, Internet of Services and Advanced Software Engineering

Duration: October 2012 - September 2015

Coordinator: Imperial College London (IMP, United Kingdom)

Partner: Ecole polytechnique fédérale de Lausanne (EPFL, Switzerland), Université de Rennes 1 (UR1, France), Konrad-Zuse-Zentrum für Informationstechnik Berlin (ZIB, Germany), Maxeler Technologies (MAX, United Kingdom), SAP AG (SAP, Germany)

UR1 contact: Guillaume Pierre

Abstract: The HARNESS FP7 project aims to incorporate innovative hardware and network technologies seamlessly into data centres that provide platform-as-a-service cloud infrastructures.

The dominant approach in offering cloud services today is based on homogeneous commodity resources: large numbers of inexpensive machines, interconnected by off-the-shelf networking equipment, supported by stock disk drives. However, cloud service providers are unable to use this platform to satisfy the requirements of many important and high-value classes of applications.

Today's cloud platforms are missing out on the revolution in new hardware and network technologies for realising vastly richer computational, communication, and storage resources. Technologies such as Field Programmable Gate Arrays (FPGA), General-Purpose Graphics Processing Units (GPGPU), programmable network routers, and solid-state disks promise increased performance, reduced energy consumption, and lower cost profiles. However, their heterogeneity and complexity makes integrating them into the standard Platform as a Service (PaaS) framework a fundamental challenge.

The HARNESS project brings innovative and heterogeneous resources into cloud platforms through a rich programme of research, validated by commercial and open source case studies.

#### 6.3.1.5. PaaSage

**Participants:** Christine Morin, Nikolaos Parlavantzas, Aboozar Rajabi.

Type: COOPERATION

Objectif: ICT-2011.1.2 Cloud Computing, Internet of Services and Advanced Software Engineering

Instrument: Collaborative Project

Duration: October 2012 - September 2016

Coordinator: GEIE ERCIM (France)

Partner: SINTEF (Norway), Science and Technology Facilities Council (UK), University of Stuttgart (Germany), Inria (France), Centre d'Excellence en Technologies de l'Information et de la Communication (Belgium), Foundation for Research and Technology Hellas (Greece), BE.Wan SPRL (Belgium), EVRY AS (Norway), SysFera SAS (France), Flexiant Limited (UK), Lufthansa Systems AG (Germany), Gesellschaft für Wissenschaftliche Datenverarbeitung MBH Gottingen (Germany), Automotive Simulation Center Stuttgart (Germany), University of Ulm (Germany), Akademia Górniczo-Hutnicza im. Stanisława Staszica (Poland), University of Cyprus (Cyprus), IBSAC-Intelligent Business Solutions Ltd (Cyprus), University of Oslo (Norway)

Inria contact: Nikolaos Parlavantzas

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

Abstract: PaaSage aims to deliver an open and integrated platform to support both deployment and design of Cloud applications, together with an accompanying methodology that allows model-based application development, configuration, optimisation, and deployment on multiple Cloud infrastructures.

### 6.3.2. Collaborations in European Programs, except FP7 & H2020

#### 6.3.2.1. NESUS

**Participant:** Anne-Cécile Orgerie.

Program: ICT COST

Project acronym: NESUS

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

Duration: 2014 - 2018

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

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

Abstract: Ultrascale systems are envisioned as large-scale complex systems joining parallel and distributed computing systems that will be two to three orders of magnitude larger 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. Some of the most active research groups of the world in this area are members of this proposal. This Action will increase the value of these groups at the European-level by reducing duplication of efforts and providing a more holistic view to all researchers, it will promote the leadership of Europe, and it will increase their impact on science, economy, and society.

#### 6.3.2.2. MC-DATA

**Participants:** Stéphane Chevalier, Teodor Crivat, Guillaume Pierre.

Program: EIT ICT Labs

Project acronym: MC-DATA

Project title: Multi-cloud data management

Duration: Jan-Dec 2014

Coordinator: Dr. Peter Pietzuch, Imperial College London

Other partners: SICS, Vodafone

Abstract: In 2014, the continuation of the MC-Data project had two main innovation objectives: (a) to provide and release a novel open-source Platform-as-a-Service (PaaS) cloud computing software stack (MC-ConPaaS) that explicitly targets cloud application deployments across multiple data centre sites; (b) to demonstrate the business value of the MC-ConPaaS platform through a use case of cloud-assisted real-time smartphone applications, thus affecting the future business models of mobile operators. Its expected outcomes are:

- to release the MC-ConPaaS multi-site cloud platform as open source;
- to foster the adoption of the MC-ConPaaS platform by creating tutorials and documentation;
- to transfer the technology of the MC-ConPaaS platform to a mobile operator (VODAFONE), enabling them to offer a cloud infrastructure that supports cloud-assisted real-time applications;
- to develop new business models for mobile operators based on cloud-assisted real-time services running on virtualised mobile base stations.

### 6.3.2.3. VEP-S

**Participants:** Roberto-Gioacchino Cascella, Yvon Jégou, Christine Morin, Arnab Sinha.

Program: EIT ICT Labs

Project acronym: VEP-S

Project title: SLA-Aware Heterogeneous Data-Centers Management through Standards

Duration: Jan-Dec 2014

Coordinator: Christine Morin, Inria

Other partners: Intel (Ireland), Reply (Italy)

**Abstract:** We designed the VEP-S system, which consists of the Virtual Execution Platform (VEP) component with support for OCCI, integration of the OCCI SLA extension, and the monitoring system for deploying and running distributed applications packaged following the Open Virtualization Format (OVF), a DMTF standard, on top of an IaaS cloud. The Virtual Execution Platform (VEP), developed in the framework of Contrail European project, is in charge of provisioning hardware resources from Cloud providers and to deploy and run distributed applications submitted by users under the control of a negotiated Service Level Agreements (SLA). VEP interacts with the underlying IaaS manager to create application networks, register VM images, generate VM templates and manage the lifecycle of virtual machines. The OCCI SLA API extends the OCCI Core Model to implement a SLA management API. This API allows for the creation and management of resources related with the realization of agreements between an OCCI-enabled cloud service provider and potential consumers of the provider's resources. In the context of the VEP-S project, this extension is used to describe SLA terms and map them with the resources and services a cloud provider can offer. The monitoring component will provide three types of services: monitoring the IaaS resource manager to check whether the machine has started or not; monitoring the IaaS to check the usage of the resources; monitoring on the VM (monitoring agent in the VM and activated by the user). The technology used for the monitoring is Zabbix.

## 6.4. International Initiatives

### 6.4.1. Inria International Labs

Christine Morin was one of the co-organizers of the BIS 2014 workshop held in Paris in June 2014 in the framework of the Inria@Silicon Valley Inria International Lab. Christine Morin and Deb Agarwal were the co-chairs of the session on computation and communication for the future internet at BIS 2014. Several Myriads team members (Christine Morin, Anne-Cécile Orgerie, Javier Rojas Balderrama, Matthieu Simonin, Cédric Tedeschi) are involved in the DALHIS associate team on data analysis on large-scale heterogeneous infrastructures for science, which is part of the Inria@SiliconValley program.

### 6.4.2. Inria Associate Teams

#### 6.4.2.1. DALHIS

**Participants:** Christine Morin, Anne-Cécile Orgerie, Javier Rojas Balderrama, Matthieu Simonin, Cédric Tedeschi.

Title: Data Analysis on Large Heterogeneous Infrastructures for Science

International Partner (Institution - Laboratory - Researcher):

Lawrence Berkeley National Laboratory, Berkeley, USA

Data Science and Technology department

French PI: Christine Morin

American PI: Deb Agarwal, head of the Data Science and Technology department

Duration: 2013 - 2015

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

The worldwide scientific community is generating large datasets at increasing rates causing data analysis to emerge as one of the primary modes of science. Existing data analysis methods, tools and infrastructure are often difficult to use and unable to handle the “data deluge”. A scientific data analysis environment needs to address three key challenges: a) programmability: easily composable and reusable programming environments for analysis algorithms and pipeline execution, b) agility: software that can adapt quickly to changing demands and resources, and, c) scalability: take advantage of all available resource environments including desktops, clusters, grids, clouds and HPC environments. The goal of the DALHIS associated team is to coordinate research and create together a software ecosystem to facilitate data analysis seamlessly across desktops, HPC and cloud environments. Specifically, our end goal is to build a dynamic environment that is user-friendly, scalable, energy-efficient and fault tolerant through coordination of existing projects. We plan to design a programming environment for scientific data analysis workflows that will allow users to easily compose their workflows in a programming environment such as Python and execute them on diverse high-performance computing (HPC) and cloud resources. We will develop an orchestration layer for coordinating resource and application characteristics. The adaptation model will use real-time data mining to support elasticity, fault-tolerance, energy efficiency and provenance. We investigate how to provide execution environments that allow users to seamlessly execute their dynamic data analysis workflows in various research environments. The work done in 2014 on scientific workflows, energy efficiency and data management is described respectively in Sections 5.5.1, 5.4.1 and 5.3.3. Christine Morin, Anne-Cécile Orgerie, Javier Rojas Balderrama, Cédric Tedeschi and Deb Agarwal participated in the BIS 2014 workshop held in Paris in June 2014. Christine Morin and Deb Agarwal were the co-chairs of the session on Computation and communication for the Future Internet at BIS 2014. Cédric Tedeschi presented the DALHIS activities during this session focusing on our results on scientific workflows. Deb Agarwal has been awarded an Inria International Chair for the 2015-2019 period enabling long visits in the Myriads team.

### **6.4.3. Inria International Partners**

#### *6.4.3.1. Informal International Partners*

**Northeastern University** We started a collaboration with Professor Gene Cooperman, Northeastern University, Boston, USA on the design of a cloud agnostic checkpointing service on top of IaaS clouds for reliable application execution, inter-cloud application migration and easing application "cloudification". Gen Cooperman was hosted in Myriads team for a 1.5-month visit in March-April 2014. His PhD student, Jiajun Cao did a 3-month internship in Myriads team from May to August 2014.

**ORNL/TTU** We collaborate on cloud computing with Stephen Scott, Professor at Tennessee Tech University (TTU) and researcher at Oak Ridge National Laboratory (ORNL) in the USA. He visited Myriads team in July 2014 to investigate synergetic work directions on cloud security.

**Argonne/ Chicago University** We collaborate on cloud computing with Kate Keahey from Argonne National Laboratory, USA. She hosted Ismael Cuadrado Cordero in her team for a 12-week summer internship (June-September 2014) on using extended on-availability leases to increase utilization in scientific IaaS clouds.

**University of Guadalajara** Nikolaos Parlavantzas is collaborating with the team of Prof. Héctor Duran-Limon of the University of Guadalajara, Mexico, preparing a joint ANR-CONACYT project submission.

**VU University amsterdam** We collaborate with Thilo Kielmann’s research group at VU University Amsterdam on research and development around the ConPaaS system. This collaboration has led to two joint publications this year, and another paper has been accepted in 2015.

## **6.5. International Research Visitors**

### **6.5.1. Visits of International Scientists**

Jiajun Cao, PhD student at the Northeastern University (Boston, USA), made a 3-month visit in Myriads team (May-August 2014). He contributed to the design, implementation and evaluation of a cloud agnostic checkpointing service exploiting the DMTCP process-level checkpointing technology developed in Gene Cooperman's team at the Northeastern University. This service was experimented on top of Snooze IaaS cloud management system developed in Myriads team. A paper on this work will be presented at CC-Grid 2015.

Gene Cooperman, Professor at the Northeastern University (Boston, USA), made a 1.5 month sabbatical visit in Myriads team (March-April 2014). His visit was partially funded by the University of Rennes 1.

Georgios Ioannidis (PhD student at EPFL, Switzerland) made a 3-months visit in the Myriads team (Oct-Dec 2014). The goal was to reinforce the collaboration between the two teams in the context of the HARNESS FP7 project.

Palakiyem Wallah, assistant professor at the University of Kara (Togo) visited Myriads team from October to December 2014 in the framework of his PhD thesis, which is co-advised by Jean-Louis Pazat and Cédric Tedeschi.

Qian Zhang (PhD student at the Australian National University) spent 3 weeks in Myriads team in October 2014 to learn more about our research activities on SLA management. Her visit was supported by a grant from the Australian-French Association for Science and Technology (AFAS).

#### *6.5.1.1. Internships*

Vishrut Mehta Vishrut

Date: May 2014 - Jul 2014

Institution: IITH (India)

### **6.5.2. Visits to International Teams**

#### *6.5.2.1. Research stays abroad*

Ancuta Iordache visited Maxeler Technologies (London, U.K.) from May 1st 2014 to July 31st 2014. This visit reinforced the collaboration between the two teams in the context of the HARNESS E.U. project, and was funded by the EIT ICT Labs Doctoral Training Center. We plan another 3-months visit in 2015.

Ismael Cuadrado Cordero, who is a student of the EIT ICT Labs Doctoral School, visited the Argonne National Laboratory (USA) for a research internship from June to September 2014. He was hosted in Kate Keahey's team working on resource management in scientific clouds.



## PANAMA Project-Team

# 8. Partnerships and Cooperations

## 8.1. National Initiatives

### 8.1.1. Labex Comin Labs projets

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

#### 8.1.1.1. HEMISFER

**Participant:** Rémi Gribonval.

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

Research axis: 3.1

CominLabs partners : EPI VISAGES; EPI HYBRID; EPI PANAMA

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

Coordinator: Christian Barillot, EPI VISAGES

*Description: The goal of HEMISFER is to make full use of neurofeedback paradigm in the context of rehabilitation and psychiatric disorders. The major breakthrough will come from the use of a coupling model associating functional and metabolic information from Magnetic Resonance Imaging (fMRI) to Electro-encephalography (EEG) to "enhance" the neurofeedback protocol. We propose to combine advanced instrumental devices (Hybrid EEG and MRI platforms), with new man-machine interface paradigms (Brain computer interface and serious gaming) and new computational models (source separation, sparse representations and machine learning) to provide novel therapeutic and neuro-rehabilitation paradigms in some of the major neurological and psychiatric disorders of the developmental and the aging brain (stroke, attention-deficit disorder, language disorders, treatment-resistant mood disorders, ...).*

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

Hybrid Eeg-MrI and Simultaneous neuro-feedback for brain Rehabilitation

#### 8.1.1.2. TEPN

**Participant:** Rémi Gribonval.

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

Research axis: 3.1

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

Coordinator: Nicolas Montavont, IRISA OCIF - Telecom Bretagne

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

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

Toward Energy Proportional Networks

### **8.1.2. OSEO-FUI: S-POD: “Assistance à personnes en danger potentiel”**

**Participants:** Frédéric Bimbot, Romain Lebarbenchon, Ewen Camberlein.

*Duration: August 2012-November 2016*

*Research axis: 3.2*

*Partners: ERYMA, CAPT/FOTON, CASSIDIAN, KAPTALIA, KERLINK, le LOUSTIC and Telecom Bretagne*

*Coordinator: ERYMA*

*Description: S-POD gathers research teams and industrial partners to that aim at setting up a framework to process and fuse audio, physiological and contextual data. The goal is to design an embedded autonomous system able to detect situations of potential danger arising in the immediate environment of a person (military, police, CIT, fire, etc.)*

*Contribution of PANAMA: PANAMA is in charge of R&I activities related to the qualitative and quantitative analysis of information from the acoustic environment (intensity, direction of arrival, nature of noise sounds, properties of voices, etc.) as well as to the exploitation of these analyses. The need for real-time embedded processing induces specific constraints.*

### **8.1.3. Action de Développement Technologique: FASST**

**Participants:** Nancy Bertin, Frédéric Bimbot, Jules Espiau de Lamaestre, Nathan Souviraà -Labastie.

*Duration: 2 years (2012–2014).*

*Research axis: 3.2.2*

*Partners: Inria Teams Parole (Nancy) and Texmex (Rennes)*

*Description: This Inria ADT aims to develop a new version of our FASST audio source separation toolbox in order to facilitate its large-scale dissemination in the source separation community and in the various application communities. A specific effort will be made towards the speech processing community by developing an interface with existing speech recognition software. The software was publicly released in January 2014.*

## 8.2. European Initiatives

### 8.2.1. FP7 & H2020 Projects

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

**Participants:** Rémi Gribonval, Srdan Kitic, Pierre Machart, Cagdas Bilen, Luc Le Magoarou, Nancy Bertin, Nicolas Keriven, Yann Traonmilin, Laurent Albera, Gilles Puy.

*Duration:* January 2012 - December 2016

*Research axis:* 3.1

*Principal investigator:* Rémi Gribonval

*Program:* ERC Starting Grant

*Project acronym:* PLEASE

*Project title:* Projections, Learning and Sparsity for Efficient data processing

*Abstract:* The Please ERC is focused on the extension of the sparse representation paradigm towards that of sparse modeling, with the challenge of establishing, strengthening and clarifying connections between sparse representations and machine learning

*Web site:* <https://team.inria.fr/panama/projects/please/>

## 8.3. International Initiatives

### 8.3.1. Inria International Partners

#### 8.3.1.1. Informal International Partners

PANAMA has strong recurrent collaborations with the LTS2 lab at EPFL, the Center for Digital Music at Queen Mary University of London, the Institute for Digital Communications at the University of Edinburgh.

## 8.4. International Research Visitors

### 8.4.1. Visits of International Scientists

- Mike Davies, in November, Professor of Signal and Image Processing, University of Edinburgh
- Pierre Vandergheynst, in November, Professor of Signal and Image Processing, EPFL
- Karin Schnass, in July, University of Innsbruck Department of Mathematics
- Gilles Blanchard, in May, Professor, University of Postdam
- Ivan Dokmanic, in January, Assistant Professor, EPFL, Lausanne

#### 8.4.1.1. Internships

- Thomas Aubert, from April until June, University of Rennes 1
- Theo Dabreteau, from June until August, Insa of Rennes
- Melanie Ducoffe, from February until June, ENS Rennes
- Anh-tho Le, from April until June, University of Hanoi
- Maxime Lecoq, from April until July, University of Rennes 1

## SAGE Project-Team

# 7. Partnerships and Cooperations

## 7.1. Regional Initiatives

### 7.1.1. *Brittany council: FRACINI project*

**Participants:** Jean-Raynald de Dreuzy, Jocelyne Erhel, Géraldine Pichot.

Contract with Brittany council

Duration: one year from December 2013.

Title: European initiative towards models and numerical methods for simulations in fractured-porous geological media.

Coordination: Géraldine Pichot.

Partners: Geosciences Rennes.

Web page: <http://www.irisa.fr/sage/>

Abstract: FRACINI is an initiative funded by the Région Bretagne. It aims at gathering researchers from the European community working on models and numerical methods for simulations in fractured-porous media. Two international workshops were organized in 2014. These workshops ended up with a proposal submitted in response to the Future and Emerging Technology (FET) call of H2020 Funding.

## 7.2. National Initiatives

### 7.2.1. *ANR-MN: H2MNO4 project*

**Participants:** Édouard Canot, Jocelyne Erhel, Grégoire Lecourt, Lionel Lenôtre, Géraldine Pichot.

Contract with ANR, program Modèles Numériques

Duration: four years from November 2012.

Title: Original Optimized Object Oriented Numerical Model for Heterogeneous Hydrogeology.

Coordination: Jocelyne Erhel and Géraldine Pichot, with Fabienne Cuyolla.

Partners: Geosciences Rennes, University of Poitiers, University of Lyon 1, Andra, Itasca.

International collaborations: University of San Diego (USA), UPC, Barcelona (Spain)

Web page: <http://h2mno4.inria.fr/>

Abstract: The project H2MNO4 develops numerical models for reactive transport in heterogeneous media. It defines six mathematical and computational challenges and three applications for environmental problems with societal impact (see 6.4, 5.1.1). ANR organized a review of the project in December 2014.

### 7.2.2. *Inria Project Lab: HEMERA project*

**Participants:** Jocelyne Erhel, Géraldine Pichot.

Title: Hemera - developing large scale parallel and distributed experiments

Duration: September 2010 - July 2014

Coordination: C. Perez, Avalon team.

Partners: 22 Inria teams.

Webpage: <http://www.grid5000.fr/mediawiki/index.php/Hemera>

Abstract: Hemera is an Inria Project Lab, started in 2010, that aims at demonstrating ambitious up-scaling techniques for large scale distributed computing by carrying out several dimensioning experiments on the Grid'5000 infrastructure, at animating the scientific community around Grid'5000 and at enlarging the Grid'5000 community by helping newcomers to make use of Grid'5000. The final evaluation was in December 2014.

The team Sage was the leader of the Scientific Challenge Hydro: Multi-parametric intensive stochastic simulations for hydrogeology. The objective was to run multiparametric large scale simulations (see 6.4).

### 7.2.3. *Inria Project Lab: C2S@EXA project*

**Participants:** Édouard Canot, Jocelyne Erhel, Géraldine Pichot.

Title: C2S@EXA - Computer and Computational Sciences at Exascale

Duration: from January 2012.

Coordination: S. Lanteri, Nachos team.

Partners: Inria teams working on HPC; external partners: ANDRA and CEA.

Webpage: [http://www-sop.inria.fr/c2s\\_at\\_exa/](http://www-sop.inria.fr/c2s_at_exa/)

Abstract: The C2S@Exa Inria Project Lab is concerned with the development of numerical modeling methodologies that fully exploit the processing capabilities of modern massively parallel architectures in the context of a number of selected applications related to important scientific and technological challenges for the quality and the security of life in our society (see 6.2, 6.4, 6.5). The team participated in several workshops.

### 7.2.4. *GENCI: project on advanced linear solvers*

**Participants:** Édouard Canot, Jocelyne Erhel, Grégoire Lecourt, Lionel Lenôtre, Géraldine Pichot.

Title: Scalabilité de méthodes numériques pour l'hydrogéologie

Duration: 2012

Coordination: J. Erhel and G. Pichot.

Webpage: <http://www.genci.fr/>

Abstract: To run large scale simulations, we defined a project, based on the platform H2OLab. We obtained and used computing time on machines located at GENCI supercomputing centers. (see 6.2, 6.4).

### 7.2.5. *GDR MOMAS: project on reactive transport*

**Participant:** Jocelyne Erhel.

Webpage: <https://www.ljll.math.upmc.fr/cances/gdrmomas/>

The working group MOMAS includes many partners from CNRS, Inria, universities, CEA, ANDRA, EDF and BRGM. It covers many subjects related to mathematical modeling and numerical simulations for nuclear waste disposal problems (see 6.4, 6.5). The team participated in workshops.

## 7.3. European Initiatives

### 7.3.1. *FP7 & H2020: EXA2CT project*

Type: FP7

Challenge: Special action

Instrument: Specific Targeted Research Project

Objective: Exascale computing platforms, software and applications

Duration: September 2013 - August 2016

Coordinator: S. Ashby, IMEC, Belgium

Partners: 10 partners

Inria contact: Luc Giraud

Web page: <https://projects.imec.be/exa2ct/>

Abstract: The goal of this project is to develop novel algorithms and programming models to tackle what will otherwise be a series of major obstacles to using a crucial component of many scientific codes at exascale, namely solvers and their constituents. The results of this work will be combined in running programs that demonstrate the application-targeted use of these algorithms and programming models in the form of proto-applications.

### 7.3.2. Collaborations with Major European Organizations

UPC: Universitat Politècnica de Catalunya-UPC, Institute of Environmental Assessment and Water Research (Spain)

numerical simulations in hydrogeology, reactive transport in heterogeneous media, upscaling, scientific software platform (see 5.1.1 ).

UFZ: Helmholtz Centre for Environmental Research-UFZ, Hydrogeology group (Germany)

numerical simulations in hydrogeology, flow in porous fractured media, scientific software platform

HPCLab: University of Patras, High Performance Information Systems Laboratory (Greece)

cooperation with B. Philippe in writing a book, and in common research on low rank approximations of matrix functions.

ERCIM: working group on numerical algorithms, high performance computing.

## 7.4. International Initiatives

### 7.4.1. LIRIMA laboratory: momappli team (Cameroon)

**Participant:** Bernard Philippe.

Program: Laboratoire International de Recherche en Informatique et Mathématiques Appliquées

Title: Modélisation Mathématique et Applications

Inria principal investigator: Bernard Philippe

International Partner (Institution - Laboratory - Researcher): University of Yaoundé, Cameroon - Norbert Noutchequeme

Duration: 2010-2014

See also: <http://www.lirima.uninet.cm/index.php/recherche/equipes-de-recherche/momappli>

Abstract: The team deals with high performance scientific computing, with a focus on reliable tools for localizing eigenvalues of large sparse matrices.

### 7.4.2. LIRIMA laboratory: EPIC team (Tunisia)

**Participants:** Édouard Canot, Jocelyne Erhel, Sinda Khalfallah, Bernard Philippe.

Program: Laboratoire International de Recherche en Informatique et Mathématiques Appliquées

Title: Problèmes Inverses et Contrôle

Inria principal investigator: Housseem Haddar, Defi team

International Partner (Institution - Laboratory - Researcher): ENIT, University of Tunis, Tunisia - LAMSIN - Amel ben Abda

Duration: 2011-2015

See also: <http://www.lirima.uninet.cm/index.php/recherche/equipes-de-recherche/epic>

Abstract: The team deals with nonlinear and inverse problems.

### 7.4.3. ECOS Sud (Argentina): ARPHYMAT project

**Participant:** Édouard Canot.

Program: COFECUB

Title: Processus de formation et transformation de structures de combustion archéologique

Inria principal investigator: Édouard CANOT

International Partner (Institution - Laboratory - Researcher): University of Buenos Aires (Argentina)

Duration: Jan 2012 - Dec 2014

Abstract: the project concerns numerical simulations of prehistoric fires and comparison with archaeological data in South America.

**7.4.4. ECOS Sud (Chili): ARPHYMAT project****Participant:** Édouard Canot.

Program: CONICYT

Title: Processus de formation et transformation de structures de combustion archéologique : un regard interdisciplinaire

Inria principal investigator: Édouard CANOT

International Partner (Institution - Laboratory - Researcher): Universidad de Tarapaca (Chili)

Duration: Jan 2014 - Dec 2016

Abstract: Multidisciplinary study of prehistoric fire traces in South America, by means of different approaches: taphonomy of the soil, physical processes involved during the heat transfer, modeling and numerical simulations.

**7.4.5. Inria Euromediterranean: HYDRINV project****Participants:** Édouard Canot, Jocelyne Erhel, Sinda Khalfallah, Bernard Philippe.Program: **Euromediterranean 3+3**

Title: Direct and inverse problems in subsurface flow and transport

Coordination: H. ben Ameer, ENIT, Tunisia and J. Jaffré, Inria, Paris

Inria-Rennes principal investigator: Jocelyne Erhel

International Partners (Institution - Laboratory - Researcher):

Université Ibn Tofail - Faculté des Sciences de Kénitra (Morocco) - Laboratoire Interdisciplinaire en Ressources Naturelles et en Environnement - Zoubida Mghazli

Ecole Nationale d'Ingénieurs de Tunis (Tunisia) - Laboratoire de Modélisation en Hydraulique et Environnement - Rachida Bouhlila

Universidad de Sevilla (Spain) - Department Ecuaciones Diferenciales y Análisis Numérico - Tomas Chacon Rebollo

Universitat Politècnica de Catalunya (Spain) - Department of Geotechnical Engineering and Geo-Sciences - Xavier Sánchez Vila

University Centre of KHEMIS MILIANA (Algeria) - Laboratoire de l'Energie et des Systèmes Intelligents - Mohammed Hachama

Ecole Mohammadia d'Ingénieurs (Morocco) - LERMA - Rajae Aboulaich

Ecole Nationale d'Ingénieurs de Tunis (Tunisia) - Laboratoire de Modélisation Mathématique et Numérique dans les Sciences de l'Ingénieur - Hend Ben Ameer

Duration: Jan 2012 - Dec 2015

The management of water resources is a problem of great importance in all countries, and is particularly acute around the Mediterranean sea. The goal is to find a reasonable balance between these resources and demand while preserving the quality of water. Towards this goal it is essential to understand and simulate flow and transport in the subsurface. The science corresponding to this topic is hydrogeology. Since models become more and more complicated and quantitative answers must be given, numerical modeling become more and more sophisticated and mathematicians must also be involved. This project brings together hydrogeologists and mathematicians from France, Spain, Algeria, Morocco and Tunisia in order to develop, analyze, and validate numerical methods for several problems arising from modeling flow and transport in the subsurface. The emphasis is put on direct nonlinear problems (air-water flow, density driven flow related to salinization, transport with chemistry) and on inverse problems.

#### **7.4.6. Joint supervision of S. Khalfallah's PhD (Tunisia)**

**Participants:** Jocelyne Erhel, Sinda Khalfallah.

Program: International joint supervision of PhD agreement

Title: Contribution à l'analyse mathématique et numérique de quelques problèmes issus de l'hydrogéologie

Inria principal investigator: Jocelyne Erhel

International Partner (Institution - Laboratory - Researcher): Ecole Nationale d'Ingénieurs de Tunis - LAMSIN (Tunisia) - Amel ben Abda

Duration: 2010 - 2014

Abstract: The objective is to solve data completion problems applied to hydrogeology (see 7.4.5 , 7.4.2 ).

#### **7.4.7. Informal International Partners**

University of Purdue (USA)

High Performance Scientific Computing

University of San Diego (USA)

Hydrogeology

### **7.5. International Research Visitors**

#### **7.5.1. Visits of International Scientists**

- Emmanuel Kamgnia, University of Yaoundé, 2 months, March-April 2014
- Nabil Nassif, American University of Beirut, 1 week, May 2014
- Stratis Gallopoulos, University of Patras, 1 week, May 2014
- Ahmed Sameh, University of Purdue, 1 week, May 2014

#### **7.5.2. Internships (Joint supervision of Ph-D students)**

- Louis-Bernard Nguenang, University of Yaoundé, 4 months, April-July 2014
- Marwen ben Refifa, University of Tunis, 5 months, April-July and Sep 2014
- Salwa Mansour, Lebanese University, 8 months, Feb-Sep 2014

#### **7.5.3. Visits to International Teams**

- Édouard Canot, ENIT Tunis, Tunisia, 1 week, November 2014 (project HYDRINV)



## SERPICO Project-Team

# 8. Partnerships and Cooperations

## 8.1. Regional Initiatives

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

BioGenOuest: Advisory committee of the Biogenouest engineer S. Prigent in charge of the organization of image processing services for Biogenouest bio-imaging facilities.

## 8.2. National Initiatives

### 8.2.1. ANR GreenSwimmers project

**Participant:** Charles Kervrann.

Biofilms are composed of spatially organized microorganisms (possibly including pathogens) embedded in an extracellular polymeric matrix. A direct time-lapse confocal microscopic technique was recently developed to enable the real-time visualization of biocide activity within the biofilm. It can provide information on the dynamics of biocide action in the biofilm and the spatial heterogeneity of bacteria-related susceptibilities that are crucial for a better understanding of biofilm resistance mechanisms. The approach is here to characterize the spatial and temporal exploration of the biofilm by microorganisms.

In this project, SERPICO develop methods and software for the computation of mean velocity as well as other descriptors of swimmers bacteria dynamics inside biofilm image sequences. We investigate spatio-temporal features and descriptors for comparison, classification, indexing and retrieval.

**Funding:** ANR, duration: 24 months

**Partners:** INRA, AgroParisTech, Naturatech company

### 8.2.2. France-BioImaging project

**Participants:** Charles Kervrann, Patrick Bouthemy, Tinaherinantenaina Rakotoarivelo, Thierry Pécot, Geoffrey Dieffenbach, Emmanuel Moebel, Perrine Paul-Gilloteaux.

The goal of the project is to build a distributed coordinated French infrastructure for photonic and electronic cellular bioimaging dedicated to innovation, training and technology transfer. High computing capacities are needed to exhaustively analyse image flows. We address the following problems: i) exhaustive analysis of bioimaging data sets; ii) deciphering of key steps of biological mechanisms at organ, tissular, cellular and molecular levels through the systematic use of time-lapse 3D microscopy and image processing methods; iii) storage and indexing of extracted and associated data and metadata through an intelligent data management system. SERPICO is co-head of the IPDM (Image Processing and Data Management) node of the FBI network composed of 6 nodes.

**Funding:** Investissement d'Avenir - Infrastructures Nationales en Biologie et Santé, ANR (2011-2016)

**Partners:** CNRS, Institut Jacques Monod, Institut Pasteur, Institut Curie, ENS Ulm, Ecole Polytechnique, INRA, INSERM

## 8.3. European Initiatives

### 8.3.1. Collaborations with Major European Organizations

**ESFRI Euro-BioImaging initiative:** SERPICO participates in the ESFRI Euro-BioImaging project, one of the four new biomedical science projects in the roadmap of the European Strategic Forum on Research Infrastructures (ESFRI). The mission of Euro-BioImaging is to provide access, service and training to state-of-the-art imaging technologies and foster the cooperation and networking at the national and European level including multidisciplinary scientists, industry regional, national and European authorities. SERPICO also participates in the French counterpart, the so-called “France-BioImaging” (FBI) network which gathers several outstanding cellular imaging centers (microscopy, spectroscopy, probe engineering and signal processing) as described in Section 8.2.2 .

## 8.4. International Initiatives

### 8.4.1. Inria International Partners

#### 8.4.1.1. Informal International Partners

Collaboration with UT Southwestern Medical Center, Dallas (TX), Prof. G. Danuser, on object tracking in video-microscopy.

Collaboration with University of California - San Francisco (USA), J. Sedat and D. Agard, on image deconvolution in light microscopy.

Collaboration with Imaging Systems Lab, Department of Electrical Engineering, Indian Institute of Science, Bangalore, India (Prof. Muthuvel Arigovindan) on image deconvolution in fluorescence imaging.

## 8.5. International Research Visitors

### 8.5.1. Visits of International Scientists

#### 8.5.1.1. Internships

Deepak George Skariah: Internship, Imaging Systems Lab, Department of Electrical Engineering, Indian Institute of Science, Bangalore, India.

## SIROCCO Project-Team

# 8. Partnerships and Cooperations

## 8.1. European Initiatives

### 8.1.1. FP7 & H2020 projects

#### 8.1.1.1. FP7-PEOPLE-SHIVPRO

**Participants:** Olivier Le Meur, Zhi Liu.

- Title : Saliency-aware High-resolution Video Processing.
- Research axis : 6.1.1 .
- Partners : Visting professor from Shanghai University.
- Funding : EC-FP7 MC-IIF International Incoming Fellowships (IIF).
- Period : 08/2012-07/2014

The SHIVPRO project has been supporting the visit of Dr. Z. Liu, from Beijing University in the team from August 2012 to August 2014. The objective of this project was to propose an efficient spatio-temporal saliency model to predict salient regions in High-Resolution (HR) videos, and fully exploit it to ease the design and improve the performance of HR video compression and retargeting applications. With the aim to overcome the drawbacks of existing saliency models, based on a multiscale region representation, the proposed model systematically realizes statistical model saliency measuring, intra-scale saliency modification, inter-scale saliency propagation and flexible incorporation of top-down information, to generate a novel saliency representation form with scalability, saliency tree, from which a multiscale saliency fusion scheme is used to derive high-quality saliency maps at various scales.

## 8.2. International Research Visitors

### 8.2.1. Visits of International Scientists

Dr. Zhi Liu, from Shanghai University, has been visiting the team from August 2012 until August 2014. His stay has been funded by the FP7-PEOPLE-2011-IIF program. The funding scheme is the MC-IIF International Incoming Fellowships (IIF).

### 8.2.2. Visits to International Teams

#### 8.2.2.1. Sabbatical programme

C. Guillemot has spent a six months sabbatical stay (Mar. 2014- Aug. 2014) at EPFL (Ecole Polytechnique Federale de Lausanne)

## SUMO Project-Team

# 8. Partnerships and Cooperations

## 8.1. National Initiatives

### 8.1.1. ANR

**ANR VACSIM:** Validation of critical control-command systems by coupling simulation and formal analysis, 2011-2015, [web site](#)

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

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

**ANR Ctrl-Green:** Autonomic management of green data centers, 2011-2014, [web site](#)

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

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

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

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

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

**ANR STOCH-MC:** Model-Checking of Stochastic Systems using approximated algorithms, 2014-2018, [web site](#).

Led by SUMO.

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

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

### 8.1.2. National informal collaborations

We collaborate with Yliès Falcone (VaSCO - LIG) and Antoine Rollet (Labri) on the enforcement of timed properties.

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

## 8.2. International Initiatives

### 8.2.1. Inria International Labs

Eric Badouel is member of the team Aloco (Architecture logicielle à composants) of LIRIMA, the Inria International Lab in Africa. This collaboration is on the development of artifact-centric business process models.

### 8.2.2. Inria Associate Teams

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

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

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

### 8.2.3. Inria International Partners

#### 8.2.3.1. Informal International Partners

We have long lasting relations with indian labs : The Chennai Mathematical Institute in Chennai (M. Mukund, N. Kumar), the Institute for Mathematical Sciences in Chennai (R. Ramanujam, K. Lodaya). We are extending these relations in India. S. Akshay holds a permanent position in IIT Bombay after his postdoc at IRISA. Our relation with our Indian partners has been formalized as associated teams (currently EA DISTOL 2012-2015).

We have started a collaboration with J. Mullins from Université Polytechnique de Montréal. The main theme of this collaboration is security properties in concurrency models. We have submitted a joint paper of variants of interference properties (information leakage) for partial order models.

We collaborate with Laurie Ricker (Mount Allison University, Canada) on the control of distributed systems and the enforcement of opacity.

### 8.2.4. Participation In other International Programs

**AVeRTS** is an Indo-French project on the algorithmic verification of real-time systems. The project is funded by CNRS on the french side, and by DST on the Indian side, under the CEFIPRA - Indo-French Program in ICST 2014-2016. From SUMO, Nathalie Bertrand and Blaise Genest are involved and contribute on stochastic timed games.

## 8.3. International Research Visitors

### 8.3.1. Visits of International Scientists

This year, S. Akshay, from IIT Bombay visited us for a one month stay, from end of May to July. This visit was funded by Rennes 1 University. During this visit, he has worked with B. Genest and L. Hélouët on verification of extensions of Petri nets calle time Petri nets with restricted urgency, that can be used to model communication systems with threshold and latency in messages. The work performed this summer is currently under submission.

Christel Baier, professor at Dresden University, was also invited for a 2-week stay paid by Rennes 1 University. She has worked during her visit with N. Bertrand on long-run quantiles in Markov decision processes.

Doron Peled visited our team for a total duration of a month in Spring 2014. He worked with B. Genest on knowledge computation in distributed systems, a work currently under review.

Valentin Goranko, professor at Stockholm University, was invited for a 2-week stay paid by Rennes 1 University. He has worked during his visit with C. Morvan on first order properties of Rational Graphs.

Laurie Ricker (Mount Allison University) visited us during for 2 months [Mai-June 2014] on the control of distributed systems and the enforcement of opacity.

Robert Nsaibirni (University of Yaoundé) visited SUMO from July to August 2014 on the use of the Guarded Attribute Grammar formalism for the description of the workspaces of actors of a disease surveillance system.

#### *8.3.1.1. Internships*

Rishika Garg

Date: May 2014 - Jul 2014

Institution: IIT Kampur (India)

Engel Lefauchaux

Date: March 2014 - July 2014

Institution: ENS Cachan (France)

Ayush Maheshwari

Date: May 2014 - July 2014

Institution: IIT Kanpur (India)

Maroua Maalej

Date: Apr 2014 - July 2014

Institution: ENSI Tunis (Tunisia)

Sanaa Mairouch

Date: May 2014 - Aug 2014

Institution: ISTIC (France)

Aminatou Mohamadou

Date: Jun 2014 - July 2014

Institution: ISTIC (France)

Dhananjay Raju

Date: March 2014 - July 2014

Institution: CMI (India)

#### *8.3.1.2. Research stays abroad*

N. Bertrand spent two visits of one month each at Mons University (Belgium), pursuing a collaboration with Thomas Brihaye, and funded by the FNRS. The resulting work on stochastic timed automata with decisions was presented at the QEST conference [29].

## **TACOMA Team**

# **7. Partnerships and Cooperations**

## **7.1. National Initiatives**

### **7.1.1. *Pervasive\_RFID***

- Partner: IETR
- Starting: July 2013; ending: July 2016

Pervasive\_RFID is a joint effort (within the CominLabs initiative, see <http://www.cominlabs.ueb.eu/>) started in July 2013 with IETR (institut d'électronique et de télécommunications de Rennes) to study and design innovative RFID reading protocols in the context of pervasive computing applications. Some limitations of existing RFID technology become challenging: unlike standard RFID application scenarios, pervasive computing often involves uncontrolled environment for RFID, where tags and reader have to operate in much more difficult situations that those usually encountered or expected for classical RFID systems.

### **7.1.2. *GLIE - Guidage Lumineux par l'Intelligence de l'Environnement***

- Partner: OyaLight
- Starting: December 2014; ending: December 2015

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

## TASC Project-Team

# 8. Partnerships and Cooperations

## 8.1. Regional Initiatives

### 8.1.1. *Atlanstic*

**Participants:** Raphael Chenouard, Laurent Granvilliers, Christophe Jermann, Frédéric Lardeux, Éric Monfroy, Frédéric Saubion.

Title: Atlanstic project about problem modelisation, conversion, and transformation.

Duration: 2014-2015.

Budget: 8000 Euros.

Others partners: [LERIA](#), [IRCYNN](#).

Topic: modelling and model transformation.

### 8.1.2. *EPOC*

**Participants:** Nicolas Beldiceanu, Didier Lime, Gilles Madi Wamba, Jean-Marc Menaud, Olivier H. Roux.

Title: EPOC: Energy Proportional and Opportunistic Computing system.

Duration: 2014-2017.

Budget: founding for a PhD thesis.

Topic: an integrated approach combining time automata and constraint programming for modeling dynamic aspects of vm management in a data center.

## 8.2. National Initiatives

### 8.2.1. *IBEX*

**Participants:** Ignacio Araya, Clément Carbonnel, Gilles Chabert, Benoit Desrochers, Luc Jaulin, Bertrand Neveu, Jordan Ninin, Gilles Trombettoni.

Title: Development of [IBEX](#).

Others partners: [ENSTA Bretagne](#), [ENPC PariTech](#), [Lirimm](#), [LAAS](#), [University Federico Santa Maria, Chile](#).

Development of [IBEX](#) (see Section 6.3).

### 8.2.2. *SUSTAIN*

**Participants:** Charlotte Truchet, Bruno Belin.

Title: SUSTAINS.

Duration: 2010-2014.

Type: FUI.

Budget: 151400 Euros.

Others partners: [Artefacto](#), [Artelys](#), [Areva TA](#), [EPAMarne](#), [LIMSI](#).

The [SUSTAINS](#) project (*Constraint-based Prototyping of Urban Environments*) aims at building decision support system for city development planning with evaluation of energy impacts. The project is focused on spatial allocation of typical units such as industrial areas, commercial areas and leaving areas with their respective appropriate infrastructure. Its integrates sustainability, transport and energy concerns.



### 8.2.3. ANR NetWMS2

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

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

Duration: 2011-2014.

Type: cosinus research program.

Budget: 189909 Euros.

Others partners: **KLS Optim** and **CONTRAINTEs** (Inria Rocquencourt).

This project builds on the former European FP6 **Net-WMS** Strep project that has shown that constraint-based optimisation techniques can considerably improve industrial practice for box packing problems, while identifying hard instances that cannot be solved optimally, especially in industrial 3D packing problems with rotations, the needs for dealing with more complex shapes (e.g. wheels, silencers) involving continuous values. This project aims at generalizing the geometric kernel *geost* for handling non-overlapping constraints for complex two and three dimensional curved shapes as well as domain specific heuristics. This will be done within the continuous solver **IBEX**, where discrete variables will be added for handling polymorphism (i.e., the fact that an object can take one shape out of a finite set of given shapes). In 2013 a filtering algorithm has been devised in the case of objects described by nonlinear inequalities and is now under testing with the **Ibex** library. This work has been presented in a workshop on interval methods & geometry in **ENSTA Bretagne**.

### 8.2.4. ANR INFRA-JVM

**Participants:** Xavier Lorca, Charles Prud'Homme.

Title: Towards a Java Virtual Machine for pervasive computing.

Duration: 2011-2015.

Type: **new project**.

Budget: 78000 Euros.

Others partners: Univ. Paris 6 (**REGAL** team), **LaBRI** (**LSR** team), **IRISA** (**TRISKELL**).

The **INFRA-JVM** project investigates how to enhance the design of Java virtual machines with new functionalities to better manage resources, namely resource reservation, scheduling policies, and resource optimization at the middleware level. **TASC** is concerned with this later aspect. The performance of **CHOCO** will be improved using the memory snapshot mechanism that will be developed.

## 8.3. European Initiatives

### 8.3.1. FP7 & H2020 Projects

The **GRACeFUL** project (Global systems Rapid Assessment tools through Constraint FUnctional Languages) from the H2020-FETPROACT track has been accepted and will start in January 2015 for a period of three year. The abstract of the project is given below.

The making of policies coping with Global Systems is a process that necessarily involves stakeholders from diverse disciplines, each with their own interests, constraints and objectives. People play a central role in such collective decision making and the quest for solutions to a problem generally intertwines its very specification. Simulators can assist in this process provided they employ adequate high-level modelling to separate the political question from the underlying scientific details. Domain-specific Languages (DSL) embedded in Functional Programming (FP) languages offer a promising way to implement scalable and verifiable simulators. But the use of simulators is essentially a trial-and-error process too tedious for execution in a group session. A paradigm shift is needed towards active problem solving where stakeholders' objectives can be taken along from the very beginning. Constraint Programming (CP) has demonstrated to enable such a shift for e.g. managed physical systems like water and power networks. This project lays the base for a DSL aimed at building scalable Rapid Assessment Tools for collective policy making in global systems. This can be achieved through foundational scientific work at different levels: from the high-level, political modelling,

adapting the social discipline of Group Model Building (as used in business organizations), through visual forms of CP as well as gamification aspects, down to the needs for a host language, combining CP and FP. Special emphasis is put on domain-specific constraints, constraint composition, and composable solvers and heuristics. Results are applied and validated for the problem case of Climate-Resilient Urban Design, but the ambition is a general framework applicable to many other systems. The case study is assessed by an external multi-disciplinary Advisory Board of Stakeholders that guides the specification process and evaluates needs and usability of the tools.

### 8.3.2. Collaborations in European Programs, except FP7 & H2020

#### 8.3.2.1. PHC Ulysses

**Participants:** Charlotte Truchet, Florian Richoux, Alejandro Reyes.

Title: Development and estimation analysis of massively parallel local search approaches to the k-medoids problem.

Duration: 2014.

Type: **new project**.

Budget: 2500 Euros.

Others partners: 4C (Cork, Ireland).

The goal of this project is to develop parallel local search techniques for solving large instances of the k-medoids problem, a location problem with several applications, in particular in optical fiber networks deployment.

## 8.4. International Initiatives

### 8.4.1. Inria Associate Teams

#### 8.4.1.1. TASC MELB

Title: Synergy between Filtering and Explanations for Scheduling and Placement Constraints  
International Partner (Institution - Laboratory - Researcher):

NICTA (AUSTRALIE)

Duration: 2014 - 2016

See also: <http://www.normalesup.org/truchet/TASC MELB.html>

In the context of Constraint Programming and SAT the project addresses the synergy between filtering (removing values from variables) and explanations (explaining why values were removed in term of clauses) in order to handle in a more efficient way correlated resource scheduling and placement constraints. It combines the strong point of Constraint Programming, namely removing value that leads to infeasibility, with the strong point of SAT, namely taking advantage from past failure in order to quickly identify infeasible sub-problems.

#### 8.4.1.2. BANANAS

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

### 8.4.2. Inria International Partners

#### 8.4.2.1. Informal International Partners

- **SICS**, Sweden.
- **Uppsala University**, Sweden.
- **4C**, Ireland.
- Univ. Austral de Chile, Valparaiso, Chile.

### 8.4.3. Participation In other International Programs

Ulysse (cooperation with 4C, Cork, Ireland).

## 8.5. International Research Visitors

### 8.5.1. Visits of International Scientists

- **Mats Carlsson** (SICS, Sweden), *Automata constraints* (5 days).
- **Philippe Codognet** (Japanese-French Laboratory for Informatics at the University of Tokyo, Japan), *Prediction models of local search speed-up* (15 days).
- **Pierre Flener**, (Uppsala University, Sweden), *Automata constraints* (5 days).
- **Justin Pearson**, (Uppsala University, Sweden), *Automata constraints* (5 days).
- **Helmut Simonis**, (Insight Centre for Data Analytics, University College Cork, Ireland), *Learning constraint models* (3 months).

### 8.5.2. Visits to International Teams

#### 8.5.2.1. Sabbatical programme

**Thierry Petit** is currently visiting the Foisie School of business of WPI (Worcester Polytechnic Institute, Massachusetts, USA), collaborating with **Andrew C. Trapp** on optimization problems, since July, 2014.

#### 8.5.2.2. Research stays abroad

- **Nicolas Beldiceanu**, 4C Cork Ireland: work on *learning generic models* and work on *learning constraints in the context of EDF* with **Helmut Simonis** (two weeks).
- **Nicolas Beldiceanu**, Uppsala University and SICS: work on *automata and constraints* with **Pierre Flener** and **Justin Pearson** and **Mats Carlsson** (one month).
- **Éric Monfroy**, Univ. Austral de Chile, Valparaiso, Chile: work with Ricardo Soto.
- **Florian Richoux** visited the Japanese-French Laboratory for Informatics at the University of Tokyo, to work with **Philippe Codognet** on massively parallel combinatorial optimization algorithms and to start collaborations on Game AI, with Ruck Thawonmas from Ritsumeikan University (from the 1st of April till the 31st of August).

## TEA Project-Team

# 8. Partnerships and Cooperations

## 8.1. National Initiatives

### 8.1.1. ANR

Program: ANR

Project acronym: **VeriSync**

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

Duration: Nov. 2010 - Oct. 2013

Coordinator: IRIT

Other partners: IRIT

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

Abstract:

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

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

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Program: ANR

Project acronym: **Feever**

Project title: Faust Environment Everywhere

Duration: 2014-2016

Coordinator:

Other partners:

URL: <http://www.feever.fr>

Abstract:

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

### 8.1.2. Competitivity Clusters

Program: FUI

Project acronym: P

Project title: Project P

Duration: March 2011 - Sept. 2015

Coordinator: Continental Automotive France

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

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

Abstract:

The aim of project P is 1/ to aid industrials to deploy model-driven engineering technology for the development of safety-critical embedded applications, 2/ to contribute on initiatives such as ITEA2 OPEES and Artemisia CESAR to develop support for tools inter-operability, and 3/ to provide state-of-the-art automated code generation techniques from multiple, heterogeneous, system-levels models. The focus of project P is the development of a code generation toolchain starting from domain-specific modeling languages for embedded software design and to deliver the outcome of this development as an open-source distribution, in the aim of gaining an impact similar to GCC for general-purpose programming, as well as a kit to aid with the qualification of that code generation toolchain.

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

### 8.1.3. PAI CORAC

Program: CORAC

Project acronym: CORAIL

Project title: Composants pour l'Avionique Modulaire Étendue

Duration: July 2013 - May 2017

Coordinator: Thales Avionics

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

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

Abstract:

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

## 8.2. International Initiatives

### 8.2.1. International Project Grants

#### 8.2.1.1. USAF Office for Scientific Research – Grant FA8655-13-1-3049

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

Inria principal investigator: Jean-Pierre Talpin

International Partner (Institution - Laboratory - Researcher):

Virginia Tech Research Laboratories, Arlington (United States)

Embedded Systems Group, Technische Universität Kaiserslautern (Germany)

Duration: 2013 - 2016

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

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

## 8.2.2. Inria International Partners

### 8.2.2.1. Declared Inria International Partners

#### 8.2.2.1.1. The University of Hong Kong

Title: Virtual Prototyping of embedded software architectures

International Partner (Institution - Laboratory - Researcher):

The University of Hong Kong (Hong Kong)

Duration: 2012 - now

We collaborate with John Koo at the University of Hong Kong (HKU) and the LIAMA since two years through visiting grants of the Chinese Academy of Science and of the University of Rennes on the topics of heterogeneous time modelling and virtual prototyping. We submitted an ANR project proposal on this topic.

An engineer of SIAT, Riu Li, has developed a pilot project to evaluate Polychrony in the context of virtual prototyping and real-time simulation of automotive systems (the controller of a V6 turbo-charged engine model in LMS<sup>0</sup>). Our collaboration started in 2011 at the occasion of a joint Summer School on Embedded Systems organised by SIAT and LIAMA at SIAT. John Koo was invited scientist at Inria-Rennes in Summer 2012 and Jean-Pierre Talpin invited at SIAT by the Chinese Academy of Science from December 2012 to August 2013.

The partners submitted a PHC proposal and intend to resubmit a joint project proposal for the ANR-HK international program. A longer term goal of our collaboration is to setup, within the IET, a joint laboratory with Inria, in order to both disseminate formal methods for embedded system design on a specific Master program, and jointly contribute to an open-source system design platform with European and Asian industrial partners which are sponsoring the IET.

#### 8.2.2.1.2. Virginia Tech Research Laboratories

Title: Models of computation for embedded software design

International Partner (Institution - Laboratory - Researcher):

Virginia Tech Research Laboratories (USA)

Duration: 2003 - now

Team TEA collaborates with Sandeep Shukla, Virginia Tech, since 2002. First, in the frame of the NSF-Inria program with Rajesh Gupta, UCSD, until 2004; Inria’s associated project BALBOA, until 2007; with the sabbatical of Sandeep Shukla at IRISA in 2008-2009 (funded by Inria-Rennes, the University of Rennes 1, Inria’s scientific board); and, from 2011 to 2013, in the context of the associate-project POLYCORE, together with the ESG group at TU Kaiserslautern.

Following up Sandeep’s sabbatical, the Fermat Laboratory was awarded a series of research grant by the US Air Force Research Laboratory (AFRL) to develop a modelling environment based on Polychrony. In this context, Virginia Tech hired a former PhD. of team ESPRESSO, Julien Ouy, to contribute and coordinate this project’s work. Since 2013, the scope of our collaboration has extended with the three years grant awarded to team TEA by the USAF Office for Scientific Research (AFOSR).

To date, our fruitful and sustained collaboration has yield the creation of the ACM-IEEE MEM-OCODE conference series<sup>0</sup> in 2003, of the ACM-SIGDA FMGALS workshop series, and of a full-day tutorial at ACM-IEEE DATE’09 on formal methods in system design. We have jointly edited

<sup>0</sup>LMS by Siemens [http://www.plm.automation.siemens.com/en\\_us/products/lms](http://www.plm.automation.siemens.com/en_us/products/lms)

<sup>0</sup>ACM-IEEE MEMOCODE conference series. <http://memocode-conference.com>

two books with Springer<sup>00</sup>, two special issues of the IEEE Transactions on Computers and one of the IEEE Transactions on Industrial Informatics, and published more than 30 joint papers in international scientific journals and conferences.

### 8.2.2.2. Informal International Partners

#### 8.2.2.2.1. Technische Universitaet Kaiserslautern (DE)

We collaborate with Klaus Schneider, leader of the ESG group at Uni. Kaiserslautern, since 2011 in the frame of the POLYCORE associate project. Our aim is to develop a joint, open-source, toolchain based on the Averest (ESG) and POP (TEA) environments. Our collaboration has been quite fruitful with several recent journal publications<sup>00</sup>. Numerous visits and exchanges of personnel between team TEA and the ESG have allowed us to develop ONYX, a cross-compiler between the Averest and POP environments.

Onyx mixes imperative Quartz modules and declarative Signal networks to specify multi-clocked systems. We intend to further its development by the submission of a joint ANR or European project. Our objective is to develop an environment capable of synthesising distributed, loosely synchronised executives from imperative Quartz modules whose schedules are specified by multi-clocked data-flow specifications. A new version of this front-end, developed by Sun Ke, will be integrated in the POP environment.

## 8.3. International Research Visitors

### 8.3.1. Visits to International Teams

#### 8.3.1.1. Research stays abroad

Jean-Pierre Talpin was awarded a visiting researcher grant by the US Air Force Research Laboratories for collaborative research with the Virginia Tech Research Laboratories. In this context, he visited the Arlington and Falls Church VT campuses in Spring, Summer and Fall 2014 for a duration of two and a half months.

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

<sup>0</sup>*Synthesis of embedded systems*. S. Shukla, J.-P. Talpin, Eds. ISBN 978-1-4419-6399-4. Springer, 2010

<sup>0</sup>*Embedding polychrony into synchrony*. J. Brandt, M. Gemünde, K. Schneider, S. Shukla, and J.-P. Talpin. In Transactions on Software Engineering (TSE). IEEE, 2012.

<sup>0</sup>*Representation of synchronous, asynchronous, and polychronous components by clocked guarded Actions*. J. Brandt, M. Gemünde, K. Schneider, S. Shukla, and J.-P. Talpin. In Design Automation for Embedded Systems (DAES), Special Issue on Languages, Models and Model Based Design for Embedded Systems. Springer, 2012.

## VISAGES Project-Team

# 8. Partnerships and Cooperations

## 8.1. Regional Initiatives

### 8.1.1. Biogenouest

The VisAGeS team and the Neurinfo platform integrated the Biogenouest "Groupement d'Intérêt Scientifique (GIS)" in 2012.

Biogenouest is a Western France life science and environment core facility network. Research programmes are undertaken in the fields of Marine biology, Agriculture/Food-processing, Human health, and Bioinformatics. Set up in keeping with the inter-regional principle of complementarity, Biogenouest coordinates over twenty technological core facilities in both the Brittany and Pays de la Loire regions.

### 8.1.2. COREC projects

COREC is the "COMité de REcherche Clinique" of the University Hospital of Rennes. This comity proposes an annual project funding in the limit of 30k€ per project. In 2014, the Neurinfo platform as an incitative action for clinical research project emergence accompanied the COREC call by financially supporting the imaging part of the projects up to 50 MRI hours, i.e. 30k€. Two projects including brain MRI were selected. The EPMR-MA project led by the neuropsychologist Pierre-Yves Jonin, and co-funded by Fondation de l'avenir in 2014, will evaluate memory effects in healthy adults and in patients presenting cognitive impairments using BOLD fMRI, ASL and Diffusion MRI. The second project is a complementary funding for the project led by Dr Fabienne Pelé (see below).

### 8.1.3. *Projet Fondation de France : PERINE*

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

This study evaluates the effect of prenatal exposure to neurotoxicants on the developing brain. Following previous studies in the PELAGIE cohort this MRI study involves ASL, Diffusion and working memory as well as motor inhibition BOLD fMRI together with neuropsychological tests in children. Inclusions have started in November 2014 and will continue over 2 years.

### 8.1.4. *Fondation de l'Avenir - Depression, suicide and fMRI*

**Participants:** Elise Bannier, Isabelle Corouge, Jean-Christophe Ferré, Christian Barillot.

*initial duration: 12 months from November 2012. Project extended in 2014.*

In collaboration with EA 4712 "Comportement et Noyaux Gris Centraux" of the University of Rennes I, a complementary funding (20 000€) was obtained to support an ongoing fMRI research project on emotions, impulsivity and suicide. The study protocol and the fMRI task was finalized. Inclusions started in early 2013. The project was extended in 2014 to recruit more patients.

### 8.1.5. *Fondation de l'Avenir - Stroke, rehabilitation and fMRI*

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

*duration: 12 months from November 2012. Project extended in 2014.*

A complementary funding (20 000€) was obtained to support a new research project on rehabilitation of stroke patients. The fMRI protocol was setup, the task developed and validation on volunteers is ongoing. Patient inclusions started in spring 2013. This project was also extended to 2014 to recruit more patients. Group analysis on the control group was performed and a paper will be submitted soon.



## 8.2. National Initiatives

### 8.2.1. ANR

#### 8.2.1.1. ANR "Neurological and Psychiatric diseases" NUCLEIPARK

**Participants:** Christian Barillot, Sylvain Prima.

NucleiPark project: In the context of the ANR-09-MNPS-016 Nucleipark project we develop a pipeline for detecting shape changes in Parkinson and Paralysis Supranuclear Progressive (PSP) diseases. The pipeline is based on the previous work of Benoit Combès et al. [35]. The pipeline was first validated on controlled synthetic data. For Parkinson disease, a total of 16 patients and 11 healthy controls were evaluated. The structures analyzed were: PPN, GPe, GPi, Caudate, Putamen, SN, STN, RN. Differences (uncorrected  $P < 0.001$ ) were found in the right putamen and caudate structures. And slight difference (uncorrected  $P < 0.05$ ) in the right GPe. No significant correlation was found in PPN, GPi, SN, STN, and RN structures. In the case of PSP disease, a total of 10 patients and 11 healthy controls were evaluated. The structures analyzed were: PPN, GPe, GPi, Caudate, Putamen, SN, STN, RN. Differences (uncorrected  $P < 0.001$ ) were found in the left caudate structure. No significant correlation was found in PPN, GPe, GPi, Putamen, SN, STN, and RN structures. This project involves three partners: NeuroSpin, Inria (Athena and Visages) and UPMC (University Pierre and Marie Curie, Paris) including Inserm U678 and the CENIR.

In the context of this project, we propose a statistical data analysis pipeline that uses the apparent diffusion coefficient (ADC) as biomarker. The ADC is computed considering the diffusion weighted signal as a scalar field on a 5-D manifold. This consideration allows to keep the information about direction of the ADC. We have tested the proposed pipeline on synthetic dataset with promising results. Other contributions were the implementation and minimization, in the 5-D non-euclidean space, of the total variation (in its dual formulation) inpainting problem as interpolation method used in the statistical pipeline.

#### 8.2.1.2. TRANSLATE-MS-REPAIR

**Participants:** Laurence Catanese, Olivier Commowick, Isabelle Corouge, Jean-Christophe Ferré, Elise Banner, Gilles Edan, Christian Barillot.

It is now commonly admitted that MS is not only an inflammatory disease but a neurodegenerative disease as well. This project is devoted to show that the olesoxime molecule is not only neuroprotective, but it has the ability to promote the maturation of oligodendrocyte progenitor cells (OPCs) into myelinating oligodendrocytes. However, before considering a large-scale clinical trial to assess efficacy. An important aspect is that to date, no treatment for neuroprotection / remyelination has reached the stage of clinical proof of concept that aims Trophos company who is leading this project. It appears that the best criteria for assessing neuroprotective/remyelinating effect of the drug candidate, are MRI criteria. However, these imaging criteria have not yet been validated for use in multicentre trials - so we will also check the feasibility of such measures under this condition. In addition to Trophos company, the partners of this project are AP-HM/CNRSCEMEREM-CRMBM, CHU Rennes, CHU Reims, and Inria-VISAGES.

### 8.2.2. Competitivity Clusters

#### 8.2.2.1. The HEMISFER Project

**Participants:** Elise Banner, Isabelle Bonan, Isabelle Corouge, Jean-Christophe Ferré, Jean-Yves Gauvrit, Pierre Maurel, Lorraine Perronnet, Christian Barillot.

The HEMISFER project ("Hybrid Eeg-Mri and Simultaneous neuro-FEedback for brain Rehabilitation") will be conducted at Inria Rennes with the support of the Cluster of Excellence "CominLabs"<sup>0</sup>. The goal of HEMISFER is to make full use of the neurofeedback paradigm in the context of rehabilitation and psychiatric disorders. The major breakthrough will come from the use of a coupling model associating functional and metabolic information from Magnetic Resonance Imaging (fMRI) to Electro-encephalography (EEG) to "enhance" the neurofeedback protocol. We propose to combine advanced instrumental devices

<sup>0</sup><https://www.inria.fr/cominlabs-newsletter/april-2013-four-projects-selected/#hemisfer>

(Hybrid EEG and MRI platforms), with new man-machine interface paradigms (Brain computer interface and serious gaming) and new computational models (source separation, sparse representations and machine learning) to provide novel therapeutic and neuro-rehabilitation paradigms in some of the major neurological and psychiatric disorders of the developmental and the aging brain (stroke, attention-deficit disorder, language disorders, treatment-resistant mood disorders, ...). This project will be conducted with the HYBRID and PANAMA Teams from Inria Rennes, the EA 4712 team from University of Rennes I and the ATHENA team from Inria Sophia-Antipolis. This work will benefit from the research 3T MRI and MRI-compatible EEG systems provided by the NeurInfo in-vivo neuroimaging platform on which these new research protocols will be set up. A budget of 500keuros will be provided by the CominLabs cluster in the next 3 years to support this project (through experimental designs, PhDs, Post-docs and Expert Engineers).

#### 8.2.2.2. *France Life Imaging (FLI)*

**Participants:** Christian Barillot, Olivier Commowick, Florent Leray, Michael Kain, Yao Yao.

France Life Imaging (FLI) is a proposed large-scale research infrastructure project aimed at establishing a coordinated and harmonized network of biomedical imaging in France. This project was recently selected by the call “Investissements d’Avenir - Infrastructure en Biologie et Santé”. One node of this project is the node Information Analysis and Management (IAM), a transversal node build by a consortium of teams that will contribute to the construction of a network for data storage and information processing. Instead of building yet other dedicated facilities, the IAM node will use already existing data storage and information processing facilities (LaTIM Brest; CREATIS Lyon; CIC-IT Nancy; Visages U746 Inria Rennes; CATI CEA Saclay; LSIT/ICube Strasbourg) that will increase their capacities for the FLI infrastructure. Inter-connections and access to services will be achieved through a dedicated software platform that will be developed based on the expertise gained through successful existing developments. The IAM node has several goals. It aims first at building a versatile facility for data management that will inter-connect the data production sites and data processing for which state-of-the-art solutions, hardware and software, will be available to infrastructure users. Modular solutions are preferred to accommodate the large variety of modalities acquisitions, scientific problems, data size, and adapted for future challenges. Second, it aims at offering the latest development that will be made available to image processing research teams. The team VISAGES fulfills multiple roles in this nation-wide project. Christian Barillot is the chair of the node IAM, Olivier Commowick is participating in the working group workflow and image processing and Michael Kain the technical manager. Apart from the team members, software solutions like medInria and Shanoir will be part of the final software platform.

#### 8.2.2.3. *OFSEP*

**Participants:** Justine Guillaumont, Elise Banner, Christian Barillot, Olivier Commowick, Gilles Edan, Isabelle Corouge, Jean-Christophe Ferré, Michael Kain.

The French Observatory of Multiple Sclerosis (OFSEP) is one of 10 projects selected in January 2011 in response to the call for proposal in the “Investissements d’Avenir - Cohorts 2010” program launched by the French Government. It allows support from the National Agency for Research (ANR) of approximately € 10 million for 10 years. It is coordinated by the Department of Neurology at the Neurological Hospital Pierre Wertheimer in Lyon (Professor Christian Confavreux), and it is supported by the EDMUS Foundation against multiple sclerosis, the University Claude Bernard Lyon 1 and the Hospices Civils de Lyon. OFSEP is based on a network of neurologists and radiologists distributed throughout the French territory and linked to 61 centers. OFSEP national cohort includes more than 35,000 people with Multiple Sclerosis, approximately half of the patients residing in France. The generalization of longitudinal monitoring and systematic association of clinical data and neuroimaging data is one of the objectives of OFSEP in order to improve the quality, efficiency and safety of care and promote clinical, basic and translational research in MS. For the concern of data management, the Shanoir platform of Inria has been retained to manage the imaging data of the National OFSEP cohort in multiple sclerosis.

#### 8.2.3. *Collaboration with the CEA (Commissariat à l’Energie Atomique) : Imaging data quality control in the context of dementia*

**Participants:** Elise Banner, Christian Barillot, Isabelle Corouge, Jean-Christophe Ferré, Cédric Meurée.

*duration: 12 months from September 2014.*

Dementia, in particular Alzheimer Disease (AD), affects about 900,000 people in France. As an early and reliable diagnosis remains a difficult task, neuroimaging plays a crucial role in assisted-diagnosis by analyzing structural and functional brain abnormalities associated with the disease. The "Centre pour l'Acquisition et le Traitement des Images (CATI)" has created a national network of neuroimaging centers in order to promote clinical research on MA using advanced imaging techniques. Visages and the Neurinfo platform are recognized in the CATI for their expertise in Arterial Spin Labeling, both on the acquisition and the post-processing sides. In this context and in the frame of the Alzheimer plan, a collaboration contract was signed between Inria and CEA, the coordinator for the CATI, in order to host an engineer at Inria for a year. This engineer develops control quality tools and advanced post-processing techniques for ASL to be used in nation-wide clinical studies coordinated by the CATI.

## 8.3. European Initiatives

### 8.3.1. FP7 & H2020 Projects

#### 8.3.1.1. EuroBioimaging

Type: CAPACITIES

Defi: Provide access and training in imaging technologies, and share the best practice and image data in order to make Euro-BioImaging an engine that will drive European innovation in imaging research and technologies

Instrument: Combination of COLLABORATIVE PROJECTS and COORDINATION and SUPPORT ACTIONS

Objective: Euro-BioImaging is a large-scale pan-European research infrastructure project on the European Strategy Forum on Research Infrastructures (ESFRI) Roadmap.

Duration: December 2010 - 2016

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

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

Inria contact: C. Kervrann, C. Barillot

Abstract: Euro-BioImaging is a pan-European infrastructure project whose mission is to build a distributed imaging infrastructure across Europe that will provide open access to innovative biological and medical imaging technologies for European researchers. The project is funded by the EU and currently the consortium is finalizing the basic principles for the operation of future Euro-BioImaging organisation.

Euro-BioImaging will be governed by representatives of the European countries that will join Euro-BioImaging (Euro-BioImaging member states).

The infrastructure established by Euro-BioImaging will consist of a set of geographically distributed but strongly interlinked imaging facilities (Euro-BioImaging Nodes), which will be selected among the leading European imaging facilities based on an independent evaluation process.

Inria and the Visages team is involved through the FLI national infrastructure and contributes to the WG11 Working Group on Data Storage and Analysis. This WG performs a series of tasks to define a European Biomedical Imaging Data Storage and Analysis infrastructure plan for the construction phase.

### 8.3.2. Collaborations in European Programs, except FP7 & H2020

Program: COST

Project acronym: AID (oc-2010-2-8615)

Project title: Arterial spin labeling Initiative in Dementia

Acceptation date: 18/05/2011

Coordinator: X. Golay, UCL, London, UK

Other partners: Ghent University (BE), Liege University (BE), Hospital Cantonal de Geneve (CH), Fraunhofer MEVIS (D), Freiburg University (D), Max Planck Institute for Human Cognitive & Brain Sciences (D), Glostrup Hospital (DK), Hospital Santa Creu I Sant Pau (ES), Universidad Rey Juan Carlos (ES), University of Navarra (ES), INSERM U836 Grenoble (FR), University of Rennes I (FR), Centro San Giovanni di Dio - Fatebenefratelli (IT), Fondazione Istituto Neurologico Besta (IT), Leiden University Medical Center (NL), UMC Utrecht (NL), VU University Medical Centre (NL), Instituto Superior Técnico (PT), University of Porto (PT), Lund University Hospital (SE), Uppsala University Hospital (SE), Skane University Hospital (SE), Bogazici University (TR), King's College London (UK), University College London (UK), University of Nottingham (UK), University of Oxford (UK)

Abstract: Dementia is a major clinical challenge with care costs approaching 1% of global GDP. Recent estimates suggest that delaying disease onset by 5 years would halve its prevalence. As new disease-modifying treatments will be specific to causative diseases, expensive and bear significant side effects, early diagnosis of dementia will be essential. Current diagnostic criteria include the use of image-based biomarkers using radiotracers. The AID Action aims at coordinating the development of an alternative and cost-effective tool based on an MRI technique, Arterial Spin Labeling (ASL), to obtain reproducible brain perfusion measurements in dementia patients by bringing together scientists and clinicians from across Europe through the flexibility of the COST mechanism. The scientific program is centered around four work packages and three workgroups aiming at developing standards, improving the reliability of the technique and as establishing it as a possible clinical trial outcome measure. Development of MRI methods, post-processing tools, protocols of cross-validation, statistical analyses and launch of clinical and comparative studies will be undertaken. The main benefit of this Action will be to provide a cost-effective alternative to radiotracer-based biomarkers, and help care providers throughout Europe balancing the need for early diagnosis of dementia with the necessary healthcare cost containment. The Visages team is involved in the workgroups ASL data acquisition (E. Bannier), ASL data analysis (C. Barillot, I. Corouge, P. Maurel) and clinical validation of ASL in cognitive impairment (J.-C. Ferré).

## 8.4. International Initiatives

### 8.4.1. Inria Associate Teams

#### 8.4.1.1. BARBANT

Title: Boston and Rennes, Brain image Analysis Team

International Partner (Institution - Laboratory - Researcher):

Boston Children's Hospital (ÉTATS-UNIS)

Duration: 2012 - 2014

See also: <http://team.inria.fr/barbant/>

This associated team is shared between Inria Visages team and the Computational Radiology Laboratory of the Children's hospital Boston at Harvard Medical School. We will address the topic of better understanding the behavior and evolution of neurological pathologies (such as neurodevelopmental delay or multiple sclerosis) at the organ and local level, and the modeling of normal and pathological groups of individuals (cohorts) from image descriptors. At term, this project will allow to introduce objective figures to correlate qualitative and quantitative phenotypic markers coming from the clinic and image analysis, mostly at the early stage of the pathologies. This will allow for the selection or adaptation of the treatment for patients at an early stage of the disease. In 2014, two workshops were organized (one in Rennes, one in Boston), and several publications were accepted /submitted in diffusion imaging. An extension for three more years has been applied for in December 2014.

## 8.5. International Research Visitors

### 8.5.1. Visits of International Scientists

- Within the BARBANT associate team, P. Simon K. Warfield, Dr. Benoit Scherrer and Dr. Maxime Taquet (Computational Radiology Laboratory, Harvard Medical School) visited us for a workshop on multiple sclerosis and diffusion image processing.

### 8.5.2. Visits to International Teams

- Several members of the Visages team (Christian Barillot, Olivier Commowick, Renaud Hédouin, Yogesh Karpaté) visited the Computational Radiology Laboratory (Harvard Medical School) for an associate team (BARBANT) meeting to discuss new research topics.
- From November 2014 to February 2015, Hrishikesh Deshpande visits Duke University (in Durham, North Carolina, United States) to collaborate with Professor Guillermo Sapiro on classification using Dictionary Learning. This visit was partially founded by a mobility grant from the doctoral school MATISSE.
- Maia Proisy was co-supervised by UCL and Visages (Pr Jean-Christophe Ferré), during her 6 months visit at UCL for her master research work. In this collaboration was investigated and implemented a pCASL sequence at 3T for measuring brain CBF in neonates at risk of hypoxic-ischemic encephalopathy. This work was also designed to establish a pCASL protocol for further study. Arterial Spin Labelling was a part of an ongoing study (The UCH Baby Brain Study - London), led by Prof Nicola Robertson and Dr Cristina Uria-Avellanal. Imaging data acquisition and processing was made by scientist from the UCL Institute of Neurology - London (Magdalena Sokolska and Prof Xavier Golay).