



RESEARCH CENTER  
Nancy - Grand Est

FIELD

Activity Report 2014

# Section Partnerships and Cooperations

Edition: 2015-06-01



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**CAMUS Team**

## 8. Partnerships and Cooperations

### 8.1. National Initiatives

Philippe Clauss, Alain Ketterlin, Cédric Bastoul and Vincent Loechner are involved in the Inria Project Lab entitled “Large scale multicore virtualization for performance scaling and portability” and regrouping several french researchers in compilers, parallel computing and program optimization<sup>0</sup>. The project started officially in January 2013. In this context and since January 2013, Philippe Clauss is co-advising with Erven Rohou of the Inria team ALF, Nabil Hallou’s PhD thesis focusing on dynamic optimization of binary code.

### 8.2. European Initiatives

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

Program: ITEA

Project acronym: MANY

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

Duration: 09/2011 - 12/2014

Coordinator: XDIN

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

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

### 8.3. International Initiatives

#### 8.3.1. Inria Associate Teams

##### 8.3.1.1. ANCOME

Title: Memory and applications memory behavior

International Partner (Institution - Laboratory - Researcher):

Universidad de Buenos Aires (ARGENTINE)

Duration: 2011 - \_\_\_AT.ANNEEMOISFIN???

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

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

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<sup>0</sup><https://team.inria.fr/multicore>

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

#### *8.3.2.1. Informal International Partners*

The CAMUS team maintains regular contacts with the following entities:

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

### **8.4. International Research Visitors**

#### *8.4.1. Visits of International Scientists*

##### *8.4.1.1. Internships*

Matías Hernando Pérez Matías

Date: May 2014 - Nov 2014

Institution: Universidad de Buenos Aires (Argentina)

Sabater César Rufino

Date: May 2014 - Oct 2014

Institution: Universidad Nacional de Rosario (Argentina)

Campostrini Luis Esteban

Date: Jul 2014 - Dec 2014

Institution: Universidad Nacional de Rosario (Argentina)

## **CAMEL Project-Team**

# **8. Partnerships and Cooperations**

## **8.1. National Initiatives**

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

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

**Participants:** Cyril Bouvier, Nicholas Coxon, Jérémie Detrey, Pierrick Gaudry, Laurent Grémy, Hamza Jeljeli, Emmanuel Thomé [contact], Marion Videau, Paul Zimmermann.

The CATREL proposal has been accepted in ANR “programme Blanc” in 2012. This project involves CAMEL as a leading team, in cooperation with two other partners which are INRIA project-team GRACE (INRIA Saclay, LIX, École polytechnique), and the ARITH team of the LIRMM Laboratory (Montpellier). The project targets algorithms for solving the discrete logarithm problem in finite fields, using the Number Field Sieve and the Function Field Sieve algorithms. Actual work on the CATREL project started in January 2013. Four meetings have taken place already: in Nancy on December 14, 2012 (kick-off), in Palaiseau on June 19, 2013, in Montpellier on November 12-13, 2013, and in Nancy in June 18-19, 2014.

## **8.2. International Research Visitors**

### **8.2.1. Visits of International Scientists**

- Masahiro Ishii is a visiting PhD student from the Nara Institute of Science and Technology, Nara (Japan), from February 2014 until February 2015. His PhD supervisors are Atsuo Inomata and Kazutoshi Fujikawa. Locally, he is supervised by Jérémie Detrey and Pierrick Gaudry.

## CARTE Project-Team

# 7. Partnerships and Cooperations

## 7.1. Regional Initiatives

### 7.1.1. Région Lorraine- Université de Lorraine

Simon Perdrix is the principal investigator of the project *measurement-based quantum computing* funded by Région Lorraine and Université de Lorraine.

## 7.2. National Initiatives

### 7.2.1. ANR

- The team is a funding partner in ANR Elica (2014-2019), "Elargir les idées logistiques pour l'analyse de complexité". The Carte team is reknown for its expertise in implicit computational complexity.
- The team is a funding partner in ANR Binsec (2013-2017), whose aim is to fill part of the gap between formal methods over executable code, and binary-level security analyses currently used in the security industry. Two main applicative domains are targeted: vulnerability analysis and virus detection. Two other closely related applications will also be investigated: crash analysis and program deobfuscation.

## 7.3. European Initiatives

### 7.3.1. FP7 & H2020 Projects

#### 7.3.1.1. FI-WARE

Title: Morphus

Type: COOPERATION

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

Instrument: Integrated Project (IP)

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

Duration: September 2011 - May 2014

Coordinator: Telefonica (Spain)

Other Partners: Thales, SAP, Inria

Inria contact: Olivier Festor

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

## 7.4. International Initiatives

### 7.4.1. Informal International Partners

- Submission of an Inria associate team proposal THOR (complexity Theory at Higher ORder) in collaboration with Syracuse University, Wesleyan University (Royer, Danner, Ramyaa Ramyaa) and Egypt-Japan University (Walid Gomaa).

## **7.5. International Research Visitors**

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

- Cristóbal Rojas (Univ. Andres Bello, Chili) was Inria “Chercheur Invité” for 3 months from July to September 2014. The collaboration led to the paper [20] accepted at STACS 2015.
- Visit of Marco Gaboardi, full researcher at Dundee University, for one week in March 2014.

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

- Romain Péchoux, two one-week visits to Dundee University in March and August 2014.
- Simon Perdrix, visit to the quantum group, Oxford University Computing Laboratory, 1 week in October 2014.
- Simon Perdrix, visit to the Tsinghua University, Beijing, 1 week in December 2014.



## **CASSIS Project-Team**

# **8. Partnerships and Cooperations**

## **8.1. Regional Initiatives**

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

## **8.2. National Initiatives**

### **8.2.1. ANR**

- ANR PROSE *Security protocols : formal model, computational model, and implementations*, duration: 4 years, started in December 2010. The goal of the project is to increase the confidence in security protocols, and in order to reach this goal, provide security proofs at three levels: (i) the symbolic level, in which messages are terms, (ii) the computational level, in which messages are bitstrings, and (iii) the implementation level: the program itself. Partners are EPI Prosecco and EPI Cascade Paris (leader), LSV Cachan, Cassis and Verimag Grenoble.
- ANR FREC *Frontiers of recognizability*, duration: 4 years, starting in October 2010. The goal of this project is to be a driving force behind the extension of the algebraic theory of regular languages made possible by recent advances. Four directions will be investigated: tree languages,  $\lambda$ -terms, automata with counters, algebraic and topological tools. Partners are LABRI (leader), LIAFA (University Paris 7). Pierre-Cyrille Héam is a member of this project, attached to Paris 7 for administrative facilities.
- ANR SEQUOIA *Security properties, process equivalences and automated verification*, duration: 4 years, starting in October 2014. Most protocol analysis tools are restricted to analyzing reachability properties while many security properties need to be expressed in terms of some process equivalence. The increasing use of observational equivalence as a modeling tool shows the need for new tools and techniques that are able to analyze such equivalence properties. The aims of this project are (i) to investigate which process equivalences-among the plethora of existing ones-are appropriate for a given security property, system assumptions and attacker capabilities; (ii) to advance the state-of-the-art of automated verification for process equivalences, allowing for instance support for more cryptographic primitives, relevant for case studies; (iii) to study protocols that use low-entropy secrets expressed using process equivalences; (iv) to apply these results to case studies from electronic voting.

### **8.2.2. Fondation MAIF**

Project *Protection de l'information personnelle sur les réseaux sociaux*, duration: 3 years, started in October 2014. The goal of the project is to lay the foundation for a risk verification environment on privacy in social networks. Given social relations, this environment will rely on the study of metrics to characterize the security level for a user. Next, by combining symbolic and statistical techniques, it is a question to synthesize a model of risk behavior as a rule base. Finally, a verifier à la model-checking will be developed to assess the security level of user. Partners are Cassis (leader), Orpailleur and Fondation Maif.

### 8.2.3. Competitvity Clusters

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

## 8.3. European Initiatives

### 8.3.1. FP7 Projects

- Nessos is a Network of Excellence on Engineering Secure Future Internet Software Services and Systems in FP7-ICT (starting in October 2010 for a period of 42 months). Nessos has 12 partners and aims at constituting and integrating a long lasting research community on engineering secure software-based services and systems. Partner Inria is involved through project-teams Arles, Triskell and Cassis. Cassis focusses on developing tools for service security verification and testing tasks.
- ProSecure (2011-2016) <sup>0</sup>— ERC Starting Grant Project on Provably secure systems: foundations, design, and modularity. This long-term project aims at developing provably secure systems such as security protocols. The goal is to propose foundations for a careful analysis and design of large classes of up-to-date protocols. To achieve this goal, we foresee three main tasks. First, we plan to develop general verification techniques for new classes of protocols that are of primary interest in nowadays life like e-voting protocols, routing protocols or security APIs. Second, we will consider the cryptographic part of the primitives that are used in such protocols (encryption, signatures, ...), obtaining higher security guarantees. Third, we aim at proposing modular results both for the analysis and design of protocols. Véronique Cortier is the leader of the project.

## 8.4. International Initiatives

### 8.4.1. Inria Associate Teams

BANANAS (2012-2014) <sup>0</sup> — *Automated design and autonomous control of hybrid solver cooperations*. In order to tackle large scale instances and intricate problem structures, sophisticated solving techniques have been developed, combined, and hybridized to provide efficient solvers. A common idea to get more efficient and robust algorithms consists in combining several resolution paradigms in order to take advantage of their respective assets. Autonomous Search is a very attractive approach for designing adaptive systems with the capability of improving its solving performance by selecting and adapting its search strategies to the problem at hand. The main goal of the project is to apply the Autonomous Search approach to hybrid solver cooperations, by automating the selection and the cooperation of solvers, by tuning the cooperation parameters, and by adapting the cooperation during solving. The international partners are Technical University Federico Santa Maria, Valparaíso (Chile) — Department of Computer Science — Carlos Castro and Eric Monfroy; University of Chile (Chile) — Center for Mathematical Modeling — Jorge Amaya. The Inria principal investigator is Christophe Ringeissen.

### 8.4.2. Inria International Partners

- Collaboration with Bogdan Warinschi (Bristol University) on defining game-based privacy for e-voting protocols.
- Collaboration with Myrto Arapinis (University of Edinburgh) on simplification results for the formal analysis of e-voting protocols.

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<sup>0</sup><http://www.loria.fr/~cortier/ProSecure.html>

<sup>0</sup><http://www.loria.fr/~ringeiss/CHILI/bananas>

- Collaboration with Matteo Maffei (CISPA, Germany) on type systems for e-voting systems.
- Collaboration with Paliath Narendran's group (SUNY Albany) on automated deduction.
- Collaboration with Hanifa Boucheneb's group (Ecole Polytechnique de Montréal) on model-checking of collaborative systems.
- Collaboration with John Mullins's group (Ecole Polytechnique de Montréal) on information hiding.

### 8.4.3. Participation in International Programs

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

## 8.5. International Research Visitors

### 8.5.1. Visits of International Scientists

- Myrto Arapinis (University of Edinburgh), March, December 2014
- David Bernhard (Bristol University), March 2014
- Fabienne Eigner (University of Saarbruecken), February, May 2014
- Joshua Guttman (MITRE), January 2014
- Olivier Pereira (University of Louvain-la-Neuve), March 2014
- Nicolas Pouillard (DemTech, University of Copenhagen), February 2014

#### 8.5.1.1. Internships

Tushant Jha

Subject: Synthesis of Secure Services Composition

Supervisor: Michaël Rusinowitch

Date: from May 2014 until July 2014

Institution: IIIT Hyderabad

Gemma Puig-Quer

Subject: New protocols for private e-voting

Supervisors: David Galindo-Chacon and Véronique Cortier

Date: from Sep 2013 until Mar 2014

Institution: UPC Barcelona (Spain)

Itsaka Rakotonirina

Subject: Automated verification of security protocols with loops

Supervisor: Steve Kremer

Date: from June 2014 until July 2014

Institution: ENS Cachan

Ludovic Robin

Subject: Analysis of security protocols using weak secrets

Supervisor: Steve Kremer

Date: from April 2014 until September 2014

Institution: U. Bordeaux

## PAREO Project-Team

# 7. Partnerships and Cooperations

## 7.1. National Initiatives

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

We are also involved in the GDR-GPL (CNRS Research Network on Software Engineering), as a member of the FORWAL group and member of the Scientific Board of the GDR.

## 7.2. European Initiatives

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

Program: PHC Polonium

Project title: Expressing concurrency through control operators

Duration: January 2015 - December 2016

Coordinator: Sergueï Lenglet

Other partner: Institute of Computer Science, University of Wrocław, Poland

Abstract: The goal of this project is to explore the interplay between concurrency, continuations, and control operators at a fundamental level. We do not restrict ourselves to a specific programming language, but we use more general and well established formal models, namely process calculi (such as the  $\pi$ -calculus) for concurrency, and the  $\lambda$ -calculus (a model of sequential functional programming) for continuations and control operators. We want to find new connections between concurrency and control operators, and especially new ways of implementing concurrent and distributed programs with the help of control operators.

## 7.3. International Research Visitors

### 7.3.1. Visits of International Scientists

#### 7.3.1.1. Internships

Nauval Atmaja

Subject: Property Based Testing

Date: from Feb 2014 until Jun 2014

Institution: Erasmus Mundus MSc in Dependable Software Systems

## VEGAS Project-Team

# 6. Partnerships and Cooperations

## 6.1. National Initiatives

### 6.1.1. ANR PRESAGE

The white ANR grant PRESAGE brings together computational geometers (from the VEGAS and GEOMETRICA projects of Inria) and probabilistic geometers (from Universities of Rouen, Orléans and Poitiers) to tackle new probabilistic geometry problems arising from the design and analysis of geometric algorithms and data structures. We focus on properties of discrete structures induced by or underlying random continuous geometric objects.

This is a four year project, with a total budget of 400k€, that started on Dec. 31st, 2011. It is coordinated by Xavier Goaoc who moved from the Vegas team to Marne-la-Vallée university in 2013.

### 6.1.2. ANR SingCAST

The objective of the young-researcher ANR grant SingCAST is to intertwine further symbolic/numeric approaches to compute efficiently solution sets of polynomial systems with topological and geometrical guarantees in singular cases. We focus on two applications: the visualization of algebraic curves and surfaces and the mechanical design of robots.

After identifying classes of problems with restricted types of singularities, we plan to develop dedicated symbolic-numerical methods that take advantage of the structure of the associated polynomial systems that cannot be handled by purely symbolic or numeric methods. Thus we plan to extend the class of manipulators that can be analyzed, and the class of algebraic curves and surfaces that can be visualized with certification.

This is a 3.5 years project, with a total budget of 100k€, that started on March 1st 2014, coordinated by Guillaume Moroz.

In 2014, the project funded 6 months of internship for Olive Chakraborty and the beginning of the postdoc position of Rémi Imbach. We also organized the first meeting on subdivision methods for singular systems in Nantes in December, see the project website [SingCAST](#).

## 6.2. International Research Visitors

### 6.2.1. Visits of International Scientists

#### 6.2.1.1. Internships

Olive Chakraborty

Subject: Numerical algorithms for certified topological and geometrical description of singular curves.

Date: Jun-Dec 2014.

Institution: IIT Pilani, India.

## VERIDIS Project-Team

# 8. Partnerships and Cooperations

## 8.1. Regional Initiatives

**Participants:** Jingshu Chen, Pablo Federico Dobal, Pascal Fontaine, Stephan Merz.

The PhD thesis of Pablo Federico Dobal benefits from joint funding by Région Lorraine since September 2014, complementing funding through the ANR-DFG project SMArT (section 8.2).

The post-doctoral research stay of Jingshu Chen was supported by joint funding by Région Lorraine and the Airbus Foundation.

## 8.2. National Initiatives

### 8.2.1. ANR-DFG Project SMArT

**Participants:** Haniel Barbosa, David Déharbe, Pablo Federico Dobal, Pascal Fontaine, Maximilian Jaroschek, Marek Košta, Stephan Merz, Thomas Sturm.

The SMArT (Satisfiability Modulo Arithmetic Theories) project is funded by *ANR-DFG Programmes blancs 2013*, a program of the Agence Nationale de la Recherche and the (German) Deutsche Forschungsgemeinschaft DFG. It started in April 2014. The partners are both the French and German parts of VeriDis and the Systerel company. The objective of the SMArT project is to provide advanced techniques for arithmetic reasoning beyond linear arithmetic for formal system verification, and particularly for SMT. Arithmetic reasoning is one strong direction of research at MPI, and the state-of-the-art tool Redlog (section 5.4) is mainly developed by Thomas Sturm. The SMT solver veriT (section 5.1), developed in Nancy, will serve as an experimentation platform for theories, techniques and methods designed within this project.

In September 2014, Pablo Federico Dobal has been hired as a PhD student in joint supervision with Saarland University, co-funded by the SMArT project and the Région Lorraine. More information on the project can be found on <http://smart.gforge.inria.fr/>.

### 8.2.2. ANR Project IMPEX

**Participants:** Manamiary Andriamiarina, Dominique Méry.

*The ANR Project IMPEX is an INS ANR project that started in December 2013 for 4 years. It is coordinated by Dominique Méry, the other partners are IRIT/ENSEIHT, Systerel, Supelec and Telecom Sud Paris.*

All software systems execute within an environment or context. Reasoning about the correct behavior of such systems is a ternary relation linking the requirements, system and context models. Formal methods are concerned with providing tool (automated) support for the synthesis and analysis of such models. These methods have quite successfully focused on binary relationships, for example: validation of a formal model against an informal one, verification of one formal model against another formal model, generation of code from a design, and generation of tests from requirements. The contexts of the systems in these cases are treated as second-class citizens: in general, the modeling is implicit and usually distributed between the requirements model and the system model. This project proposal is concerned with the explicit modeling of contexts as first-class citizens.

Several approaches aim at formalizing mathematical theories that are applicable in the formal developments of systems. These theories are helpful for building complex formalizations, expressing and reusing proof of properties. Usually, these theories are defined within contexts, that are imported and and/or instantiated. They usually represent the implicit semantics of the systems and are expressed by types, logics, algebras, etc. However, an implicit handling of contexts loses important information, and therefore is not expressive enough for ensuring that even a verified system is “correct”. As a very simple example, take two formally developed systems that are composed to exchange currency data represented by a float. This system is no longer consistent if one system refers to Euros and the other to dollars. The objective of the IMPEX project is to build explicit formal models of contextual semantics and to extend proof-based techniques for handling such a stronger semantics [23].

### 8.2.3. Inria Development Action VeriT

**Participants:** Pablo Federico Dobal, Pascal Fontaine.

Inria funded this project (started in 2011) to support the development of the SMT solver veriT (see section 5.1), including added expressiveness, improved efficiency and code stability, and interfaces with tools that embed veriT as a backend solver. The project is coordinated by Pascal Fontaine and also includes Inria Rennes (Celtique) and Sophia Antipolis (Marelle). Pablo Federico Dobal was hired in 2012 on a position funded by this project and has in particular contributed to improvements in the code of the solver as well as of the testing platform that allows us to detect bugs and the impact of changes on the performance of the tool. He also contributed to the maintenance of the deltaSMT tool, which has been used by several other teams of SMT developers for debugging SMT solvers.

## 8.3. European Initiatives

### 8.3.1. MEALS

Type: PEOPLE

Instrument: International Research Staff Exchange Scheme

Objective: Exchange of scientists between Europe and Argentina

Duration: October 2011 - September 2015

Coordinator: Holger Hermanns, Universität des Saarlandes (Germany)

Partners: Universidad de Buenos Aires, Universidad Nacional de Córdoba, Universidad Nacional de Rio Cuarto, Instituto Tecnológico Buenos Aires

Inria contact: Catuscia Palamidessi

Abstract: The MEALS project funds exchanges between scientists in Europe (Saarland University, RWTH Aachen, TU Dresden, Inria, Imperial College, Univ. of Leicester, TU Eindhoven); it is structured in five work packages (Quantitative Analysis of Concurrent Program Behaviour, Reasoning Tasks for Specification and Verification, Security and Information Flow Properties, Synthesis in Model-based Systems Engineering, Foundations for the Elaboration and Analysis of Requirements Specifications). Our team mainly cooperates with the group led by Carlos Areces in Córdoba within work package 2. In 2014, the project funded visits by Stephan Merz to Córdoba and by Carlos Areces, Luciana Benotti, Raúl Fervari, and Guillaume Hoffmann to Nancy.

### 8.3.2. Cooperation with NUI Maynooth, Ireland

**Participant:** Dominique Méry.

We cooperate with Rosemary Monahan of NUI Maynooth on exchanges between techniques of software refinement and software verification. Our cooperation was financially supported in 2013 by a one-year project funded by PHC Ulysses. The verification of software requires the specification of preconditions and postconditions as well as other properties of the code. These properties are expressed as annotations and provide a detailed understanding of how the software is implemented. In program verification, the annotation process is often done *a posteriori*, with verification tools used to check that annotations are sound according to the semantics of the program. Determining the correct annotations to provide a complete specification is difficult, especially when specifying invariant properties of the code. *A priori* techniques for developing correct software are based on the correct-by-construction paradigm. The refinement-based approach is such a technique, providing for the construction of a correct program through the step-by-step refinement of an initial high-level model of the software. In this way, the program specification is developed alongside the code, discharging the conditions that need to be proved. We focus on combining these two software engineering techniques, to benefit from the strengths of both. We have proposed a framework for integrating the *a posteriori* paradigm Spec# and the *a priori* paradigm Event-B. This integration induces a methodology that bridges the gap between software modeling and program verification in the software development life cycle. During 2014, we have designed the Rodin plugin **EB2RC** that implements transformations of Event-B models into algorithms.

## 8.4. International Initiatives

### 8.4.1. Participation In International Programs

#### 8.4.1.1. STIC AmSud MISMT

**Participants:** Carlos Areces, Haniel Barbosa, Luciana Benotti, Richard Bonichon, David Déharbe, Pablo Federico Dobał, Raúl Fervari, Pascal Fontaine, Guillaume Hoffmann, Stephan Merz, Claudia Tavares.

VeriDis has a close working relationship with two South American teams at Universidade Federal do Rio Grande de Norte (UFRN), Brazil (more specifically with Prof. David Déharbe), and at Universidad Nacional de Córdoba, Argentina (more specifically with Prof. Carlos Areces). The STIC AmSud MISMT project, including both teams and VeriDis, started in 2014. It complements the MEALS project (section 8.3 ) and extends it to cooperation with UFRN.

The project is centered around Satisfiability Modulo Theories, with a focus on applications to Modal Logic. Notably, the project sustains the development of the veriT solver (section 5.1 ), of which David Déharbe and Pascal Fontaine are the main developers. First results on using SMT for modal logic have been accepted for publication.

In February, Stephan Merz spent three weeks in Córdoba. David Déharbe stayed in Nancy until July, on a sabbatical from UFRN. A workshop with many participants from the project took place in Nancy in early July. Richard Bonichon and Claudia Tavares visited Nancy in September. At the end of the year, Haniel Barbosa (VeriDis PhD student in joint supervision with Natal) spent three months in Natal and visited Córdoba for two weeks.

More information on the STIC AmSud MISMT project is available on <http://mismt.gforge.inria.fr/>.

## 8.5. International Research Visitors

### 8.5.1. Visits of International Scientists

David Déharbe from UFRN (Natal, Brazil) spent a sabbatical year with the VeriDis team in Nancy from August, 2013 to July, 2014.



*8.5.1.1. Internships*

Ignacio Martin Queralt

Subject: Symbolic transition checking for TLA<sup>+</sup>

Date: April to September, 2014

Institution: Universidad Nacional de Córdoba (Argentina)

Clément Herouard

Subject: SMT techniques for modal logics and extensions

Date: May to July, 2014

Institution: Ecole Normale Supérieure de Rennes (France)

## **CORIDA Team**

# **7. Partnerships and Cooperations**

## **7.1. National Initiatives**

### **7.1.1. ANR**

Most of the members of our team are involved in at least one ANR program.

Marius Tucnsak is local coordinator of ANR blanc project Hamecmopsys. This ANR project will be active up to 2015.

Antoine Henrot is head of the ANR blanc project OPTIFORM since September 2012. This project is devoted to the Geometric Analysis of Optimal Shapes. It gathers scientist from Grenoble, Chambéry, Lyon, Rennes and Paris Dauphine. This ANR project will be active up to August 2016.

Xavier Antoine is coordinator for partner 2 of ANR blanc project BECASIM since September 2013. This ANR project will be active up to 2017.

### **7.1.2. GDR**

Thomas Chambrion has been animator of the EDP group of GDR MAC since October 2014.

## **7.2. International Research Visitors**

### **7.2.1. Visits of International Scientists**

Prof Gengsheng Wang, University of Wuhan, China, visited our team for 3 months.

Prof George Weiss, University of Tel Aviv, Israel, visited our team for 1 month.

### **7.2.2. Visits to International Teams**

Julie Valein has been invited for 3 months (October-December) in the Department of Applied Physics and Applied Mathematics (APAM) at Univeristy of Columbia, New-York, USA.

## TOSCA Project-Team

## 8. Partnerships and Cooperations

### 8.1. National Initiatives

#### 8.1.1. ANR

- N. Champagnat, J. Claisse and D. Villemonais were members of the ANR MANEGE (Modèles Aléatoires en Écologie, Génétique et Évolution, ending in April 2014) whose aim is to provide methodological and conceptual advances in the study of stochastic processes modeling ecology, population genetics and evolution of life. This work is sustained by regular exchanges with biologists from several teams in France. [http://www.cmap.polytechnique.fr/~anr-manege/index\\_en.html](http://www.cmap.polytechnique.fr/~anr-manege/index_en.html)
- N. Champagnat is member of the ANR NONLOCAL (Phénomènes de propagation et équations non locales, started in October 2014), aiming at understanding, in the greatest generality, the phenomena of propagation in non-local reaction-diffusion equations. These equations can present integral forms of diffusion operators, or speed that depend on integrals of the solution, memory effects, or long-range interactions in source terms. [http://www.agence-nationale-recherche.fr/projet-anr/?tx\\_lwmsuivibilan\\_pi2\[CODE\]=ANR-14-CE25-0013](http://www.agence-nationale-recherche.fr/projet-anr/?tx_lwmsuivibilan_pi2[CODE]=ANR-14-CE25-0013)
- A. Lejay is member of the ANR H2MNO4 (ANR Cosinus, 2012–2015) on Original Optimized Object Oriented Numerical Model for Heterogeneous Hydrogeology which started in November 2012 (directed by Joceyline Erhel, IRISA, Rennes).

#### 8.1.2. Contract with ADEME

**Participants:** Mireille Bossy, Sélim Karia.

**Modéol** Since April 2013, M. Bossy was the coordinator of the MODÉOL collaboration project funded by the French Environment and Energy Agency (ADEME), and involving the IPSL (CNRS) and the French company Maïa Eolis. The overall goal of the project concerns the modeling and prediction of wind potential in France, in particular the quantification of uncertainties and the analysis of multi-scale variability.

Concerning the Inria workpackage, in collaboration with Antoine Rousseau, from the team LEMON, we have almost completed the SDM version with complex terrain description. We also improved the turbulence modelling to better take into account the shear effect near the ground.

## 8.2. European Initiatives

### 8.2.1. FP7 & H2020 Projects

- J. Inglis is a member of the European project MatheMACS (European Union Seventh Framework Programme no. 318723).

## 8.3. International Initiatives

### 8.3.1. Inria International Labs

The CIRIC Team on *Stochastic Analysis of Renewable Energies: Ocean Energy and Wind Farms; dynamics and numerics* (2012-2014) is managed by TOSCA and ANESTOC (Univ Catolica, Santiago). It is composed of three main projects.

Mireille Bossy is managing the WINDPOS project, in collaboration with Antoine Rousseau (LEMON team) and two engineers of Inria Chile, Cristian Paris and Jacques Morice. Based on the stochastic Lagrangian modeling of the wind at small scale (see SDM SOFTWARE), WINDPOS aims to develop a wind farm simulator software, able to provide fine statistical information for the managing of electricity production.

This year the WINDPOS project focused on the improvement on wind mills modeling in the SDM software (see [28]). This modeling is based on our Lagrangian version of the actuator disc actuator line methods to take the mills into account. We evaluated and compared the case of non rotating and rotating actuator disc, and started to work on the validation of the approach by comparison with measurements.

### 8.3.2. Inria Associate Teams

#### 8.3.2.1. ANESTOC-TOSCA

Title: Stochastic modelling of biology and renewable energies

International Partner (Institution - Laboratory - Researcher):

Pontificia Universidad Católica de Chile (CHILI)

Duration: 2013 - 2016

See also: [http://www.anestoc.cl/es/?page\\_id=1112](http://www.anestoc.cl/es/?page_id=1112)

This French-Chilean Associated Team deals with stochastic modeling and simulation issues for renewable energies (wind and waves) and neurosciences. It is a follow-up of a long collaboration in which each of the side takes benefit from the other side know-how and structures. In particular, a part of the Associated Team is strongly related to the CIRIC project “Stochastic Analysis of Renewable Energy”. This project aims at transferring and valuing to Chilean companies the results of researches on renewable energies, mainly wind prediction at the windfarm’s scale by developing and improving the Winpos software based on the downscaling methods, and waves energy potential of a site using video and developping stochastic models for the Wave Energy Converter called Oscillating Water Column.

The other part of this Associated Team is related to neurosciences, more specifically by considering applications to ion-channel dynamics through cell membranes (jointly with biophysicists of the CINV, Neuroscience Centre of Valparaíso).

### 8.3.3. Participation In other International Programs

#### 8.3.3.1. Math Amsud project SIN

**Participant:** Etienne Tanré.

It is likely that the stochastic components play an important role in the functions of the neurons and of the networks they form. We describe and study the effect of the noise at different scales of neural activity, such that the level of the ionic channels and the level of neural networks, which are responsible for conveying and processing the information coded in sequences of spikes. The most popular models of this class are leaky integrate and fire (LIF) neural networks. We study the synchronization of neurons in those networks.

The Math Amsud project SIN (Stochastic, Inference, Neuroscience) started in 2013. We worked specifically in 2014 on stochastic modelling in neuroscience.

## 8.4. International Research Visitors

### 8.4.1. Visits of International Scientists

- M. Baar (Bonn University) has been visiting TOSCA Nancy for one week in September.
- L. Beznea (Simion Stoilow Institute of Mathematics of the Romanian Academy) has been visiting TOSCA Nancy one week in March and three weeks in July.
- The TOSCA *seminar* organized by J. Inglis in Sophia Antipolis has received the following speakers: Maxime Bonelli (TOSCA), Hector Olivero-Quinteros (Universidad de Chile), Jean-François Jabir (CIMFAV, Fac. de Ingenieria, Universidad de Valparaiso), Tony Lelièvre (École des Ponts ParisTech), Christophe Profeta (Université d’Evry-Val d’Essone), Xiaolu Tan (Ceremade, Univ. Dauphine), Pierre Patie (ORIE, Cornell University), Alexandre Richard (Inria, Regularity), Paola Cinnella (CMI, Université Aix Marseille), Caroline Bauzet (CMI, Université Aix Marseille), Laurent Mertz (Laboratoire J.A. Dieudonné, Univ. Nice – Sophia Antipolis), Charles-Edouard Bréhier (Cermics, École des Ponts).

8.4.1.1. Internships

BEDOUI Akram

Subject: Gestion du risque de portefeuille par la méthode des copules

Date: Feb 2014 - June 2014

Institution: EPT (Tunisie)

DEJAX Florian

Subject: Carbon and electricity markets

Date: from Jun 2014 until Aug 2014

Univ. Paris (France)

FOGUEN TCHUENDOM Rinel

Subject: Bayesian Inference via Markov Chain Monte Carlo methods: A financial case study

Date: March 2014 - August 2014

Institution: Université de Nice – Sophia Antipolis (France)

LALANNE Victor

Subject: Carbon and electricity markets

Date: from Jun 2014 until Aug 2014

Univ. Nice (France)

PAPIC-PONCE Alexis

Subject: Divergence of Euler numerical scheme for SDE with non Lipschitz coefficients

Date: March 2014

Institution: PUC (Chile)

PICCOLOMINI Tatiana

Subject: Probabilistic interpretation of non-linear PDEs with branching diffusion processes

Date: from March 2013 until July 2014

Institution: Universidad de Buenos Aires (Argentina)

## BIGS Project-Team

## 7. Partnerships and Cooperations

### 7.1. Regional Initiatives

*Project "Handle your heart"* Creation of a drug prescription support software for the treatment of heart failure, in collaboration with the University Hospital of Nancy, headed by J.-M. Monnez.

### 7.2. National Initiatives

- *Truffinet* (2014), TRUFFles' microbial interaction Inference by NETwork analysis, Funding organism: PEPS CNRS-Université de Lorraine, Leader: A. Muller-Gueudin. Collaboration with IECL (Anne Gégout-Petit), CRAN (S. Martin, C. Morarescu), INRA (A. Deveau).
- *Optique-PDT* (2012-2014), mOdélisation et oPTimisation de l'Irradiance dans les tissus biologiQUEs hétérogènes traités par Thérapie PhotoDynamique interstitielle, Funding organism: PEPS CNRS-INSERM-Inria, Leader: M. Thomassin (CRAN, U. Lorraine).
- *Nano-Xrays* (2011-2014), Nanoparticles-based X ray-induced photodynamic therapy in glioblastoma multiform, Funding organism: Institut National du Cancer (INCa), Leader: M. Barberi-Heyob (CRAN, U. Lorraine), T. Bastogne.
- GDR 3477 Géométrie Stochastique, Leaders: Pierre Calka, David Coupier, Viet Chi Tran, C. Lacaux.
- GDR 3475 Analyse Multifractale, Leader: Stéphane Jaffard (C. Lacaux).
- *PhotoBrain* (2015-17), AGuIX® theranostic nanoparticles for vascular-targeted interstitial photodynamic therapy of brain tumors, Funding organism: EuroNanoMed II, Leader: M. Barberi-Heyob (CRAN).
- (2014-16), A library of Near-InfraRed absorbing photosensitizers: tailoring and assessing photo-physical and synergetic photodynamic properties, Funding organism: PHC Bosphore - Campus France, Leader: M. Barberi-Heyob (CRAN).

### 7.3. International Research Visitors

#### 7.3.1. Visits of International Scientists

2014/05/11-2014/05/25: visit of Gennady Samorodnitsky (Cornell, USA) to C. Lacaux.

#### 7.3.2. Visits to International Teams

##### 7.3.2.1. Sabbatical programme

S. Tindel was on sabbatical at the University of Kansas from August 2013 to June 2014, working on inference for Gaussian systems with D. Nualart and Y. Hu.

## MASAIE Project-Team

# 6. Partnerships and Cooperations

## 6.1. International Initiatives

### 6.1.1. Inria International Labs

MASAIE is the Inria EPI partner of GRIMCAPE (LIRIMA). It also has strong collaboration with M2IPE2S (LIRIMA). Two PhD students (Diaby and Diouf) are members of M2IPE2S.

G. Sallet participated to The "LIRIMA evaluation seminar", Paris, September 24-26, 2014.

### 6.1.2. Participation in other International Programs

#### 6.1.2.1. Capes-Cofecub

MASAIE is the french correspondent in a cooperation program with Brazil.

We work with a Brazilian network that has been built in 2011, and which is composed of

- FGV (Fundação Getulio Vargas ) Rio de Janeiro. Principal investigator: Jair Koiller.
- UFF (Universidade Federal Fluminense) Rio de Janeiro. Principal investigator: Max Oliveira de Souza.
- UNICAMP (Universidade Estadual de Campinas ) Campinas. Principal investigator: Hyun Mo Yang.
- Fondation Oswaldo Cruz (Fiocruz, Rio). Principal investigator: Claudia Codeço.
- IMPA Rio de Janeiro. Principal investigator: Jorge Zubelli.

This project, funded by CAPES-COFECUB, "new methods in epidemiology and early detection of events" began in January 2011 and finished in December 2013. However the collaboration with the Brazilian collaborators has continued and increased during 2014.

#### 6.1.2.2. Paes-Uemoa

A research project on *Bilharzia* was submitted by the universities of Ouagadougou and Gaston Berger of Saint-Louis, in the framework of PAES(projet d'appui à l'enseignement supérieur) of UEMOA (Union Économique et Monétaire de l'Afrique de l'Ouest). MASAIE is an important component of this network. This project has been accepted in 2012 and funded with 30 000 000 CFA (XOF) ( ≈ 45 000 euro). This project will finish on January 2015.

The PhD thesis of M. Diaby (MASAIE and UGB St Louis) is part of this project.

## 6.2. International Research Visitors

### 6.2.1. Visits of International Scientists

Max Oliveira de Souza, professor at Universidade Federal Fluminense, Rio de Janeiro, Brazil, January 2014.

### 6.2.2. Visits to International Teams

G. Sallet visited FGV and UFF (Rio de Janeiro) and UNESP (São José dos Campos, Sao Paulo) from November 10, 2014 to November 29, 2014. A. Iggidr visited FGV and UFF (Rio de Janeiro) from April 20, 2014 to May 11, 2014. A. Iggidr visited FGV and UFF (Rio de Janeiro) and UNESP (São José dos Campos, Sao Paulo) from November 7, 2014 to December 5, 2014.

## NEUROSYS Team

# 7. Partnerships and Cooperations

## 7.1. Regional Initiatives

In the *Contrat de Projet État Région (CPER) Action Modeling, Simulation and Interaction* (2009-2014), we are contributing to the axis *Situed Informatic* through the project CoBras for controlling a jaco robotic arm using EEG. Contact in Neurosys is Laurent Bougrain.

## 7.2. National Initiatives

### 7.2.1. ANR

We participate in the project *Keops: Algorithms for modeling the visual system: From natural vision to numerical applications* (2011-2014).

A recent description in the retina of non-standard ganglion cells types, beside a complex repertoire of standard ganglion cells, responses in front of natural stimulus and conveys important questions about the real, early processing capacity of the retina. This leads to revisit both the neural coding of the information the eye is sending to the brain, and also sheds light to engineering applications from the understanding of such encoding, as detailed in the sequel. At the modeling level, retinal cells are mainly formalized using a LN (Linear spatio-temporal filtering followed by a static Non-linear transduction), while an important fraction of non-standard cells response cannot be represented in such a model class. This is a challenge to develop an innovative formalism that takes such complex behaviors into account, with such immediate applications as new dynamical early-visual modules. Proposing new innovative bioinspired formalisms in order to perform dynamical visuo-perceptual tasks adapted to natural environment is a main goal of this project, with a special focus to scenes including complex visual motion interacting with light.

The project is a cooperation between the University of Nice (France), the University of Valparaiso (Chile), the Pontifical Catholic University of Chile in Santiago de Chile, the Inria teams NeuroMathComp, Mnemosyne, Cortex and Neurosys.

### 7.2.2. Others

- Inria Technological development action (ADT): OpenViBE-NT  
This is a three-year multi-site project (2012–2015) to develop OpenViBE further on several fronts such as usability, new algorithms and scope of applicability. Teams of the ADT are Hybrid(Rennes), Athena (Sophia), Potioc (Bordeaux) and Neurosys. Coordinator is Laurent Bougrain.
- Multidisciplinary Exploratory Project (PEPS 2014) Bio-Maths-Info (BMI): *Characterising the laminar profile of motor cortical oscillatory synchronization during visuomotor behavior with new analysis tools.*

Oscillations are omnipresent in the brain, but their function is still disputed. In motor cortex, beta and gamma oscillations are often observed, but their proposed roles in sensorimotor behavior are largely overlapping. While much is known on the laminar distribution of oscillations in sensory areas, the very sparse data on the laminar profile of motor cortical oscillations largely limits their functional interpretations. The 2-years project studies the layer specificity of monkey motor cortical oscillations and oscillatory interactions between the motor areas M1 and PMd during visuomotor behavior. Extending conventional tools, such as coherency analysis, Neurosys develops a new method to quantify short-lasting partial amplitude and phase synchronization in single-trial data, based on wavelets, exploiting the predefined vicinity of contacts on the laminar probes. The application of this new method to the data recorded in Marseille will reveal instantaneous amplitude and phase synchronization between cortical layers and between the brain areas M1 and PMd, providing novel insights into the functional roles of beta and gamma oscillations in visuomotor behavior. The experimental partner at the *Institut de Neurosciences de la Timone* in Marseille is Bjork Kilavik. The contact in Neurosys is Axel Hutt.



## 7.3. European Initiatives

### 7.3.1. FP7 & H2020 Projects

The ITN-project *Neural Engineering Transformative Technologies (NETT)* (2012-2016) is a Europe-wide consortium of 18 universities, research institutes and private companies which together hosts 17 PhD students and 3 postdoctoral researchers over the next 4 years. Neural Engineering brings together engineering, physics, neuroscience and mathematics to design and develop brain-computer interface systems, cognitive computers and neural prosthetics. Neurosys will host a PhD-student from University of Barcelona for three months in fall 2015. Contact is Axel Hutt.

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

Program: ERC Starting Grant

Project acronym: MATHANA

Project title: Mathematical Modeling of Anaesthesia

Duration: January 2011 – December 2015

Coordinator: Axel Hutt

Abstract: MATHANA aims to study mathematically spatially extended neural systems and reveal their spatio-temporal dynamics during general anaesthesia.

### 7.3.3. Collaborations with Major European Organizations

Lifestyle Research Association (LIRA): Philips (Netherlands), Fraunhofer (Germany), Inria

Sleep is an essential part of a healthy life, but many people have trouble getting enough uninterrupted sleep. Special sensors installed in a mobile phone or bed can analyze activities, stress patterns and sleep sequences and provide ideas for new strategies and, eventually, products that support a healthier night's sleep. NEUROSYS has a Postdoc project running merging all sensor signals in a single data analysis technique to improve existing sleep monitors.

## 7.4. International Initiatives

### 7.4.1. Inria International Partners

#### 7.4.1.1. Informal International Partners

- We collaborate with Jamie Sleight (University of Auckland, New Zealand), who provides us with experimental EEG-data obtained in humans during anaesthesia (A. Hutt).
- In the collaboration with Flavio Frohlich (University of North Carolina - Chapel Hill), we receive experimental data measured intracranially in ferrets and analyse them on spectral properties (A. Hutt).
- In the collaboration with Jérémy Lefebvre (University of Lausanne), we have been working out together a stochastic delayed neural field analysis leading to new insights into the effects of additive noise (A. Hutt).
- The collaboration with Peter beim Graben (Humboldt University Berlin) on recurrence data analysis has led to analysis techniques to detect meta-stable states in EEG-signals (A. Hutt).
- We have an ongoing collaboration with Pr. Motoharu Yoshida at the Ruhr University Bochum, Germany, aiming to study the role of persistent firing neurons in memory and more specifically in neural network synchronization. M. Yoshida provides us with biological data that we combine with simulations to test hypotheses on memory formation (L. Buhry).
- We also collaborate with Pr. John Rinzel (New York University, USA) and Pr. LieJune Shiau (University of Houston, Texas, USA) on more theoretical approaches concerning the role of intrinsic neuronal dynamics in network synchronization and brain oscillations (L. Buhry).

## **7.5. International Research Visitors**

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

We have hosted the visiting professor LieJune Shiau (University of Houston, June) to discuss future collaborations on the modeling of neural populations based on single neuron properties in the presence of anaesthetic drugs. In addition, Motoharu Yoshida (Ruhr-Universität Bochum, Germany) visited our lab, gave a seminar and we discussed our current collaboration about memory and persistent firing cells of the hippocampus.

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

#### *7.5.2.1. Research stays abroad*

Axel Hutt has stayed for 1 month at the Humboldt University Berlin to enforce the collaboration with Peter beim Graben (October - November).

## SHACRA Project-Team

# 7. Partnerships and Cooperations

## 7.1. National Collaborations

The team is collaborating with many national partners, such as:

- the Oscar Lambret Hospital in the context of the interactive inverse FEM simulation (Luis Shiapacasse, Nick Reynaert and Eric Lartigau),
- CHR Lille (Laurent Thines),
- the radiology department of Nancy Hospital within the IDeaS project,
- the TeamC research lab,
- the Inria ASCLEPIOS research team,
- the Inria EVASION research team,
- the Inria MARGRIT research team,
- the Inria LAGADIC research team.

## 7.2. National Initiatives

### 7.2.1. *Sofa, OR*

In December 2014, a new ADT national initiative started. The objective of this ADT is twofold: first, we aim at achieving a level of quality and robustness compatible with IEC 62304 for the core of SOFA and a reduced set of components. This does not include the certification of the code itself, but rather the implementation of a comprehensive development process that will enable the certification by companies wishing to integrate this code into their systems. The second objective is to add new features specific to the needs of using intra-operative: interoperability with equipment from the operating room, acquisition and real-time processing of full HD video streams, data assimilation and predictive filters, path planning, visualization for augmented reality, or user interfaces dedicated to the operating room.

### 7.2.2. *RESET*

At the end of the year, the team has been awarded a new ANR project: RESET. This project will start in March 2015. Its objective is to develop a high-fidelity training system for retinal surgery. Retina surgery is an increasingly performed procedure for the treatment of a wide spectrum of retinal pathologies. Yet, as most micro-surgical techniques, it requires long training periods before being mastered. This simulator will be built upon our strong scientific expertise in the field of real-time simulation, and our success story for technology transfer in the field of cataract surgery simulation (MSICS simulation developed for the HelpMeSee foundation).

### 7.2.3. *Sofa, ADT*

SOFA Large Scale Development Initiative (ADT) : the SOFA project (Simulation Open Framework Architecture) is an international, multi-institution, collaborative initiative, aimed at developing a flexible and open source framework for interactive simulations. This will eventually establish new grounds for a widely usable standard system for long-term research and product prototyping, ultimately shared by academic and industrial sites. The SOFA project involves 3 Inria teams, SHACRA, IMAGINE and ASCLEPIOS. The development program of the ADT started in 2007.

#### **7.2.4. ANR Acoustic**

The main objective of this project is to develop an innovative strategy based on models for helping decision-making process during surgical planning in Deep Brain Stimulation. Models will rely on different levels involved in the decision-making process; namely multimodal images, information, and knowledge. Two types of models will be made available to the surgeon: patient specific models and generic models. The project will develop methods for 1) building these models and 2) automatically computing optimal electrodes trajectories from these models taking into account possible simulated deformations occurring during surgery. The project belongs to the multidisciplinary domain of computer-assisted surgery (CAS). Computer assisted surgery aims at helping the surgeon with methods, tools, data, and information all along the surgical workflow. More specifically, the project addresses surgical planning and surgical simulation in Image Guided Surgery. It is related to the exponentially growing surgical treatment of Deep Brain Stimulation (DBS), originally developed in France by Pr. Benabid (Grenoble Hospital). The key challenges for this research project are 1) to identify, extract, gather, and make available the information and knowledge required by the surgeon for targeting deep brain structures for stimulation and 2) to realistically simulate the possible trajectories.

#### **7.2.5. IHU, Strasbourg**

Our team has been selected to be part of the IHU of Strasbourg. This new institute, for which funding (67M€) has just been announced, is a very strong innovative project of research dedicated to future surgery of the abdomen. It will be dedicated to minimally invasive therapies, guided by image and simulation. Based on interdisciplinary expertise of academic partners and strong industry partnerships, the IHU aims at involving several specialized groups for doing research and developments towards hybrid surgery (gesture of the surgeon and simulation-based guidance). Our group and SOFA have a important place in the project. Since September 2011 a part of our team is located within the IHU, to develop a number of activities in close collaboration with clinicians.

#### **7.2.6. ANR IDEaS**

IDEaS is a project targeted at per-operative guidance for interventional radiology procedures. Our main goal is to provide effective solutions for the two main drawbacks of interventional radiology procedures, namely: reduce radiation exposure and provide a fully 3D and interactive visual feedback during the procedure. To do so, our project relies on an original combination of computer vision algorithms and interactive physics-based medical simulation. Computer vision algorithms extract relevant information (like the actual projected shape of the guide-wire at any given time) from X-ray images, allowing adjusting the simulation to real data. Conversely, computer-based simulation is used as a sophisticated and trustful predictor for an improved initialization of computer vision tracking algorithms. Many outcomes may be expected both in scientific and clinical aspects. On the scientific side, we believe a better understanding of how real data and simulation should be merged and confronted must lead, as a natural by-product, to image-based figures of merit to actually validate computer-based simulation outputs against real and dynamic data. A more accurate identification of the factors limiting the realism of simulation should follow with a rebound impact on the quality of the simulation itself. An actual integration of a mechanical model into the loop will improve the tracking. We firmly believe mechanical constraints can supplement the image data such that dynamic single view reconstruction of the interventional devices will be possible. On the clinical side, using the prediction capabilities of the simulation may decrease the need for X-ray images at high rates, thus leading to lower exposure to radiations for the patients and surgical staff. Finally, the output of the simulation is the 3D shape of the tool (e.g. guide-wire or catheter), but not only. Additional information may be visualized, for instance pressure of the catheter on the arterial wall, to prevent vessel wall perforations, or reduce stress on the arterial wall to prevent spasm. More generally, richer information on the live procedure may help surgeons to reduce malpractice or medical errors.

### **7.3. European Initiatives**

#### **7.3.1. RASimAs**

2014 was the first year of the RASimAs project (STREP project funded under FP7) during which we developed new models of the biomechanics of the leg and arm, as well as the simulation of the insertion of the anaesthesiology needle. Regional anaesthesia has been used increasingly during the past four decades. This is addressed to the perceived advantages of reduced postoperative pain, earlier mobility, shorter hospital stay, and significantly lower costs. Current training methods for teaching regional anaesthesia include cadavers, video teaching, ultrasound guidance, and simple virtual patient modeling. These techniques have limited capabilities and do not consider individual anatomy. The goal of this project is to increase the application, the effectiveness and the success rates of RA and furthermore the diffusion of the method through the development VPH models for anaesthesia. The goal of the SHACRA team is to provide the computational infrastructure for the physics-based simulation and to propose new methods for patient-specific modeling and simulation of soft tissues and their interaction with the needle, including its effect on nerve physiology.

See <http://rasimas.imib.rwth-aachen.de> for more details.

## **7.4. International Initiatives**

### ***7.4.1. Informal International Partners***

The team is collaborating with:

- the King's College of London,
- Aachen University (Germany),
- Bangor University (United Kingdom),
- Universidad Rey Juan Carlos (Spain),
- Foundation for Research and Technology Hellas (Greece),
- SenseGraphics (Sweden).

## TONUS Team

## 8. Partnerships and Cooperations

### 8.1. National Initiatives

#### 8.1.1. ANR

- ANR project "PEPPSI" in Programme Blanc SIMI 9 – Sciences de l'ingénierie (Edition 2012) started in 2013. Participants : Giovanni Manfredi (coordinator), Edwin Chacon Golcher, Sever Hirstoaga.

#### 8.1.2. Euratom-CEA projects

- Michel Mehrenberger and Philippe Helluy are local coordinators of the project FR FCM (CNRS Federation on Magnetic Confinement Fusion), within Euratom-CEA association, Title: "Numerical Methods for GYSELA", the goal is to help improving the numerical algorithms used by the GYSELA code developed at CEA Cadarache for the simulation of turbulence in magnetic fusion plasmas.

### 8.2. European Initiatives

#### 8.2.1. FP7 & H2020 Projects

The members of the team were in the following EUROfusion research projects:

E. Frénod, P. Helluy, S. Hirstoaga, M. Mehrenberger, L. Navoret were members of the project *CfP-WP14-ER-01/IPP-03*:

Max-Planck Institute for Plasma Physics, Garching (PI: Eric Sonnendrücker)

"Verification of global gyrokinetic codes and development of new algorithms for gyrokinetic and kinetic codes"

E. Frénod was member of the project *CfP-WP14-ER-01/Swiss Confederation-01*

École Polytechnique Fédérale de Lausanne (PI: Paolo Ricci)

"Synergetic numerical-experimental approach to fundamental aspects of turbulent transport in the tokamak edge"

E. Franck was member of the EUROfusion Enabling Research Project

CEA Cadarache, IRFM/SIPP/GP2B (PI: Marina Becoulet)

"JOEK, BOUT++ non-linear MHD modelling of MHD instabilities and their control in existing tokamaks and ITER"

### 8.3. International Research Visitors

#### 8.3.1. Visits to International Teams

##### 8.3.1.1. Research stays abroad

Michel Mehrenberger was on secondment at the Max Planck Institute in Munich until September 1st, 2014.

Emmanuel Frénod was invited professor during May 2014 at the Institute of Natural Sciences, Shanghai Jiao Tong University, Shanghai - China.

## ALGORILLE Project-Team

# 7. Partnerships and Cooperations

## 7.1. National Initiatives

### 7.1.1. ANR

Plate-form(E)<sup>3</sup> (2012-2015, 87k€) has been accepted in 2012 in the ANR SEED program. It deals with the design and implementation of a multi-scale computing and optimization platform for energetic efficiency in industrial environment. It gathers 7 partners either academic (LEMMA, Fédération Charles Hermite (including AlGorille), Mines Paris, INDEED) or industrial (IFPEN, EDF, IDEEL). We will contribute to the design and development of the platform. The engineer P. Kalitine has been recruited to work on this project from May 2014 to June 2015.

ANR SONGS (2012–2015, 1800k€) Martin Quinson is also the principal investigator of this project, funded by the ANR INFRA program. **SONGS** (Simulation Of Next Generation Systems) aims at increasing the target community of SimGrid to two new research domains, namely Clouds (restricted to the *Infrastructure as a Service* context) and High Performance Computing. We develop new models and interfaces to enable the use of SimGrid for generic and specialized researches in these domains.

As project leading team, we are involved in most parts of this project, which allows the improvement of our tool even further and sets it as the reference in its domain (see Section 6.2.1).

### 7.1.2. Inria financed projects and clusters

AEN Hemera (2010-2014, 2k€) aims at demonstrating ambitious up-scaling techniques for large scale distributed computing by carrying out several dimensioning experiments on the Grid'5000 infrastructure, and at animating and enlarging the scientific community around the testbed. M. Quinson, L. Nussbaum and S. Genaud lead three working groups, respectively on *simulating large-scale facilities*, on *conducting large and complex experimentations on real platforms*, and on *designing scientific applications for scalability*.

Other partners: 20 research teams in France, see <https://www.grid5000.fr/mediawiki/index.php/Hemera> for details.

ADT Aladdin-G5K (2007-2014, 200k€ locally) aims at the construction of a scientific instrument for experiments on large-scale parallel and distributed systems, building on the Grid'5000 testbed (<http://www.grid5000.fr/>). It structures INRIA's leadership role (8 of the 9 Grid'5000 sites) concerning this platform. The technical team is now composed of 10 engineers, of which 2 are currently hosted in the AlGorille team. As a member of the executive committee, L. Nussbaum is in charge of following the work of the technical team, together with the Grid'5000 technical director.

Other partners: EPI DOLPHIN, GRAAL, MESCAL, MYRIADS, OASIS, REGAL, RESO, RUN-TIME, IRIT (Toulouse), Université de Reims - Champagne Ardennes

ADT LAPLACE (2014-2016, AlGorille is major partner, 100k€) builds upon the foundations of the Grid'5000 testbed to reinforce and extend it towards new use cases and scientific challenges. Several directions are being explored: networks and Software Defined Networking, Big Data, HPC, and production computation needs. Already developed prototypes are also being consolidated, and the necessary improvements to user management and tracking are also being performed.

ADT Cosette (2013-2016, AlGorille is the only partner, 120k€), for *COherent SET of Tools for Experimentation* aims at developing or improving a tool suite for experimentation at large scale on testbeds such as Grid'5000. Specifically, we will work on (1) the development of Ruby-CUTE, a library gathering features useful when performing such experiments; (2) the porting of Kadeploy, Distem and XPFlow on top of Ruby-CUTE; (3) the release of XPFlow, developed in the context of Tomasz Buchert's PhD; (4) the improvement of the Distem emulator to address new scientific challenges in Cloud and HPC. E. Jeanvoine (SED) is delegated in the AlGorille team for the duration of this project.

INRIA Project Lab MultiCore (2013-) Supporting multicore processors in an efficient way is still a scientific challenge. This project introduces a novel approach based on virtualization and dynamicity, in order to mask hardware heterogeneity, and to let performance scale with the number and nature of cores. Our main partner within this project is the Camus team on the Strasbourg site. The move of J. Gustedt there, has strengthened the collaboration within this project.

ADT PLM (2014-2016, Martin Quinson is leading this project in collaboration with G. Oster from the Coast project-team, 100k€) This project is not directly in line with the goal of the AlGorille project-team, as its goal is to establish an experimental platform to study of the didactic of informatics, specifically centered on introductory programming courses.

The project builds upon a pedagogical programming exerciser developed for our own teaching, and improves this base in several ways. We want to provide more adapted feedback to the learners, and gather more data to better understand how beginners learn programming.

## 7.2. European Initiatives

### 7.2.1. FP7 Projects

#### 7.2.1.1. FED4FIRE

**Participant:** Lucas Nussbaum.

Title: Federation for Future Internet Research and Experimentation

Type: ICT

Instrument: Integrated Project

Duration: October 2012 - September 2016

Coordinator: iMinds

Other partners: IT Innovation, UPMC, Fraunhofer, TUB, UEDIN, Inria, NICTA, ATOS, UTH, NTUA, UNIVBRIS, i2CAT, EUR, DANTE Limited, UC, NIA.

See also: <http://www.fed4fire.eu>

Abstract: The key outcome of Fed4FIRE will be an open federation solution supporting all stakeholders of FIRE. Fed4FIRE is bringing together key players in Europe in the field of experimentation facilities and tool development who play a major role in the European testbeds of the FIRE initiative projects.

Lucas Nussbaum started participating in the project in September 2013, mainly with an expert role.

## 7.3. International Research Visitors

### 7.3.1. Visits of International Scientists

#### 7.3.1.1. Internships

Ezequiel Torti Lopez

Subject: Parallel and Distributed Simulation of Large-Scale Distributed Applications

Date: from May 2014 until October 2014

Institution: Universidad Nacional de Rosario (Argentina)



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## COAST Team

# 7. Partnerships and Cooperations

## 7.1. National Initiatives

### 7.1.1. ANR ConcoRDanT ANR-10-BLAN-0208 (2010–2014)

**Participants:** Pascal Urso [contact], Mehdi Ahmed-Nacer, Claudia-Lavinia Ignat, Gérald Oster.

Partners: REGAL project-team (Inria Paris - Rocquencourt / LIP6, coordinator), CITI institute (Universidade Nova de Lisboa, Portugal), GDD team (University of Nantes) and SCORE team.

Website: <http://concordant.lip6.fr/>

Massive computing systems and their applications suffer from a fundamental tension between scalability and data consistency. Avoiding the synchronisation bottleneck requires highly skilled programmers, makes applications complex and brittle, and is error-prone.

The ConcoRDanT project (oct. 2010 – apr. 2014) investigates a promising new approach that is simple, scales, and provably ensures eventual consistency. A Commutative Replicated Data Type (CRDT) is a data type where all concurrent operations commute. If all replicas execute all operations, they converge; no complex concurrency control is required. We have shown in the past that CRDTs can replace existing techniques in a number of tasks where distributed users can update concurrently, such as co-operative editing, wikis, and version control. However CRDTs are not a universal solution and raise their own issues (e.g., growth of meta-data).

The ConcoRDanT project engages in a systematic and principled study of CRDTs, to discover their power and limitations, both theoretical and practical. Its outcome will be a body of knowledge about CRDTs and a library of CRDT designs, and applications using them. We are hopeful that significant distributed applications can be designed using CRDTs, a radical simplification of software, elegantly reconciling scalability and consistency.

### 7.1.2. ANR STREAMS ANR-10-SEGI-010 (2010–2014)

**Participants:** Gérald Oster [coordinator], Luc André, Claudia-Lavinia Ignat, Pascal Urso.

Partners: SCORE team (coordinator), ASAP project-team (University of Rennes 1 / Inria Rennes - Bretagne Atlantique), CASSIS project-team (Inria Nancy - Grand Est / Nancy University), REGAL project-team (Inria Paris - Rocquencourt / LIP6) and GDD team (University of Nantes / LINA)

Website: <http://streams.loria.fr/>

The STREAMS project (nov. 2010 – may 2014) proposes to design peer-to-peer solutions that offer underlying services required by real-time social web applications and that reduce the disadvantages of centralised architectures. These solutions are meant to replace a central authority-based collaboration with a distributed collaboration that offers support for decentralisation of services.

The STREAMS project aims to advance the state of the art on peer-to-peer networks for social and real-time applications. Scalability is generally considered as an inherent characteristic of peer-to-peer systems. It is traditionally achieved using replication techniques. Unfortunately, the current state of the art in peer-to-peer networks does not address replication of continuously updated content due to real-time user changes. Moreover, there exists a tension between sharing data with friends in a social network deployed in an open peer-to-peer network and ensuring privacy. One of the most challenging issue in social applications is how to balance collaboration with access control to shared objects. Interaction is aimed at making shared objects available to all who need them, whereas access control seeks to ensure this availability only to users with proper authorisation. STREAMS project aims at providing theoretical solutions to these challenges as well as practical experimentations.

### 7.1.3. ANR Kolflow (2011–2014)

**Participant:** G r me Canals.

Partners: GDD team (University of Nantes / LINA), Loria (Orpailleur and SCORE Teams), Silex Team (LIRIS, University of Lyon), Edelweiss (Inria Project).

Website: <http://kolflow.univ-nantes.fr/>

Kolflow aims at building a social semantic space where humans collaborate with smart agents in order to produce knowledge understandable by humans and machines. Humans are able to understand the actions of smart agents. Smart agents are able to understand actions of humans. Kolflow targets the co-evolution of content and knowledge as the result of interactions of humans and machines. Our work in the Kolflow project focus on implementing knowledge base testing strategies.

### 7.1.4. FSN OpenPaaS (2012–2015)

**Participants:** Olivier Perrin, Ahmed Bouchami.

Partners: Samovar team (Telecom SudParis), SCORE team (Universit  de Lorraine, Loria), ARMINES (Ecole des Mines d'Albi), Brake France, Linagora.

Website: <http://www.open-paas.org/>

The OpenPaaS project aims at developing a PaaS (Platform as a Service) technology dedicated to enterprise collaborative applications deployed on hybrid clouds (private/public). OpenPaaS is a platform that allows to design and deploy applications based on proven technologies provided by partners such as collaborative messaging systems, integration and workflow technologies that will be extended in order to address Cloud Computing requirements. Available as an open-source Enterprise Social Network, the OpenPaaS project innovates both at the collaborative level and by its capacity to leverage heterogeneous cloud technologies at the IaaS level (Infrastructure as a Service). This project is funded under the French FSN umbrella (Fond National pour la soci t  Num rique).

## 7.2. European Initiatives

### 7.2.1. FP7 & H2020 Projects

#### 7.2.1.1. SyncFree (2013-2016)

**Participants:** Pascal Urso [contact], Jordi Martori Adrian.

Program: FP7-ICT-2013-10

Project acronym: SyncFree

Project title: Large-scale computation without synchronisation

Duration : October 2013 - September 2016

Coordinator: Marc Shapiro, Inria

Other Partners: REGAL project-team (Inria Paris - Rocquencourt / LIP6, coordinator), Basho Technologies Limited (United Kingdom), Trifork AS (Denmark), Rovio Entertainment OY (Finland), Faculdade de Ci ncias e Tecnologia (Universidade Nova de Lisboa, Portugal), Universit  Catholique de Louvain (Belgium), Ko c University (Turkey), Technische Universit t Kaiserslautern (Germany) and COAST team.

Abstract: Large-scale on-line services including social networks and multiplayer games handle huge quantities of frequently changing shared data. Maintaining its consistency is relatively simple in a centralised cloud, but no longer possible due to increased scalability requirements. Instead, data must be replicated across several distributed data centres, requiring new principled approaches to consistency that will be explored by the SyncFree project. <http://syncfree.lip6.fr/>

## 7.3. International Initiatives

### 7.3.1. Inria Associate Teams

#### 7.3.1.1. USCOAST

Title: User Studies on Trustworthy Collaborative Systems

International Partner (Institution - Laboratory - Researcher):

Wright State University (USA)

Duration: 2013 - 2015

See also: <http://uscoast.loria.fr/>

USCoast has as main objective the validation of trustworthy collaborative systems using experimental user studies. This type of validation requires the expertise of both computer scientists that designed the systems and social scientists for conceptualizing and measuring human behaviour in collaborative work. The project will focus on the real-time requirements and trust policies in collaborative editing, resulting in a theory for the effect of real-time constraints in collaborative editing and awareness management for the coordination of work in the presence of conflict and disruption. The project includes also validation of proposed light security mechanisms for decentralised collaboration, based on posted measures of voluntary compliance with data sharing restrictions. We will develop new methods for the cost-effective evaluation of collaborative work to compensate for otherwise unrealistic sample sizes and costly engineering, using game theory to inspire task analogues and simulated users along with human users.

## 7.4. International Research Visitors

### 7.4.1. Visits of International Scientists

Weihai Yu

Date: August 2013 - June 2014

Institution: University of Tromsø (Norway)

Weihai Yu examined issues concerning undo in collaborative editing and proposed an approach using a layered commutative replicated data type (CRDT) for strings.

Valerie Shalin

Date: Nov 2013 - Jul 2014

Institution: Wright State University (USA)

Valerie Shalin worked on experimental user studies of real-time collaborative editing and on the design of a game theory approach for the validation of trust-based collaboration.

Ehtesham Zahoor

Date: June, 1 2014 - July, 31 2014

Institution: National University of Computer and Emerging Sciences (Pakistan)

#### 7.4.1.1. Internships

Fox Olivia

Date: Apr 2014 - Jul 2014

Institution: Wright State University (USA)

## MADYNES Project-Team

# 8. Partnerships and Cooperations

## 8.1. Regional Initiatives

### 8.1.1. Satelor AME Lorraine regional project

**Participants:** Mandar Harshe, Bernardetta Addis, Evangelia Tsionsiou, Ye-Qiong Song [contact].

MADYNES is involved in Satelor, a regional research and development project funded by the AME (Agence de Mobilisation Economique) of Lorraine (October 2013 – September 2016). The consortium includes academic (Univ. of Lorraine, Inria), medical (OHS) and industrial (Diatelic-Pharmagest, ACS, Kapelse, Salendra, Neolinks) partners. It aims at developing innovative and easily deployable ambient assisted living solutions for their effective use in the tele-homecare systems. Madynes team is mainly involved in the data collection system development based on wireless sensors networks and IoT technology. The first topic consists in defining the basic functions of the future SATEBOX – a gateway box for interconnecting in-home sensors to the medical datacenter, based on our previously developed MPIGate software. A first specification for achieving a beta-version prototype of the future Satebox gateway has been made. It is intentionally limited to only using Zigbee wireless sensors for providing a low-cost and easily deployable solution for the daily activity monitoring. Its first real-world deployment at a OHS hospital room has also been carried out. Through this deployment, a lot of important lessons have been learned that enable us to improve the reliability, robustness and the accuracy of our system. The second topic is related to improving the data transfer reliability while still keeping minimum energy consumption. This has led us to focus on the multi-hop mesh network topology with multi-constrained QoS routing problem (PhD thesis of Evangelia Tsionsiou). A state of the art study has shown the need to look for new routing algorithms and the interest of the newly developed operator calculus approach.

### 8.1.2. Hydradrone R&D Lorraine UL project

**Participants:** Adrien Guenard, Laurent Ciarletta [contact].

*Funded by the Region Lorraine under the R&D program.*

The Madynes team has been working on the Hydradrone project since July 2014. It is starting as a collaborative R&D regional research and development project, funded by Region Lorraine. This project is a joint work between Madynes and PEMA (Pédon Environnement et Milieux aquatiques), an SME/VSE (small and medium size Enterprise, PEM/TPE). The company is providing the use cases and terrain (and business) validation.

It consists in developing a new solution for the surveillance of aquatic environment, the Hydradrone :

- based on a hybrid UxV (Unmanned Air, Surface, Ground Vehicle),
- some Cyber Physical bricks in coherence with the Alerion concept
- and an integration in the Information System of the company

The first year is dedicated to the development of a couple hydradrone proofs of concept (the UxV) for both hardware and software (embedded / remote) and for the sensor payload "cyber physical" bricks.

The Alerion spinoff will join the consortium upon creation.

### 8.1.3. 6PO Research Region Lorraine and UL project

**Participants:** Emmanuel Nataf, Ye-Qiong Song, Yael Kolasa, Laurent Ciarletta [contact].

*Funded by Region Lorraine and Université de Lorraine since 2013. Vincent Chevrier is the point of contact for the dep. 5 at Loria. Adel Belkadi (CRAN & LORIA) is co-directed by L. Ciarletta and Didier Theilliol (CRAN correspondant).*

6PO (“Systèmes Cyber-Physiques et Commande Coopérative Sûre de Fonctionnement pour une Flotte de Véhicules sans Pilote”) is a joint research project between the Loria and CRAN laboratories. It aims at researching solutions for safe formation flying of collaborative UAVs seen as part of a collection of Cyber Physical Systems. This led to a common publication and the organisation of a workshop in 09/2014. It is reinforced by a PhD grant from the Federation Charles Hermite that started in october 2014. Efforts will be pursued in 2015.

The project provides common use cases and scientific challenges that serve as catalysts for collaboration between teams from different research topics :

- Cyber Physical Systems, Real Time, Quality of service, Performance and Energy in Wireless Sensors and Activator Networks
- Collaborative, communicating autonomous systems and Unmanned Vehicles
- Safety, Dependability, Reliability, Diagnosis, Fault-Tolerance

## 8.2. National Initiatives

### 8.2.1. *Quasimodo*

**Participants:** François Despaux, Abdelkader Lahmadi, Ye-Qiong Song [contact].

The QUASIMODO ANR Blanc international project (<http://quasimodo.loria.fr>) is a fundamental research project coordinated by Prof. Ye-Qiong SONG at LORIA - University of Lorraine in France and by Prof. Youxian SUN at SKLICT of Zhejiang University in China. The project started on March 2011 and will be completed at the end of 2014. It is funded by ANR grant (ANR 2010 INTB 0206 01) and NSFC grant (NSFC 61061130563). The main objective of the project is to specify, develop and evaluate algorithms and mechanisms to provide the self-adaptive QoS support for real-time applications using wireless sensor networks (WSN). This year, the iQueue-MAC has been extended (see section 6.5.2 ) and we presented a method to estimate the e2e delay for a multi-hop scenario (section 6.5.2 )

### 8.2.2. *ANR Doctor*

**Participants:** Thomas Silverston [contact], Thibault Cholez [contact], Elian Aubry, Jérôme François, Abdelkader Lahmadi, Olivier Festor.

The DOCTOR project is an applied research project funded by the French National Research Agency (ANR), grant <ANR-14-CE28-000>, and supported by the french Systematic cluster. The project officially started on October 2014 with a effective beginning of the scientific work on December 2014. It involves five partners specialized in network architectures, network monitoring and network security: three industrial partners (Orange Labs, Thales and Montimage) and two academic partners (Université de technologie de Troyes, LORIA).

Information-Centric Networking (ICN), a novel promising networking paradigm that allows adapting networks to current content-centric usage patterns, raises many deployment issues. The DOCTOR project advocates the use of virtualized network equipment (Network Functions Virtualization), enabling the co-existence of such IP and ICN stacks and the progressive migration of traffic from one stack to the other while guaranteeing the good security and manageability of the network that are primary operator requirements that need to be assured before deploying new solutions. Therefore in DOCTOR, the main goals of the project are: (1) the efficient deployment of emerging networks functions or protocols in a virtualized networking environment; (2) the monitoring and security of virtually deployed networking architectures.

This year, we mainly prepared the kickoff meeting that took place the 10th of December in Orange Labs, Issy-les-Moulineaux. We also started a joint work with UTT to write a survey on Named-Data Networking with an emphasis on the deployment and security questions.

### 8.2.3. *ANR LAR*

**Participants:** Kévin Roussel, Ye-Qiong Song [contact].

LAR (Living Assistant Robot) is a national project getting together Inria (MAIA and MADYNES teams), Credit Agricole, Diatelic and Robotsoft. The aim is to develop an ambient assisted living system for elderly including both sensors and assistant robots. The task of our team is the development of a WSN based system integrating both sensors of the environment and sensors and actuators embedded on a mobile robot. The research issues include the QoS, energy and mobility management. This year we identified RIOT OS as our software platform for developing both protocols and IoT applications. We also evaluated and fixed three hardware platforms (Zolertia MSP430 Z1, AVR ATmega256RFR2 and Arduino DUE) for the development of the project. We have improved the robustness of the existing ports of RIOT OS on MSP430-based motes. Two MAC protocols (S-CoSenS and iQueue-MAC) have been implemented on RIOT-OS (see section 6.5.2).

#### **8.2.4. PEPS Humain - CNRS Project TrustSourcing**

**Participants:** Thomas Silverston [contact], Vassili Rivron, Isabelle Chrisment.

Crowdsourcing relies on the participation of users collecting information in order to perform complex tasks. The participating users and the collected data should be of high quality for offering a trustable service to all the users. In the Trustsourcing project, we propose to design a Trust mechanism adapted to the crowdsourcing paradigm. Based on the current work initiated by the Metroscope/PRACTIC initiative, whose main goal is to study the usage of smartphone by measuring users' activity, we will propose to classify smartphone users and deduce some categories of trustable users. According to their "fingerprint" usage of their smartphone (time spent with phone, number of applications, messages etc.), we could estimate if an user will more probably belong to a category of trustable users or not. Our predictive mechanism will rely on the measurement of realistic users' activity and could help limiting drastically the impact of malicious users and the deterioration of the crowdsourcing service.

#### **8.2.5. Action de Développement Technologique**

##### *8.2.5.1. ADT Métroscope*

This ADT is linked to the consortium Metroscope<sup>0</sup>, whose goal is to understand the behavior of the Internet and its uses within a mobile environment. Through this ADT, funded by Inria, an engineer (Mohammad-Irfan Khan) was hired for 2 years (2013-2015). He is participating in the design and deployment of a distributed platform. This platform is composed of a services providing measurement tools that collect a set of data and interact with probes located at various points of the network.

##### *8.2.5.2. ADT SEA*

The goal of this ADT is to provide a novel security solution for Android platforms where the users will be able to evaluate the security level of their devices. The solution relies on the analysis and collection of logs and network activities of running Android applications to detect malicious activities and also the detection of vulnerable configurations of the device using an OVAL-based approach. Through, this ADT, funded by Inria, an engineer (Eric Finickel) was hired for 2 years (2013-2015). He is working on the development of Android devices embedded probes to export logs and network activities. He will also design and setup the collector and the analysis applications using a Hadoop based framework. It is currently deployed in the High Security Lab.

##### *8.2.5.3. ADT R2D2*

The goal of this ADT is to provide assistance in developing the Aetournos platform. Through this ADT, funded by Inria, an engineer (Ceilidh Hoffmann) was hired for the year (2014). She has been helping maintaining the Aetournos platform, coordinating students work on the platform and tutoring the Aetournos team for the Outback Joe Search and Rescue Challenge. She is also developing tools for UAV localization using visual cues.

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<sup>0</sup> <http://metroscope.eu/>



### 8.2.6. Inria Project Lab PAL

The Inria Large-scale initiative action IPL PAL project (<http://pal.inria.fr>) aims at providing technologies and services for improving the autonomy and quality of life for elderly and fragile persons. Communication is one of the key components for ensuring real-time data gathering and exchange between heterogeneous sensors and actuators (robots). Within PAL project and using LORIA's smart apartment platform (<http://infositu.loria.fr>), we extended MPIGate (<http://mpigate.loria.fr>) functionalities by adding EnOcean sensors and defining a unified data format in JSON to ease the exchange with other data servers. The adoption of ROS (Robotic Operating System) as middleware also facilitates the interoperability of our services with the services of the other PAL partners since the new PALGate is based on ROS.

## 8.3. European Initiatives

### 8.3.1. FP7 & H2020 Projects

#### 8.3.1.1. FI-WARE

Type: COOPERATION Future Internet Core Platform

Instrument: Integrated Project

Objective/Topic: PPP FI - Technology Foundation: Future Internet Core Platform

Duration: September 2011 - May 2014

Coordinator: Telefonica (Spain)

Partners: Thales, SAP, Inria

Inria contact: Olivier Festor

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

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

The goal of the FI-WARE project is to advance the global competitiveness of the EU economy by introducing an innovative infrastructure for cost-effective creation and delivery of services, providing high QoS and security guarantees. The key deliverables of FI-WARE will be an open architecture and a reference implementation of a novel service infrastructure, building upon generic and reusable building blocks developed earlier.

The MADYNES contributions to the FI-WARE project are:

- Sicslowfuzzer, a fuzzing framework for the Internet of Things, that allows to assess the robustness of IoT OSes and applications, networkwise.
- Flowoid, a netflow probe for Android-based devices, which also provides a netflow location template to convey location information of the device;
- XOvaldi4Android, an OVAL interpreter for Android-based devices, that is able to retrieve OVAL definitions using a web service, use them to check the current status of the system, and publish a result, using a second web service;
- the coordination between the Security Work Package and the Inria teams involved in it. This includes the attending to weekly audio conferences, face to face meetings, and making sure deliverables and tasks were addressed in a timely manner.

During 2014, all the contributions of the Madynes team including the developed tools and their respective documentation have been delivered and validated by the Work Package leader.

### 8.3.1.2. *Flamingo*

Type: FP7

Instrument: Network of Excellence

Objective/Topic: Management of the Future Internet

Duration: November 2012 - October 2016

Coordinator: University of Twente (Netherlands)

Partners: University of Twente, Inria, University of Zurich, Jacobs University of Bremen, University des Bundeswehr Munich, Polytechnic University of Catalonia, Interdisciplinary Institute for Broad-band Technology, University of Ghent, University College London

Inria contact: Olivier Festor

See also: <http://www.fp7-flamingo.eu>

Abstract: The FP7 FLAMINGO Network of Excellence is composed of 8 partner universities, with complementary knowledge and strong ties to industry. It covers the entire spectrum of network management core functions and application domains, which are required for building, integrating, and disseminating the knowledge of the management plane for the Future Internet.

The objectives of FLAMINGO are (a) to strongly integrate the research of leading European research groups in the area of network and service management, (b) to strengthen the European and worldwide research in this area, and (c) to bridge the gap between scientific research and industrial application. To achieve these goals, FLAMINGO performs a broad range of activities, such as to develop open source software, establish joint labs, exchange researchers, jointly supervise Ph.D. students, develop educational and training material, interact with academia and industry, organize event, and strongly contribute to (IETF and IRTF) standardization.

Our work on network and service monitoring has focused on security for mobile and low power networks. We have proposed a strategy for addressing DODAG-based attacks [25], jointly with Jacobs University of Bremen. We have also designed a distributed monitoring architecture in the context of advanced measurement infrastructures. These results are presented in section 6.3.5. In addition, we have continued efforts with University of Twente on extending IP flow-based network monitoring with location information. These ones have been centered on additional use cases, applicability of associating IP Flows with metering processes location, and implementation guidelines from both metering process and collector sides.

We have also pursued activities on automated configuration and repair, with a particular focus on safe configuration and service orchestration issues, which are covered in section 6.3.1.

## 8.4. International Initiatives

### 8.4.1. *Inria International Labs*

- LIRIMA (Laboratoire international de recherche en informatique et mathématiques appliquées): MADYNES is associated with the MASECNESS research team of the Yaoundé University in Cameroun. The collaboration is about wireless sensors networks and was the support for funding student mobility (3 months this year). The LIRIMA has also supported the purchase of thirty sensors used in our common work.

### 8.4.2. *Inria International Partners*

#### 8.4.2.1. *Declared Inria International Partners*

- JFLI (CNRS UMI 3527) in Tokyo: Thomas Silverston is currently in this lab (délégation) in Tokyo. The main goal of his research work is to anticipate the evolution of the Internet and to focus on the design of new architectures for the Future Internet. His research program at the JFLI (CNRS, UMI 3527) focus on the use of SDN to allow deploying new network architecture and functionalities in virtualized environment (e.g., ICN) as well as providing a management plane to help network operators monitoring novel network architecture for the Future Internet.



- University of Luxembourg: we have several active cooperations with the university of Luxembourg around network security, Information Centric Networking and Software Defined Networking. Especially, we have one ongoing Ph.D. candidate (Samuel Marchal) and Jérôme François is a Fellow at SnT (Interdisciplinary Center for Security, Reliability and Trust) to empower these collaborations. Besides S. Marchal, we are working particularly with Radu State, Thomas Engel and Salvatore Signorello.

#### 8.4.2.2. *Informal International Partners*

- University of Twente, The Netherlands, joint work with Professor Aiko Pras on large scale network monitoring and attack detection
- Jacobs University Bremen, joint PhD. with Professor Schoenwaelder on security management in wireless sensor networks
- Federal University of Rio Grande do Sul (UFRGS), joint work with Professor Granville on autonomic management systems
- University of the Federal Armed Forces, Munich Germany, joint work with Professor Gabi Dreo on cloud and mobile cloud security management
- Politecnico di Milano, Italy, joint work with Professor Antonio Capone and Giuliana Carello on energy-aware network management and cloud infrastructures
- Polytechnique de Montréal, Canada, joint work with Professor Brunilde Sansò on energy-aware network management
- IASI-CNR (National Italian Center of Research), Italy, joint work with Sara Mattia on optimization methods for energy-aware survivable networks
- Zhejiang University (China), joint ANR-NSFC Quasimodo project with professors Youxian Sun, Jiming Chen and Zhi Wang on the adaptive QoS in WSN and multi-target tracking.

## 8.5. International Research Visitors

### 8.5.1. *Visits of International Scientists*

#### 8.5.1.1. *Internships*

**Pedro Paulo Martins Dos Santos**  
 Subject: Flow-based malware signatures  
 Date: from Jun 2014 to Aug 2014  
 Institution: Universidade de Brasília, Brazil

#### 8.5.1.2. *Scientific visits*

**Participant:** Raouf Boutaba.  
 Visiting Professor  
 Network and cloud managements  
 Date: from Jul to Aug 2014  
 University of Waterloo, Canada

**Participant:** Lamia Fourati-Chaari.  
 Visiting Assistant Professor  
 Content Centric Networks  
 Date: from mid-June to end June 2014  
 Institut d'Informatique et de Multimédia de Sfax (Tunisie)

**Participant:** Celia Ouanteur.

Visiting PhD student

Markov modeling of Low Latency Deterministic Networks (LLDN) of IEEE802.15.4e

Date: from May to June 2014

University A/Mira of Bejaia, Algeria

**Participant:** Xiufang Shi.

Visiting PhD student

ANR-NSFC Quasimodo joint project: multi-target location algorithm design

Date: from March to June 2014

Zhejiang University, China

**Participant:** Shuguo Zhuo.

Visiting PhD student

ANR-NSFC Quasimodo joint project: implementation of iQueue-MAC protocol on RIOT  
OS

Date: from May to August 2014

Zhejiang University, China

## ALICE Project-Team

# 7. Partnerships and Cooperations

## 7.1. Regional Initiatives

**Meshing and PDEs**, Regional Council of Lorraine, 25 KEuros for initiating the cooperation between Xavier Antoine (Prof. in Math., Nancy who joined ALICE for a short-term 1 year period) and Bruno Lévy;

## 7.2. National Initiatives

### 7.2.1. ANR BECASIM (2013 – 2016)

890 K€. X. Antoine heads the second partner, which includes Bruno Lévy. Budget for Nancy: 170 K€ of which 100 K€ are for IECL (team CORIDA). This project is managed by Inria. Becasim is a thematic "Numerical Models" ANR project granted by the French Agence Nationale de la Recherche for years 2013-2016. The acronym Becasim is related to Bose-Einstein Condensates: Advanced SIMulation Deterministic and Stochastic Computational Models, HPC Implementation, Simulation of Experiments. The members of the ANR Project Becasim belong to 10 different laboratories.

### 7.2.2. ANR Bond (2013 – 2017)

X. Antoine is a member of the ("projet blanc") ANR BOND (Boundaries, Numerics and Dispersion).

### 7.2.3. ANR TECSER (2014 – 2017)

X. Antoine is a member of ANR TECSER that stemmed from the ASTRID program (DGA). The consortium gathers Inria (S. Lantéri, Nice-Sophia, ÉPI CORIDA (X. Antoine) and HIEPACS), EADS, and Nuclétudes.

Total budget: 300 K€ of which 54 K€ are for CORIDA.

### 7.2.4. ANR Morpho (2010 – 2014)

Dobrina Boltcheva and Bruno Lévy are involved in the ANR project **Morpho**. Morpho is aimed at designing new technologies for the measure and for the analysis of dynamic surface evolutions using visual data.

## 7.3. European Initiatives

### 7.3.1. FP7 & H2020 Projects

#### 7.3.1.1. SHAPEFORGE

Type: FP7

Defi: NC

Instrument: ERC Starting Grant

Objectif: NC

Duration: December 2012 - November 2017

Coordinator: Sylvain Lefebvre

Inria contact: Sylvain Lefebvre

Abstract: Project Shapeforge aims at developing new methods for creating objects from examples, with 3D printers. The main challenge with this project is combining approaches that are very different in nature: algorithms from computer graphics which are used to build forms and textures using examples are combined with digital optimization methods which make sure that the real object complies with the function it is assigned. Thus, to produce a Louis XV bench, on the basis of a Louis XV chair, you need to not only capture the appearance of the example but also formalize the characteristics of a bench as well as its mechanical properties to ensure that it is solid enough. You then need to find, from among all the shapes that can be produced from a single example, the one that best complies with the various criteria.

#### 7.3.1.2. VORPALINE

Type: FP7

Defi: NC

Instrument: ERC Proof of Concept

Objectif: NC

Duration: July 2013 - June 2014

Coordinator: Bruno Lévy

Inria contact: Bruno Lévy

Abstract: The Vorpaline software takes a new approach to 3D mesh generation, based on the theory of numerical optimization. The optimal mesh generation algorithm developed in the frame of the European Research Council GOODSHAPE project globally and automatically optimizes the mesh elements with respect to geometric constraints (two patents). The mathematical foundations of this algorithm, i.e. the minimization of a smooth energy function, result in practice in a faster algorithm, and - more importantly - in a higher flexibility. For instance, it will allow automatic generation of the aforementioned "hex-dominant" meshes. It is now proposed (since 2014) to the sponsors of the Gocad consortium, as an extension package of the Gocad software.

## 7.4. International Initiatives

### 7.4.1. Inria Associate Teams

#### 7.4.1.1. PREPRINT3D

Title: Model Preparation for 3D Printing

International Partner (Institution - Laboratory - Researcher):

HKU (HONG KONG)

Duration: Delayed for administrative reasons

We seek to develop novel ways to prepare objects for 3D printing which better take into account limitations of the fabrication processes as well as real-world properties such as the mechanical strength of the printed object. This is especially important when targeting an audience which is not familiar with the intricacies of industrial design. We target complex, intricate shapes such as models of vegetation and highly detailed meshes, as well as models with thin walls such as architectural models. Our methods will modify the object geometry and topology while remaining as close as possible to its initial appearance.

### 7.4.2. Inria International Partners

#### 7.4.2.1. Informal International Partners

- We have a long-term cooperation with the Gocad Consortium (Nancy school of Geology), with co-advised students. This resulted in some applications of our result to oil exploration, listed in the *numerical simulation* item above (Ph.D. theses of Arnaud Botella, Nicolas Cherpeau, Jeanne Pellerin);

- We cooperate since 2008 with Wenping Wang's group (Hong-Kong University), on centroidal Voronoi tessellation. The last results of this cooperation on *Sampling and Remeshing* are published in : [22] Siam J. on Scientific Computing and [30] (SIGGRAPH 2013)
- Cooperation with Pierre Poulin and Gilles-Philippe Paillé on volumetric distance minimization [26] (SGP 2009)
- Cooperation with Tsinghua University (Jean-Claude Paul was Professor there from 2004 to 2013).
- We started a research project with "Ateliers Cini", "Institut Jean Lamour" (IJL) and the "Ecole de Chirurgie de Nancy", to develop new 3D printers using novel types of materials developed by IJL. This project is funded by the "Region Lorraine" under the "Pacte Lorraine" program.

## **7.5. International Research Visitors**

### **7.5.1. Visits to International Teams**

#### *7.5.1.1. Research stays abroad*

Jérémie Dumas (PhD student) stayed in Hong Kong for 1 month as a visiting student (12-04-2014 to 10-05-2014). This visit was done in the context of the Equipe Associée PrePrint3D.

## MAGRIT Project-Team

# 8. Partnerships and Cooperations

## 8.1. Regional Initiatives

### Collaboration with Nancy School of Surgery

We are working with Nancy School of Surgery on soft tissue dissection simulation. In an effort to generate a more realistic model of tissue dissection in laparoscopic surgery we started to investigate on a novel method based on a task analysis. Nancy School of Surgery experts have defined the key features of the simulator. Initially we have chosen to model the basic geometry of this task rather than a whole laparoscopic procedure. Preliminary work has led to the development of a real time simulator performing cutting with a haptic thread at 1000Hz on a simple 2D geometry using SOFA Framework [23].

## 8.2. National Initiatives

### 8.2.1. ANR

- ANR IDeaS (2012-2016)  
Participants: R. Anxionnat, M.-O. Berger, E. Kerrien.  
The IDeaS Young Researcher ANR grant explores the potential of Image Driven Simulation (IDS) applied to interventional neuroradiology. IDS recognizes the current, and maybe essential, incapacity of interactive simulations to exactly superimpose onto actual data. Reasons are various: physical models are often inherently approximations of reality, simplifications must be made to reach interactive rates of computation, (bio-)mechanical parameters of the organs and surgical devices cannot but be known with uncertainty, data are noisy. This project investigates filtering techniques to fuse simulated and real data. MAGRIT team is in particular responsible for image processing and filtering techniques development, as well as validation.

### 8.2.2. Project funded by GDR ISIS in collaboration with Institut Pascal, Université de Clermont-Ferrand

- Participant: F. Sur.  
Since June 2012, we have been engaged in a collaboration with Pr. Michel Grédiac. The aim is to give a mathematical analysis and to help improving the image processing tools used in experimental mechanics at Institut Pascal.  
The TIMEX project (2014-2016) is funded by GDR ISIS ("Appel à projet exploratoire, projet interdisciplinaire"). It aims at investigating image processing tools for enhancing the metrological performances of contactless measurement systems in experimental mechanics.

### 8.2.3. Collaboration with the SHACRA team and AEN SOFA

Participants: R. Anxionnat, M.-O. Berger, E. Kerrien, A. Yureidini.  
The SOFA-InterMedS large-scale Inria initiative is a research-oriented collaboration across several Inria project-teams, international research groups and clinical partners. Its main objective is to leverage specific competences available in each team to further develop the multidisciplinary field of Medical Simulation research. Our action within the initiative takes place in close collaboration with both SHACRA Inria project-team in Lille and the Department of diagnostic and therapeutic interventional neuroradiology of Nancy University Hospital. We aim at providing in-vivo models of the patient's organs, and in particular a precise geometric model of the arterial wall. Such a model is used by SHACRA team to simulate the coil deployment within an intracranial aneurysm. The associated medical team in Nancy, and in particular our external collaborator René Anxionnat, is in charge of validating our results. For three years, we have also been collaborating with the SHACRA team about real time augmentation of deformable organs

#### **8.2.4. Collaboration with the Parole team**

Participants: M.-O. Berger, P. -F. Villard, B. Wrobel-Dautcourt

Our collaboration with the local Inria team Parole is about the augmented head. This project aims at building a realistic head augmented by external and internal articulators with foreseen applications to language learning technologies [18].

### **8.3. International Research Visitors**

#### **8.3.1. Visits to International Teams**

##### *8.3.1.1. Research stays abroad*

Pierre-Frédéric Villard started a one year full time CNRS delegation in September 2014 in the Harvard Bi-robotics Laboratory.

## MAIA Project-Team

## 8. Partnerships and Cooperations

### 8.1. Regional Initiatives

#### 8.1.1. AME Satelor SATELOR

**Participants:** François Charpillet, Maxime Rio, Nicolas Beaufort, Xuan Nguyen, Thomas Moinel, Mélanie Lelaure, Theo Biasutto-Lervat.

Economic mobilisation agency in Lorraine has launched a new project SATELOR providing it with 2.5 million Euros of funding over 3 years, out of an estimated total of 4.7 million. The leader of the project is Pharmagest-Diatelic. PHARMAGEST is the French leader in computer systems for pharmacies, with a 43.5 % share of the market, 9,800 clients and more than 700 employees. Pharmagest is in Nancy. Recently, PHARMAGEST Group expanded its activities into e-health and the development of telemedicine applications. The SATELOR project will accompany the partners of the project in developing new services for maintaining safely elderly people with loss of autonomy at home or people with a chronic illness. Maia team will play an important role for bringing some research results such as :

- developing a low cost environmental sensor for monitoring the daily activities of elderly people at home
- developing a low cost sensor for fall detection
- developing a low cost companion robot able to interact with people and monitoring their activities while detecting emergency situations.
- developing a general toolbox for data-fusion : bayesian approach.

#### 8.1.2. CNRS / Université de Lorraine PEPS project “MAJESTIC” (2014)

**Participants:** Vincent Thomas, Amine Boumaza, Olivier Buffet, Alain Dutech.

*Sylvain Castagnos (KIWI team, LORIA/UL), and several members of the Centre de recherche sur les médiations (CREM) of Université de Lorraine—in particular Sébastien Genvo—are external members.*

This multidisciplinary project—which involves humanities, social sciences, computer science, and cognitive sciences—proposes to evaluate the playful elements of “expressive” games, which involve and express complex social or individual issues. It aims at elaborating and testing—through qualitative usage analyses—a set of hypotheses allowing to study the factors contributing to reinforce, on the one side, the commitment of the user in these often atypical products and, on the other side, the player’s knowledge-building.

This project led to the organisation of an international seminar “expressive game” and to the creation of two platforms for qualitative usage analysis: one in term-Blida (Metz), and one in Artem (Nancy).

#### 8.1.3. Université de Lorraine MSH project “PSYPHINE”

**Participants:** Amine Boumaza, Alain Dutech.

This multidisciplinary project – which involves philosophy, sociology, psychology and computer sciences – aims at exploring the concept of consciousness in an artificial being. Our main objective is to devise a new non-verbal “Turing test” in order to think about various cognitive levels that are less linked to the capacity of using a language.

### 8.2. National Initiatives

#### 8.2.1. Inria IPL PAL Personally Assisted Living

**Participants:** François Charpillet, Olivier Simonin, Mihai Andries.



The PAL project is a national Inria Large Scale Initiative involving several teams of the institute (Arobas, Coprin, E-motion, Lagadic, Demar, Maia, Prima, Pulsar and Trio). It is coordinated by David Daney (Inria Sophia-Antipolis, EPI Coprin). The project focuses on the study and experiment of models for health and well-being. Maia is particularly involved in the People Surveillance work package, by studying and developing intelligent environments and distributed tracking devices for people walking analysis and robotic assistance (smart tiles, 3D camera network, assistant robots).

The PhD of Mihai Andries is funded by the PAL project.

### 8.2.2. PIA LAR Living Assistant Robot

**Participants:** François Charpillat, Abdallah Dib.

Partners : Crédit Agricole, Diatelic, Robosoft

LAR project has the objective to designing an assistant robot to improve the autonomy and quality of life for elderly and fragile persons. The project started at the beginning of the year. The role of the Maia Team is to develop a simultaneous localisation and mapping algorithm using a RGB-D camera. The main issue is to develop an algorithm able to deal with dynamic environment. An other issue is for the robot to be able to behave with acceptable social skills.

### 8.2.3. ANR

#### 8.2.3.1. ANR PHEROTAXIS

**Participants:** François Charpillat, Olivier Simonin.

*Dominique Martinez (Cortex team, Inria NGE) is an external collaborator and the coordinator of the project for Nancy members.*

PHEROTAXIS is an “Investissements d’Avenir” ANR 2011-2014 (Coordination: J.-P. Rospars, UMR PISC, INRA Versailles).

The theme of the research is localisation of odour sources by insects and robots. By associating experimental data with models, the project aims at defining a behavioral model of olfactive processes. This work provides several applications, in particular the development of bio-inspired components highly sensitive and selective.

The project is organized in five work packages and involves the PISC research unit (Versailles), Pasteur Institute (Paris) and LORIA/Inria institute (Nancy).

## 8.3. European Initiatives

### 8.3.1. FP7 & H2020 Projects

#### 8.3.1.1. CoDyCo

Serena Ivaldi, arrived in November 2014, participates to the European Project CODYCO since its beginning. Her participation to the project has been formalized by including Inria as a new partner of the consortium.

Type: FP7

Defi: NC

Instrument: STREP

Objectif: Cognitive Systems and Robotics (b)

Duration: Marc 2013 - February 2017 (4 years)

Coordinator: Francesco Nori (Italian Institute of Technology)

Partners: TU Darmstadt (Germany), Université Pierre et Marie Curie (France), Josef Stefan Institute (Slovenia), University of Birmingham (UK)

Inria contact: Serena Ivaldi

Abstract: The aim of CoDyCo is to advance the current control and cognitive understanding about robust, goal-directed whole-body motion interaction with multiple contacts. CoDyCo will go beyond traditional approaches: (1) proposing methodologies for performing coordinated interaction tasks with complex systems; (2) combining planning and compliance to deal with predictable and unpredictable events and contacts; (3) validating theoretical advances in real-world interaction scenarios. First, CoDyCo will advance the state-of-the-art in the way robots coordinate physical interaction and physical mobility. Traditional industrial applications involve robots with limited mobility. Consequently, interaction (e.g. manipulation) was treated separately from whole-body posture (e.g. balancing), assuming the robot firmly connected to the ground. Foreseen applications involve robots with augmented autonomy and physical mobility. Within this novel context, physical interaction influences stability and balance. To allow robots to surpass barriers between interaction and posture control, CoDyCo will be grounded in principles governing whole-body coordination with contact dynamics. Second, CoDyCo will go beyond traditional approaches in dealing with all perceptual and motor aspects of physical interaction, unpredictability included. Recent developments in compliant actuation and touch sensing allow safe and robust physical interaction from unexpected contact including humans. The next advancement for cognitive robots, however, is the ability not only to cope with unpredictable contact, but also to exploit predictable contact in ways that will assist in goal achievement. Third, the achievement of the project objectives will be validated in real-world scenarios with the iCub humanoid robot engaged in whole-body goal-directed tasks. The evaluations will show the iCub exploiting rigid supportive contacts, learning to compensate for compliant contacts, and utilizing assistive physical interaction.

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

#### 8.3.2.1. PHC MURROTEX

This project is with Olivier Simonin from Insa Lyon, Citi lab and Jan Faigl from Czech Technical University in Prague.

Program: Hubert Curien Partnerships

Project acronym: MURROTEX

Project title: Multi-agent coordination in robotics exploration and reconnaissance missions

Duration: 2 years from 1st january 2014

Coordinator: O. Simonin (INSA LYON)

Other partners: Czech Technical University in Prague

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

## 8.4. International Initiatives

Serena Ivaldi and Francois Charpillet are part of the joint Inria-TUD team that was selected to participate to the KUKA Innovation Award. On December 2014, the team received a new industrial manipulator, KUKA iiwa, to prepare the challenge for the first quarter of 2015. The manipulator is lent by KUKA and will be returned at the end of the competition.

## 8.5. International Research Visitors

### 8.5.1. Visits of International Scientists

- Dr. Samuel Nicol, postdoctoral researcher at CSIRO, Ecosystem Sciences division (Brisbane, Australia), visited MAIA for 2 weeks in June 2014.

## MULTISPEECH Team

# 8. Partnerships and Cooperations

## 8.1. National Initiatives

### 8.1.1. Equipex *ORTOLANG*

Project acronym: ORTOLANG <sup>0</sup>

Project title: Open Resources and TOols for LANGuage

Duration: September 2012 - May 2016 (phase I, signed in January 2013)

Coordinator: Jean-Marie Pierrel, ATILF (Nancy)

Other partners: LPL (Aix en Provence), LORIA (Nancy), Modyco (Paris), LLL (Orléans), INIST (Nancy)

Abstract: The aim of ORTOLANG (Open Resources and TOols for LANGuage) is to propose a network infrastructure offering a repository of language data (corpora, lexicons, dictionaries, etc.) and tools and their treatment that are readily available and well-documented which will:

- enable a real mutualization of analysis research, of modeling and automatic treatment of the French language;
- facilitate the use and transfer of resources and tools set up within public laboratories towards industrial partners, in particular towards SME which often cannot develop such resources and tools for language treatment due to the costs of their realization;
- promote the French language and local languages of France by sharing knowledge which has been acquired by public laboratories.

Several teams of the LORIA laboratory contribute to this Equipex, mainly with respect to providing tools for speech and language processing. MULTISPEECH contributes text-speech alignment and speech visualization tools.

### 8.1.2. ANR *ORFEO*

Project acronym: ORFEO <sup>0</sup>

Project title: Outils et Ressources pour le Français Ecrit et Oral

Duration: February 2013 - February 2016

Coordinator: Jeanne-Marie DEBAISIEUX (Université Paris 3)

Other partners: ATILF, CLLE-ERSS, ICAR, LIF, LORIA, LATTICE, MoDyCo

Abstract: The main objective of the ORFEO project is the constitution of a Corpus for the Study of Contemporary French.

In this project, we have provided so far an automatic alignment at the word and phoneme levels for audio files from the corpus TCOF (Traitement de Corpus Oraux en Français). This corpus contains mainly spontaneous speech, recorded under various conditions with a large SNR range and a lot of overlapping speech. We tested different acoustic models and different adaptation methods for the forced speech-text alignment. Other corpora are currently being processed.

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<sup>0</sup><http://www.ortolang.fr>

<sup>0</sup>[http://www.agence-nationale-recherche.fr/en/anr-funded-project/?tx\\_lwmsuivibilan\\_pi2\[CODE\]=ANR-12-CORP-0005](http://www.agence-nationale-recherche.fr/en/anr-funded-project/?tx_lwmsuivibilan_pi2[CODE]=ANR-12-CORP-0005)

### 8.1.3. ANR-DFG IFCASL

Project acronym: IFCASL

Project title: Individualized feedback in computer-assisted spoken language learning

Duration: March 2013 - February 2016

Coordinator: Jürgen Trouvain (Saarland University)

Other partners: Saarland University (COLI department)

Abstract: The main objective of IFCASL is to investigate learning of oral French by German speakers, and oral German by French speakers at the phonetic level.

The work has mainly focused on the design of a corpus of French sentences and text that has been recorded by German speakers learning French, recording a corpus of German sentences read by French speakers, and tools for annotating French and German corpora. Beforehand, two preliminary small corpora have been designed and recorded in order to bring to the fore the most interesting phonetic issues to be investigated in the project. In addition this preliminary work was used to test the recording devices so as to guarantee the same quality of recording in Saarbrücken and in Nancy, and to design and develop recording software.

In this project, we also provided an automatic alignment procedure at the word and phoneme levels for 4 corpora: French sentences uttered by French speakers, French sentences uttered by German speakers, German sentences uttered by French speakers, German sentences uttered by German speakers.

### 8.1.4. ANR ContNomina

Project acronym: ContNomina

Project title: Exploitation of context for proper names recognition in diachronic audio documents

Duration: February 2013 - July 2016

Coordinator: Irina Illina (Loria)

Other partners: LIA, Synalp

Abstract: the project ContNomina focuses on the problem of proper names in automatic audio processing systems by exploiting in the most efficient way the context of the processed documents. To do this, the project addresses:

- the statistical modeling of contexts and of relationships between contexts and proper names;
- the contextualization of the recognition module through the dynamic adjustment of the lexicon and of the language model in order to make them more accurate and certainly more relevant in terms of lexical coverage, particularly with respect to proper names;
- the detection of proper names, on the one hand, in text documents for building lists of proper names, and on the other hand, in the output of the recognition system to identify spoken proper names in the audio/video data.

### 8.1.5. FUI RAPSODIE

Project acronym: RAPSODIE<sup>0</sup>

Project title: Automatic Speech Recognition for Hard of Hearing or Handicapped People

Duration: March 2012 - February 2016 (signed in December 2012)

Coordinator: eRocca (Mieussy, Haute-Savoie)

Other partners: CEA (Grenoble), Inria (Nancy), CASTORAMA (France)

Abstract: The goal of the project is to realize a portable device that will help a hard of hearing person to communicate with other people. To achieve this goal the portable device will embed a speech recognition system, adapted to this task. Another application of the device will be environment vocal control for handicapped persons.

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<sup>0</sup><http://erocca.com/rapsodie>

In this project, MULTISPEECH is involved for optimizing the speech recognition models for the envisaged task, and contributes also to finding the best way of presenting the speech recognition results in order to maximize the communication efficiency between the hard of hearing person and the speaking person.

### **8.1.6. ADT FASST**

The Action de Développement Technologique Inria (ADT) FASST (2012–2014) was conducted by PAROLE in collaboration with the teams PANAMA and TEXMEX of Inria Rennes. It reimplemented into efficient C++ code the Flexible Audio Source Separation Toolbox (FASST) originally developed in Matlab by the METISS team of Inria Rennes. This enabled the application of FASST on larger data sets, and its use by a larger audience. The new C++ version was released in January 2014. Two modules were also developed for HTK and Kaldi in order to perform noise robust speech recognition by uncertainty decoding.

### **8.1.7. ADT VisArtico**

The technological Development Action (ADT) Inria Visartico (2013–2015) aims at developing and improving VisArtico, an articulatory visualization software. In addition to improving the basic functionalities, several articulatory analysis and processing tools are being integrated. We will also work on the integration of multimodal data.

## **8.2. European Initiatives**

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

E. Vincent was responsible for his former team (PANAMA) of the following project.

Program: Eureka - Eurostars

Project acronym: i3DMusic

Project title: Real-time Interactive 3D Rendering of Musical Recordings

Duration: October 2010 to March 2014

Coordinator: Audionamix (FR)

Other partners: EPFL (CH), Sonic Emotion (CH)

Abstract: The i3DMusic project aims to enable real-time interactive respatialization of mono or stereo music content. This is achieved through the combination of source separation and 3D audio rendering techniques. PANAMA is responsible for the source separation work package, more precisely for designing scalable online source separation algorithms and estimating advanced spatial parameters from the available mixture.

## **8.3. International Initiatives**

### **8.3.1. Inria International Partners**

#### **8.3.1.1. Informal International Partners**

E. Vincent is involved as an associate member in the national Japanese JSPS Grant-in-Aid for Scientific Research project on distributed microphone arrays led by Nobutaka Ono from the National Institute of Informatics together with other partners from the University of Tsukuba and Tokyo Institute of Technology.

A. Liutkus is involved in a national project in Ireland, still at the proposal stage, on the topic of Audio Forensics, led by Derry Fitzgerald (Cork Institute of Technology). He is an associate researcher on some workpackages of this project, notably those focusing on the theory of audio source separation.

A. Liutkus is co-advisor for the Ph.D. of Donal O'Donovan (Cork Institute of Technology, Ireland), whose Ph.D. topic lies in the applications of the Kernel Additive Modelling framework to image processing.

### **8.3.2. Participation in other International Programs**

A. Liutkus is an associate researcher in a national project in the USA, funded by the National Science Foundation (NSF) on the program "Cyber-Human Systems" (CHS) under the name "CHS:Small: Robust Interactive Audio Source Separation" and led by Bryan Pardo (Northwestern University, Chicago).

## **8.4. International Research Visitors**

### **8.4.1. Visits of International Scientists**

RIBAS Dayana

Date: Sep 2014 - Dec 2014

Institution: **CENATAV** Advanced Technologies Application Center, La Habana (Cuba)

BANDINI Andrea

Date: Oct 2014 - Mar 2015

Institution: University of Bologna, Bologna, Italy.

### **8.4.2. Visits to International Teams**

#### **8.4.2.1. Explorer program**

VINCENT Emmanuel

Date: Jun 2014 - Aug 2014

Institution: **Mitsubishi Electric Research Labs** (USA)

LIUTKUS Antoine

Date: Oct 2014 - Dec 2014

Institution: **BU** (Turkey)

Description: This Explorer program had several objectives. First, it aims at studying several ambitious scientific problems, such as the analysis of multimodal and multirate data and also to extend Nonnegative Matrix Factorization to alpha-stable models, significantly generalizing the classical Gaussian model for audio signals. Second, this program is the occasion to build an international academic network involving researchers of the Bogazici University. It is planned to submit an ambitious proposal for a Marie-Curie International Training Network (ITN) in 2015.

## ORPAILLEUR Project-Team

# 8. Partnerships and Cooperations

## 8.1. International Initiatives

### 8.1.1. Participation In International Programs

#### 8.1.1.1. *Ciência Sem Fronteiras*

**Participant:** Amedeo Napoli [contact person].

Program “Ciência Sem Fronteiras” is a Brazilian research fellowship which provides a funding for the stay of a visiting French researcher in Brazil at Universidade Federal Pernambuco Recife for three years. The on-going project is called “Formal Concept Analysis as a Support for Knowledge Discovery” and is aimed at combining FCA methods with numerical clustering methods used by Brazilian colleagues. This project is supervised in Brazil by Professor Francisco de A.T. de Carvalho (CIn/UFPE).

The project aims at developing and comparing classification and clustering algorithms for complex data (especially interval and multi-valued data). Two families of algorithms are studied, namely “clustering algorithms” based on the use of a similarity or a distance for comparing the objects, and “classification algorithms in Formal Concept Analysis (FCA)” based on attribute sharing between objects. The objectives here are to combine the facilities of both families of algorithms for improving the potential of each family in dealing with more complex and voluminous datasets.

#### 8.1.1.2. *Pronex Brasilia*

**Participant:** Bernard Maigret [contact person].

In this research project, the goal is to identify, using virtual screening techniques that we developed, new compounds against tropical diseases (e.g. trypanosome, dengue and mycosis) in collaboration with several Brazilian laboratories among which the Department of Biology at University of Brasilia, together with the Harmonic Pharma start-up. Through this collaboration, several PhD and postdocs came to the lab for one year training with our home-developed virtual screening engine (VSM-G). This project is in part supported by the Brazilian CNPq agency. Fruitful results were already obtained leading to several papers in preparation and patents. These patents concern the discovery of new putative treatment of strong mycosis due to fungi particularly virulent in South America. These patents were funded by the University of Brasilia, Embrapa and Harmonic Pharma.

#### 8.1.2. *Inria Associate Team: Snowflake*

**Participants:** Adrien Coulet [contact person], Gabin Personeni, Malika Smaïl-Tabbone.

Snowflake (<http://snowflake.loria.fr/>) is an Inria Associate Team which started in 2014. It is aimed at facilitating the collaboration between researchers from the Inria ORPAILLEUR team and the Stanford Center for Biomedical Informatics Research, Stanford University, USA. The main objective of Snowflake is to improve biomedical knowledge discovery by connecting Electronic Health Records (EHRs) with LOD (Linked Open Data). Such a connection could allow to complete domain knowledge w.r.t. EHRs. The initial focus of Snowflake is the identification and characterization of groups of patients w.r.t. reactions to drugs. Identifies features associated with such groups of patients could be used as predictors of over- or under-reactions to some drugs. The considered use case is related to pharmacogenomics drugs, i.e., drugs known to cause variable effects depending on the genetic profile of patients. Data associated with pharmacogenomics drugs and their mechanisms are available in LOD and, once connected to EHRs, they can be used to classify drugs and then patients presenting a specific reaction profile to a given group of drugs.

#### 8.1.3. *Explorer Programme*

**Participant:** Chedy Raïssi [contact person].

Chedy Raïssi visited the MIT Lab (Massachusetts Institute of Technology, MIT <http://web.mit.edu/>) during one month between July and August 2014. The objective of this research visit was the following.

Over the last decade, the annual turnovers generated by the electronic entertainment industry went beyond those of both cinema and music industries, making video game production a highly profitable business. In parallel with the game industry growth, watching video-game live streams is becoming an increasingly popular way of entertainment. Given the shared interests, between Orpailleur team and the GameLab at MIT, in emerging broadcasting platforms for games and work on analytics, Chedy Raïssi started a productive collaboration with researchers from the GameLab at MIT where we he explored for one month the potential for future collaborations between the MIT and Inria on this interesting new topic.

#### 8.1.4. *Miscellaneous*

**Participants:** Mehwish Alam, Aleksey Buzmakov, Melisachew Chekol, Victor Codocedo, Adrien Coulet, Elias Egho, Ioanna Lykourantzou, Amedeo Napoli [contact person], Chedy Raïssi, Jean-Sébastien Sereni, Mario Valencia.

- The team had a Fapemig – Inria research project between 2009 and 2013, called “Incorporating Knowledge Models into Scalable Data Mining Algorithms” (IKMSDM). The IKMSDM project involved researchers at Universidade Federal de Minas Gerais in Belo Horizonte –a group led by Prof. Wagner Meira– and the Orpailleur team at Inria Nancy Grand Est. In this project we were interested in the mining of large amount of data with two relevant application scenarios: text mining and graph mining. This year, contact and work was going on, focusing on the preparation of a joint publication on the notion of skylines for tensor data.
- An on-going collaboration involves the Orpailleur team and Sergei Kuznetsov at Higher School of Economics in Moscow (HSE). Amedeo Napoli visited HSE laboratory several times (with the support of HSE) while Sergei Kuznetsov visited Inria Nancy Grand Est several times too. The collaboration is materialized by the joint supervision of the thesis of Aleksey Buzmakov and the organization of scientific events, and in particular the workshop FCA4AI whose fourth edition will take place this year in July at IJCAI 2014 (see <http://www.fca4ai.hse.ru>).
- LEA STRUCO is an “Associated International Laboratory” of CNRS between IÚUK, Prague, and LIAFA, Paris. It focuses on high-level study of fundamental combinatorial objects, with a particular emphasis on comprehending and disseminating the state-of-the-art theories and techniques developed. The obtained insights shall be applied to obtain new results on existing problems as well as to identify directions and questions for future work. Jean-Sébastien Sereni is the contact person for LEA STRUCO which was initiated when Jean-Sébastien was a member of LIAFA.
- At present, Mario Valencia is the international coordinator of the MathAmSud project 13MATH-07 “Structural an algebraic problems on graph theory” (2013–2015). This project is funded by the following research institutes: CNRS in France, MinCyT in Argentina, CAPES in Brazil and CMM in Chile.

## 8.2. National Initiatives

### 8.2.1. ANR

#### 8.2.1.1. HEREDIA

**Participant:** Jean-Sébastien Sereni [contact person].

HEREDIA (<http://www.liafa.univ-paris-diderot.fr/~sereni/Heredia/>) is an ANR JCJC (“Jeunes Chercheurs”) focusing on hereditary properties of graphs, which provide a general perspective to study graph properties. Several important general theorems are known and the approach offers an elegant way of unifying notions and proof techniques. Further, hereditary classes of graphs play a central role in graph theory. Besides their theoretical appeal, they are also particularly relevant from an algorithmic point of view. With Jean-Sébastien Sereni, the HEREDIA project involves Pierre Charbit (LIAFA, Paris), Louis Esperet (G-SCOP, Grenoble) and Nicolas Trotignon (LIP, Lyon).



8.2.1.2. *Hybride*

**Participants:** Adrien Coulet, Luis-Felipe Melo, Amedeo Napoli, Matthieu Osmuk, Chedy Raïssi, My Thao Tang, Mohsen Sayed, Yannick Toussaint [contact person].

The Hybride research project (<http://hybride.loria.fr/>) aims at combining Natural Language Processing (NLP) and Knowledge Discovery in Databases (KDD) for text mining. A key idea is to design an interacting and convergent process where NLP methods are used for guiding text mining and KDD methods are used for guiding the analysis of textual documents. NLP methods are mainly based on text analysis and extraction of general and temporal information. KDD methods are based on pattern mining, e.g. patterns and sequences, formal concept analysis and graph mining. In this way, NLP methods applied to texts extract “textual information” that can be used by KDD methods as constraints for focusing the mining of textual data. By contrast, KDD methods extract patterns and sequences to be used for guiding information extraction from texts and text analysis. Experimental and validation parts associated with the Hybride project are provided by an application to the documentation of rare diseases in the context of Orphanet.

The partners of the Hybride consortium are the GREYC Caen laboratory (pattern mining, NLP, text mining), the MoDyCo Paris laboratory (NLP, linguistics), the INSERM Paris laboratory (Orphanet, ontology design), and the Orpailleur team at Inria NGE (FCA, knowledge representation, pattern mining, text mining).

8.2.1.3. *ISTEX*

**Participants:** Luis-Felipe Melo, Amedeo Napoli, Yannick Toussaint [contact person].

ISTEX is a so-called “Initiative d’excellence” managed by CNRS and DIST (“Direction de l’Information Scientifique et Technique”). ISTEX aims at giving to the research and teaching community an on-line access to scientific publications in all the domains. Thus ISTEX is in concern with a massive acquisition of documentation such as journals, proceedings, corpus, databases...ISTEX-R is one research project within ISTEX in which is involved the Orpailleur team, with two other partners, namely the ATILF laboratory and the INIST Institute (both in Nancy). ISTEX-R aims at developing new tools for querying full-text documentation, analyzing content and extracting information. A platform is currently under development to provide robust NLP tools for text processing, as well as methods in text mining and domain conceptualization.

8.2.1.4. *Kolflow*

**Participants:** Jean Lieber [contact person], Alice Hermann, Amedeo Napoli, Emmanuel Nauer, My Thao Tang, Yannick Toussaint.

Kolflow (<http://kolflow.univ-nantes.fr/>) is a 3-year basic research project taking place from February 2011 to November 2014, funded by French National Agency for Research (ANR), program ANR CONTINT. The aim of the project is to investigate man-machine collaboration in continuous knowledge-construction flows.

Kolflow partners are GDD (LINA Nantes), Silex (LIRIS Lyon), Orpailleur (Inria NGE/LORIA), Coast (Inria NGE/LORIA), and Wimmics (Inria Sophia Antipolis).

8.2.1.5. *PEPSI: Polynomial Expansions of Protein Structures and Interactions*

**Participants:** David Ritchie [contact person], Marie-Dominique Devignes, Malika Smaïl-Tabbone, Seyed Ziaeddin Alborzi.

The PEPSI (“Polynomial Expansions of Protein Structures and Interactions”) project is a collaboration with Sergei Grudinin at Inria Grenoble (project Nano-D) and Valentin Gordeliy at the Institut de Biologie Structurale (IBS) in Grenoble. This four-year project funded by the ANR “Modèles Numériques” program involves developing computational protein modeling and docking techniques and using them to help solve the structures of large molecular systems experimentally (<http://pepsi.gforge.inria.fr>).

8.2.1.6. *Termith*

**Participants:** Luis-Felipe Melo, Yannick Toussaint [contact person].

Termith (<http://www.atilf.fr/ressources/termith/>) is an ANR Project which involves the following laboratories: ATILF, LIDILEM, LINA, INIST, Inria Saclay and Inria Nancy Grand Est. It aims at indexing documents belonging to different domain of Humanities. Thus, the project focuses on extracting candidate terms (information extraction) and on disambiguation.

In the Orpailleur team, we are mainly concerned by information extraction using Formal Concept Analysis techniques, but also pattern and sequence mining. The objective is to define “contexts introducing terms”, i.e. finding textual environments allowing a system to decide whether a textual element is actually a candidate term and its corresponding environment.

#### 8.2.1.7. *Trajcan: a study of patient care trajectories*

**Participants:** Elias Egho, Nicolas Jay [contact person], Amedeo Napoli, Chedy Raïssi.

Since 30 years, many patient classification systems (PCS) have been developed. These systems aim at classifying care episodes into groups according to different patient characteristics. In France, the so-called “Programme de Médicalisation des Systèmes d’Information” (PMSI) is a national wide PCS in use in every hospital. It systematically collects data about millions of hospitalizations. Though it is used for funding purposes, it includes useful information for public health domains such as epidemiology or health care planning.

The objective of the Trajcan project was to represent and analyze “patient care trajectories” (patient suffering from cancer limited to breast, colon, rectum, and lung cancers) and the associated healthcares (it should be noticed that the Trajcan Project ended at the beginning of 2014). The data are related to patients receiving hospital cares in the “Bourgogne” region and using data from PMSI. Such an analysis involves various data, e.g. type of cancer, number of visits, type of stays, hospitalization services, therapies used, and demographic factors such as age, gender, place of residence.

Elias Egho defended a Phd thesis on this subject in July 2014 [15]. Combining knowledge discovery and knowledge representation methods for improving the definition of patients as temporal objects (sequential data mining), he successfully developed different approaches for characterizing Patient Care Trajectories (PCT). A first characterization is based on sequential pattern structures, extending Formal Concept Analysis techniques to multidimensional sequential data. A second one, involves an algorithm called MMISP for “Mining Multidimensional Itemsets Sequential Patterns” and makes use of external knowledge to improve the mining process and discover sequential patterns at different levels of granularity [62]. Finally, a new similarity measure was developed for comparing sequences of itemsets and for applying clustering methods to classify patients having similar healthcare trajectories. This later work was distinguished by a forthcoming publication in Data Mining and Knowledge Discovery.

### 8.2.2. *Other National Initiatives and Collaborations*

#### 8.2.2.1. *Towards the discovery of new nonribosomal peptides and synthetases*

We have initiated a collaboration with researchers from the LIFL and Université Lille Nord de France on the NRPS toolbox. Data was cleaned and integrated from various public and specific analysis programs. The resulting database should facilitate the process of knowledge discovery of new nonribosomal peptides and synthetases. Actual results of this research collaboration were published in [21].

#### 8.2.2.2. *FUI Poqemon*

**Participant:** Chedy Raïssi [Contact Person].

The POQEMON project aims at developing new pattern mining methods and tools for guiding knowledge discovery from mobile phone networks for monitoring purposes. The main idea is to develop sound approaches that handle the trade-off between privacy of data and the power of analysis.

## 8.3. Regional Initiatives

### 8.3.1. *Le Bois Santé (LBS)*

**Participants:** Marie-Dominique Devignes [contact person], Malika Smaïl-Tabbone.

The project "LBS – Le Bois Santé – #38017" is funded by the European Regional Development Fund (FEDER) and the French "Fonds Unique Interministériel (FUI)" in the framework of the BioProLor consortium. This project is coordinated by "Harmonic Pharma", a start-up specialized in the identification of active principles in natural products. The aim of LBS is to exploit wood products in the pharmaceutical and nutriment domains. Concerned people in the team are working on data management and knowledge discovery about new therapeutic applications.

### 8.3.2. *PEPS Mirabelle EXPLOD-Biomed*

**Participants:** Adrien Coulet [contact person], Marie-Dominique Devignes, Gabin Personeni, Malika Smail-Tabbone.

This project has initiated a collaboration with geneticists from the Hospital of Nancy, namely Philippe Jonveaux and Céline Bonnet. The aim of the EXPLOD-Biomed project is to propose novel knowledge discovery methods applied to Linked Open Data for discovering gene that could be responsible for intellectual deficiencies. Linked Open Data are available on-line, interconnected and encoded in a format which can be straightforwardly mapped to ontologies. Thus they offer novel opportunities for knowledge discovery in biomedical data. Here, geneticists play the role of experts and guide the knowledge discovery process at different steps.

### 8.3.3. *Hydreos*

**Participant:** Jean-François Mari [contact person].

Hydreos is a state organization –actually a so-called "Pôle de compétitivité"– aimed at evaluating the quality of water (<http://www.hydreos.fr/fr>). Actually, water resources rely on many agronomic variables, including land use successions. Accordingly, one objective of our participation in Hydreos is to have a better understanding of the changes in the organization of a territory. The data to be analyzed are obtained by surveys or by satellite images and describe the land use at the level of the agricultural parcel. Then there is a search for detecting changes in land use and for correlating these changes to groundwater quality.

The systems ARPEntAge (see § 5.2.2 ) and CarottAge (see § 5.2.1 ) are used in this context, especially by agronomists of INRA (ASTER Mirecourt <http://www6.nancy.inra.fr/sad-aster>).

This year, our research work focused on implementing various display tools to have a better understanding of the clustering results that a stochastic modeling provide <http://www.loria.fr/~jfmari/App/Arpentage/Yar.avi>.

### 8.3.4. *Contrat Plan État Région" (CPER)*

A part of the links between the Regional Administration and Inria Nancy Grand Est/LORIA are materialized through the so-called "Contrat Plan État Région" (CPER) which is running from 2015 to 2020. There is an associated scientific program in which the Orpailleur team is involved.

Some members of the Orpailleur team participated to the definition of a project in one of the two tracks of the interdisciplinary scientific program called "Santé et Vieillessement". The other track called "Innovations Technologiques, Modélisation et Médecine Personnalisée (IT2MP)" is coordinated by Pr. Zannad (CHU-Nancy). We proposed a project called "Simulation et Modélisation pour l'Extraction de Connaissances (SMEC)" which gathers physicians, bio-statisticians, chemists and computer scientists. The objective of this project is to design innovative methodologies for analyzing cohort data and make progress towards personalized medicine.

## SEMAGRAMME Project-Team

# 7. Partnerships and Cooperations

## 7.1. Regional Initiatives

### 7.1.1. SLAM: Schizophrenia and Language, Analysis and Modeling

**Participants:** Maxime Amblard [coordinator], Philippe de Groote, Sylvain Pogodalla, Karën Fort.

Schizophrenia is well-known among mental illnesses for the strength of the thought disorders it involves, and for their widespread and spectacular manifestations: from deviant social behavior to delusion, not to speak about affective and sensitive distortions. It aims at exploring a specific manifestation, namely disorders in conversational speech. This is an interdisciplinary research, both empirical and theoretical from several domains, namely psychology, philosophy, linguistic and computer science.

The SLAM project starts for three years at the Maison des Sciences de l'Homme de Lorraine (MSH-Lorraine, USR 3261). While this year work was dedicated to the test protocol definition, the coming years will be devoted to building an open-access corpus of pathological uses of language.

The first transcriptions of pathological interviews are analyses. The management chain was implemented for disfluences and POS.

Other participants are: Denis Apotheloz (ATILF, Université de Lorraine), Valérie Aucouturier (Centre Léo Apostel, Université Libre de Bruxelles), Katarina Bartkova (ATILF, Université de Lorraine), Fethi Bretel (CHS Le Rouvray, Rouen), Michel Musiol (InterPSY, Université de Lorraine), Manuel Rebuschi (Archives Poincaré, Université de Lorraine).

The SLAM project was supported by the MSH-Lorraine, USR 3261, and won a PEPS project HuMaIn (mission pour l'interdisciplinarité du CNRS). The CNRS part of the budget allowed the organization of the second workshop which gather linguists, psychologists and computer scientists in december : <http://discours.loria.fr>

## 7.2. National Initiatives

### 7.2.1. ANR

#### 7.2.1.1. Polymnie: Parsing and synthesis with abstract categorial grammars. From lexicon to discourse

**Participants:** Maxime Amblard, Philippe de Groote, Aleksandre Maskharashvili, Sylvain Pogodalla [coordinator], Sai Qian.

POLYMNIE<sup>0</sup> is a research project funded by the French national research agency (ANR). It relies on the grammatical framework of Abstract Categorial Grammars (ACG). A feature of this formalism is to provide the same mathematical perspective both on the surface forms and on the more abstract forms the latter correspond to. As a consequence:

- ACG allows for the encoding of a large variety of grammatical formalisms such as context-free grammars, Tree Adjoining grammars (TAG), etc.
- ACG defines two languages: an abstract language for the abstract forms, and an object language for the surface forms.

Importantly, the notions of object language and abstract language are relative to each other. If we can naturally see surface forms as strings for instance and abstract forms as the associated syntactic trees, we can also consider to associate this abstract form to a first order logical formula as surface (object) form. This property is central in our project as it offers a unified approach to text analysis and text generation, in particular considering the underlying algorithms and their complexity.

<sup>0</sup><http://semagramme.loria.fr/doku.php?id=projects:polymnie>

ACG definition uses type-theory and lambda-calculus. From this point of view, they smoothly integrate formal semantics models issuing from Montague's proposal. Theories that extend to the discourse level such as Discourse Representation Theory (DRT) and Dynamic Predicate Logic (DPL) were not initially formulated using lambda-calculus. But such formulations have been proposed. In particular, a formulation based on continuation semantics allows them to be expressed quite naturally in the ACG architecture. Dynamic effects of discourse, in particular those related to anaphora resolution or rhetorical relation inference, have then to be expressed by lexical semantics or computed from the syntactic rules as studied in the Inria Collaborative Research Project (ARC) CAuLD<sup>0</sup>.

It has been shown that the discourse structure of texts plays a key role in their understanding. This is the case for both human readers and automatic processing systems. For instance, it can enhance text transformation systems such as the ones performing automatic summarization.

POLYMNIE focuses on studying and implementing the modelling of sentences and discourses in a compositional paradigm that takes into account their dynamics and their structures, both in parsing and in generation. To that end, we rely on the ACG framework. The kind of processing we are interested in relate to the automatic construction of summaries or to text simplification. This has to be considered in the limits of the modelling of the linguistic processes (as opposed to inferential processes for instance) these tasks involve.

The complexity of the phenomena, of their formal description, and of their interactions, require to set up a testing and development environment for linguistic modelling. It will consist in extending and stabilizing a software implementing the functionalities of the ACG framework. It will provide a tool for experimentation and validation of the approach.

Partners:

- Sémagramme people,
- Alpage (Paris 7 university & Inria Paris-Rocquencourt): Laurence Danlos (local coordinator), C. Braud, C. Roze, Éric Villemonte de la Clergerie,
- MELODI (IRIT, CNRS): Stergos Afantenos, Nicholas Asher (local coordinator), Juliette Conrath, Philippe Muller,
- Signes (LaBRI, CNRS): Jérôme Kirman, Richard Moot, Christian Retoré (local coordinator), Sylvain Salvati, Noémie-Fleur Sandillon-Rezer.

## 7.3. International Research Visitors

### 7.3.1. Visits of International Scientists

On the occasion of the workshop in honor of Hans KAMP we have invited in Nancy:

- Nicholas ASHER, Université Paul Sabatier, France
- Paul DEKKER, Universiteit van Amsterdam, the Netherlands
- Bart GEURTS, Universiteit van Nijmegen, the Netherlands
- Irène HEIM, Massachusetts Institute of Technology, USA
- Klaus von HEUSINGER, Universität zu Köln, Germany
- Hans KAMP, Universität zu Stuttgart, Germany

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<sup>0</sup><http://www.loria.fr/~pogodall/cauld/>

### **7.3.2. Visits to International Teams**

#### *7.3.2.1. Sabbatical programme*

Sylvain Pogodalla

Date: Aug 2014 - Jul 2015

Institution: Computational Linguistic Department of the University of Düsseldorf (Germany).

The objective of the research project deals with studying the syntax-semantics interface. It relies on two alternative approaches of this interface for mCSG: a unification based approach for Lexicalized Tree Adjoining Grammars (LTAG) [60], [61] as proposed in [57], [62], and a type-theoretic approach using Abstract Categorical Grammars (ACG) [80], [73], [74]. These two approaches provide the core mechanisms of structure mapping for the syntax-semantics interface. Because they both provide a perspective on the syntax-semantics interface for the same grammatical formalism, they offer an interesting meeting place for exchanges on the strength of each of the approaches. In the project, we focus on two of them: the role of lexical semantics and its interaction with the syntax-semantics design, and the integration of discourse related phenomena to the syntax-semantics interface. With that respect, the formal semantics expertise of the department in the modeling of tense and aspects plays is essential in enriching the approach.