



RESEARCH CENTER
Paris - Rocquencourt

FIELD

Activity Report 2015

Section Partnerships and Cooperations

Edition: 2016-03-21

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ANTIQUÉ Project-Team

7. Partnerships and Cooperations

7.1. National Initiatives

7.1.1. ANR

7.1.1.1. AnaStaSec

Title: Static Analysis for Security Properties

Type: ANR générique 2014

Defi: Société de l'information et de la communication

Instrument: ANR grant

Duration: January 2015 - December 2018

Coordinator: Inria Paris-Rocquencourt (France)

Others partners: Airbus France (France), AMOSSYS (France), CEA LIST (France), Inria Rennes-Bretagne Atlantique (France), TrustInSoft (France)

Inria contact: Jérôme Feret

See also: <http://www.di.ens.fr/feret/anastasec/>

Abstract: An emerging structure in our information processing-based society is the notion of trusted complex systems interacting via heterogeneous networks with an open, mostly untrusted world. This view characterises a wide variety of systems ranging from the information system of a company to the connected components of a private house, all of which have to be connected with the outside.

It is in particular the case for some aircraft-embedded computer systems, which communicate with the ground through untrusted communication media. Besides, the increasing demand for new capabilities, such as enhanced on-board connectivity, e.g. using mobile devices, together with the need for cost reduction, leads to more integrated and interconnected systems. For instance, modern aircrafts embed a large number of computer systems, from safety-critical cockpit avionics to passenger entertainment. Some systems meet both safety and security requirements. Despite thorough segregation of subsystems and networks, some shared communication resources raise the concern of possible intrusions.

Some techniques have been developed and still need to be investigated to ensure security and confidentiality properties of such systems. Moreover, most of them are model-based techniques operating only at architectural level and provide no guarantee on the actual implementations. However, most security incidents are due to attackers exploiting subtle implementation-level software vulnerabilities. Systems should therefore be analyzed at software level as well (i.e. source or executable code), in order to provide formal assurance that security properties indeed hold for real systems.

Because of the size of such systems, and considering that they are evolving entities, the only economically viable alternative is to perform automatic analyses. Such analyses of security and confidentiality properties have never been achieved on large-scale systems where security properties interact with other software properties, and even the mapping between high-level models of the systems and the large software base implementing them has never been done and represents a great challenge. The goal of this project is to develop the new concepts and technologies necessary to meet such a challenge.

The project **ANASTASEC** project will allow for the formal verification of security properties of software-intensive embedded systems, using automatic static analysis techniques at different levels of representation: models, source and binary codes. Among expected outcomes of the project will be a set of prototype tools, able to deal with realistic large systems and the elaboration of industrial security evaluation processes, based on static analysis.

7.1.1.2. VerAsCo

Title: Formally-verified static analyzers and compilers

Type: ANR Ingénierie Numérique Sécurité 2011

Instrument: ANR grant

Duration: Septembre 2011 - September 2015

Coordinator: Inria (France)

Others partners: Airbus France (France), IRISA (France), Inria Saclay (France)

See also: <http://www.systematic-paris-region.org/fr/projets/verasco>

Abstract: The usefulness of verification tools in the development and certification of critical software is limited by the amount of trust one can have in their results. A first potential issue is *unsoundness* of a verification tool: if a verification tool fails (by mistake or by design) to account for all possible executions of the program under verification, it can conclude that the program is correct while it actually misbehaves when executed. A second, more insidious, issue is *miscompilation*: verification tools generally operate at the level of source code or executable model; a bug in the compilers and code generators that produce the executable code that actually runs can lead to a wrong executable being generated from a correct program.

The project **VERASCO** advocates a mathematically-grounded solution to the issues of formal verifying compilers and verification tools. We set out to develop a generic static analyzer based on abstract interpretation for the C language, along with a number of advanced abstract domains and domain combination operators, and prove the soundness of this analyzer using the Coq proof assistant. Likewise, we will continue our work on the CompCert C formally-verified compiler, the first realistic C compiler that has been mechanically proved to be free of any miscompilation will be continued. Finally, the tool qualification issues that must be addressed before formally-verified tools can be used in the aircraft industry, will be investigated.

7.1.1.3. AstréeA

Title: Static Analysis of Embedded Asynchronous Real-Time Software

Type: ANR Ingénierie Numérique Sécurité 2011

Instrument: ANR grant

Duration: January 2012 - December 2015

Coordinator: Airbus France (France)

Others partners: École normale supérieure (France)

Inria contact: Antoine Miné

See also: <http://www.astreea.ens.fr>

Abstract: The focus of the **ASTRÉE** project is on the development of static analysis by abstract interpretation to check the safety of large-scale asynchronous embedded software. During the THESEE ANR project (2006–2010), we developed a concrete and abstract models of the ARINC 653 operating system and its scheduler, and a first analyzer prototype. The gist of the **ASTRÉE** project is the continuation of this effort, following the recipe that made the success of **ASTRÉE**: an incremental refinement of the analyzer until reaching the zero false alarm goal. The refinement concerns: the abstraction of process interactions (relational and history-sensitive abstractions), the scheduler model (supporting more synchronisation primitives and taking priorities into account), the memory model (supporting volatile variables), and the abstraction of dynamical data-structures (linked lists). Patrick Cousot is the principal investigator for this project.

7.2. European Initiatives

7.2.1. FP7 & H2020 Projects

7.2.1.1. MemCad

Type: IDEAS

Defi: Design Composite Memory Abstract Domains

Instrument: ERC Starting Grant

Objectif: Design Composite Memory Abstract Domains

Duration: October 2011 - September 2016

Coordinator: Inria (France)

Inria contact: Xavier Rival

Abstract: The MemCAD project aims at setting up a library of abstract domains in order to express and infer complex memory properties. It is based on the abstract interpretation frameworks, which allows to combine simple abstract domains into complex, composite abstract domains and static analyzers. While other families of abstract domains (such as numeric abstract domains) can be easily combined (making the design of very powerful static analyses for numeric intensive applications possible), current tools for the analysis of programs manipulating complex abstract domains usually rely on a monolithic design, which makes their design harder, and limits their efficiency. The purpose of the MemCAD project is to overcome this limitation.

Our proposal is based on the observation that the complex memory properties that need to be reasoned about should be decomposed in combinations of simpler properties. Therefore, in static analysis, a complex memory abstract domain could be designed by combining many simpler domains, specific to common memory usage patterns. The benefit of this approach is twofold: first it would make it possible to simplify drastically the design of complex abstract domains required to reason about complex softwares, hereby allowing certification of complex memory intensive softwares by automatic static analysis; second, it would enable to split down and better control the cost of the analyses, thus significantly helping scalability. As part of this project, we propose to build a static analysis framework for reasoning about memory properties, and put it to work on important classes of applications, including large softwares.

7.3. International Initiatives

7.3.1. *EXE*cutable Knowledge

Title: EXEcutable Knowledge

Type: DARPA

Instrument: DARPA Program

Program: Big Mechanism

Duration: July 2014 - December 2017

Coordinator: Harvard Medical School (Boston, USA)

Partner: Inria Paris-Rocquencourt, École normale supérieure de Lyon Université Paris-Diderot,

Inria contact: Jérôme Feret

Abstract: Our overarching objective is Executable Knowledge: to make modeling and knowledge representation twin sides of biological reasoning. This requires the definition of a formal language with a clear operational semantics for representing proteins and their interaction capabilities in terms of agents and rules informed by, but not exposing, biochemical and biophysical detail. Yet, to achieve Executable Knowledge we need to go further:

- Bridge the gap between rich data and their formal representation as executable model elements. Specifically, we seek an intermediate, but already formal, knowledge representation (meta-language) to express granular data germane to interaction mechanisms; a protocol defining which and how data are to be expressed in that language; and a translation procedure from it into the executable format.

- Implement mathematically sound, fast, and scalable tools for analyzing and executing arbitrary collections of rules.
- Develop a theory of causality and attendant tools to extract and analyze the unfolding of causal lineages to observations in model simulations.

We drive these technical goals with the biological objective of assembling rule-based models germane to Wnt signaling in order to understand the role of combinatorial complexity in robustness and control.

7.3.2. Active Context

Title: Active Context

Type: DARPA

Instrument: DARPA Program

Program: Communicating with Computers

Duration: July 2015 - December 2018

Coordinator: Harvard Medical School (Boston, USA)

Partner: University of California, (San Diego, USA), Inria Paris-Rocquencourt, École normale supérieure de Lyon Université Paris-Diderot,

Inria contact: Jérôme Feret

Abstract: The traditional approach to the curation of biological information follows a philatelic paradigm, in which epistemic units based on raw or processed data are sorted, compared and catalogued in a slow and all too often insufficiently coordinated process aimed at capturing the meaning of each specimen in isolation. The swelling bounty of data generated by a systematic approach to biology founded on high-throughput technologies appears to have only intensified a sense of disconnected facts, despite their rendering as networks. This is all the more frustrating as the tide of static data (sequences, structures) is giving way to a tide of dynamic data about (protein-protein) interaction that want to be interconnected and understood (think annotated) in terms of process, i.e. a systemic approach.

The barrier is the complexity of studying systems of numerous heterogeneously interacting components in a rapidly evolving field of science. The complexity comes from two kinds of dynamically changing context: the internal dynamics of a biological system, which provide the context for assessing the meaning of a protein-protein interaction datum, and the external dynamics of the very fact base used to define the system in the first place. We propose the integration of dynamic modeling into the practice of bioinformatics to address these two dynamics by coupling them. The external dynamics is at first handled by a novel kind of two-layered knowledge representation (KR). One layer contextualizes proteins and their interactions in a structure that incrementally constructs, in an open-ended dialogue with the user, its own semantics by piecing together fragments of knowledge from a variety of sources tapped by the Big Mechanism program. The other layer is a model representation (MR) that handles and prioritizes the many executable abstractions compatible with the KR. The internal dynamics is handled not only by execution but also by addressing the impedance mismatch between the unwieldy formal language(s) required for execution and the more heuristic, high-level concepts that structure the modeling discourse with which biologists reason about molecular signaling systems. To the extent that we are successful on both ends, users will be able to effectively deploy modeling for curating the very fact base it rests upon, hopefully achieving self-consistency.

7.4. International Research Visitors

7.4.1. Visits of International Scientists

Josef Widder, associate professor at TU Wien, Embedded Computing Systems group, visited Cezara Drăgoi for a week, from Oct 12 to Oct 17.

7.4.1.1. Internships

Jérôme Feret is supervizing the Internships of Ken Chanseau Germain (M2 student), on “approximated model reduction of differential semantics”, since november 2015.

AOSTE Project-Team

9. Partnerships and Cooperations

9.1. Regional Initiatives

9.1.1. CIM PACA Design Platform

Participant: Robert de Simone.

The objective of this platform, run by a French association under the same name, is to provide mutualized equipments and tools for the design of embedded connected objects, and in our case mostly EDA software for hardware and SoC synthesis at high-level. We collaborate to the definition of the user needs and the choice of purchases, mostly to promote the construction of collaborative R&D projects using those resources. ANR HOPE project is a good example of such project.

CIM PACA also runs the eSAME yearly forum, a meeting point for various partners in the field around Sophia-Antipolis, with our active contribution. Further moves towards embedded software and IoT design form the upcoming roadmap.

9.2. National Initiatives

9.2.1. ANR

9.2.1.1. HOPE

Participants: Carlos Gomez Cardenas, Ameni Khecharem, Emilien Kofman, Robert de Simone.

The **ANR HOPE** project focuses on hierarchical aspects for the high-level modeling and early estimation of power management techniques, with potential synthesis in the end if feasible.

Although this project was officially started in November 2013, it was in part postponed due to the replacement of a major partner (Texas Instruments) by another one (Intel). Current partners are CNRS/UNS UMR LEAT, Intel, Synopsys, Docea Power, Magillem, and ourselves. A publication on multiview modeling (including performance, power, and temperature) was presented at eSAME'2014, reflecting Ameni Khecharem ongoing PhD work.

9.2.1.2. GeMoC

Participants: Matias Vara Larsen, Julien Deantoni, Frédéric Mallet.

This project is administratively handled by CNRS for our joint team, on the UMR I3S side. Partners are Inria (Triskell EPI), ENSTA-Bretagne, IRIT, Obeo, Thales TRT.

The project focuses on the modeling of heterogeneous systems using Models of Computation and Communication for embedded and real-time systems, described using generic means of MDE techniques (and in our case the MARTE profile, and most specifically its Time Model, which allows to specify precise timely constraints for operational semantic definition).

As part of the project dissemination purpose we organize a community-building international workshop [47], whose third edition gathered a growing number of participants.

9.2.2. FUI

9.2.2.1. FUI P

Participants: Abderraouf Benyahia, Dumitru Potop Butucaru, Yves Sorel.

The goal of project P is to support the model-driven engineering of high-integrity embedded real-time systems by providing an open code generation framework able to verify the semantic consistency of systems described using safe subsets of heterogeneous modeling languages, then to generate optimized source code for multiple programming (Ada, C/C++) and synthesis (VHDL, SystemC) languages, and finally to support a multi-domain (avionics, space, and automotive) certification process by providing open qualification material. Modeling languages range from behavioural to architectural languages and present a synchronous and asynchronous semantics (Simulink/Matlab, Scicos, Xcos, SysML, MARTE, UML),

See also: <http://www.open-do.org/projects/p/>

Partners of the project are: industrial partners (Airbus, Astrium, Continental, Rockwell Collins, Safran, Thales), SMEs (AdaCore, Altair, Scilab Enterprise, STI), service companies (ACG, Aboard Engineering, Atos Origins) and research centers (CNRS, ENPC, Inria, ONERA).

9.2.2.2. *FUI CLISTINE*

Participants: Robert de Simone, Amin Oueslati, Emilien Kofman.

This project was started in Oct 2013, and provides PhD funding for Amine Oueslati. Partners are SynergieCAD (coordinator), Avantis, Optis, and the two EPIs Aoste and Nachos. The goal is to study the feasibility of building a low-cost, low-power "supercomputer", reusing ideas from SoC design, but this time with out-of-chip network "on-board", and out-of-the-shelf processor elements organized as an array. The network itself should be time predictable and highly parallel (far more than PCI-e for instance). We started a thorough classification of parallel program types (known as "Dwarfs" in the literature), to provide benchmarks and evaluate the platform design options.

9.2.2.3. *FUI Waruna*

Participants: Liliana Cucu, Adriana Gogonel, Walid Talaboulma, Dorin Maxim.

This recent project was started in September 2015. It targets the creation of a framework allowing to connect different existing methods while enriching the description with Waruna results. This framework allows timing analyses for different application domains like avionics, railways, medical, aerospace, automotive, etc.

9.2.3. *Investissements d'Avenir*

9.2.3.1. *DEPARTS*

Participants: Liliana Cucu-Grosjean, Adriana Gogonel, Walid Talaboulma.

This project is funded by the BGLE Call (*Briques Logicielles pour le Logiciel Embarqué*) of the national support programme *Investissements d'Avenir*. Formally started on October 1st, 2012 with the kick-off meeting held on April, 2013 for administrative reasons. Research will target solutions for probabilistic component-based models, and a Ph.D. thesis should start at latest on September 2015. The goal is to unify in a common framework probabilistic scheduling techniques with compositional assume/guarantee contracts that have different levels of criticality.

9.2.3.2. *CLARITY*

Participants: Frédéric Mallet, Julien Deantoni, Ales Mishchenko, Robert de Simone, Marie Agnès Peraldi-Frati, Yann Bondue.

This project is funded by the LEOC Call (*Logiciel Embarqué et Objets Connectés*) of the national support programme *Investissements d'Avenir*. It was started in September 2014, and a kick-off meeting was held on October 9th. Partners are: Thales (several divisions), Airbus, Areva, Altran, All4Tec, Artal, the Eclipse Foundation, Scilab Enterprises, CESAMES, U. Rennes, and Inria. The purpose of the project is to develop and promote an open-source version of the ARCADIA Melody system design environment from Thales, renamed CAPPELLA for that purpose.

Our technical contributions to the project achievement are described in subsection 7.2.

9.2.3.3. *Capacites*

Participants: Liliana Cucu-Grosjean, Dumitru Potop-Butucaru, Yves Sorel, Walid Talaboulma.

This project is funded by the LEOC Call (*Logiciel Embarqué et Objets Connectés*) of the national support programme *Investissements d'Avenir*. It has started on November 1st, 2014 with the kick-off meeting held on November, 12th 2014. The project coordinator is Kalray, and the objective of the project is to study the relevance of Kalray-style MPPA processor array for real-time computation in the avionic domain (with partners such as Airbus for instance). The post-doc of Mihail Asavoae and the PhD of Walid Talaboulma are funded on this contract.

9.3. European Initiatives

9.3.1. FP7 & H2020 Projects

9.3.1.1. FP7 PROXIMA

Participants: Liliana Cucu, Adriana Gogonel, Walid Talaboulma, Dorin Maxim, Cristian Maxim.

PROXIMA is a Integrated Project (IP) of the Seventh framework programme for research and technological development (FP7). The PROXIMA project provides industry ready software timing analysis using probabilistic analysis for many-core and multi-core critical real-time embedded systems and will enable cost-effective verification of software timing analysis including worst case execution time. Our technical results in this project are described in 7.13 .

9.3.2. Collaborations in European Programs, except FP7 & H2020

9.3.2.1. ITEA3 Assume

Project title: Affordable Safe And Secure Mobility Evolution

Duration: Oct. 2015 - Sept. 2018

Coordinator: Daimler AG (Germany)

Other partners: Airbus, Thales, Safran, Ansys/Esterel Technologies, Kalray, Sagem, UPMC, ENS Ulm, Inria (France). AbsInt, BTC, FZI. Karlsruhe IT, Kiel U. Offis, Bosch, TU Muenchen (Germany), NXP, Recore, VDL, Verum, TU Eindhoven, U. Twente (Netherlands), Arcelik, Ericsson, Ford, Havelsan, KocSistem, Unit, Koc University (Turkey), Arcticus, FindOut, Scania, KTH, Malardalen U. (Sweden)

Abstract: ASSUME aims at providing a seamless engineering methodology for affordable, safe multi-core development that allows industry to deliver new trustworthy functions at competitive prices. The project started on September 1st, 2015, and the kick-off meeting was held on October 1-2. The project coordinator is Daimler AG. The expected contributions of the Aoste team-project include the improvement of the Lopht tool, with the definition of a back-end targeting the Kalray MPPA256 many-core, and the proof of its scheduling algorithms.

9.4. International Initiatives

9.4.1. Inria International Labs

LIAMA

Associate Team involved in the International Lab:

9.4.1.1. FM4CPS

Title: Formal Models and tools for Cyber-Physical Systems

International Partner (Institution - Laboratory - Researcher):

ECNU (China) - Artificial Intelligence Lab - Jifeng He

Start year: 2015

See also: <https://project.inria.fr/fm4cps/>

The FM4CPS Associated team is tightly linked to the SACCADES LIAMA project. It is also involved in the International Key Laboratory on Trustworthy Computing by ECNU Shanghai on the Chinese side.

FM4CPS addresses several facets of Formal Model-Driven Engineering for Cyber-Physical Systems and Internet of Things. The design of such large heterogeneous systems calls for hybrid modeling, and the combination of classes of models, most previously well-established in their own restricted area: Formal Models of Computations drawn from Concurrency Theory for the “cyber” discrete processors, timed extension and continuous behaviors for physical environments, requirement models and user constraints extended to non-functional aspects, new challenges for designing and analyzing large and highly dynamic communicating software entities. Orchestration and comparison of models, with their expressive power vs. their decidability aspects, shall be considered with the point of view of hybrid/heterogeneous modeling here. Main aspects are the various timing or quantitative structure extensions relying for instance on a hybrid logical clock model for the orchestration of underlying components.

The associated team aims at various level of research, from formal models, semantics, or complexity, to experimental tools development. This will start for example on one side with building a formal orchestration model for CPSs, based on an hybrid clock model that combine discrete and physical time, synchronous and asynchronous computations or communications. Another goal will be the study of expressiveness and decidability for CPS, based on dedicated sub-families of well-structured push-down systems, addressing both unbounded communication and time-sensitive models.

9.5. International Research Visitors

9.5.1. Visits of International Scientists

9.5.1.1. Invited Professor

Qingguo XU

Date: July 2014 to June 2015

Institution: Shanghai University (China)

9.5.1.2. Internships

Nieto Luis Agustin

Date: Sep 2015 - Feb 2016

Institution: Universidad de Buenos Aires (Argentina)

9.5.2. Visits to International Teams

9.5.2.1. Sabbatical programme

Mallet Frédéric

Date: Sep 2014 - Aug 2015

Institution: [ECNU](#) (China)

CASCADE Project-Team

7. Partnerships and Cooperations

7.1. National Initiatives with Industrials

7.1.1. PRINCE

Title: Proven Resilience against Information leakage in Cryptographic Engineering

Program: ANR ARPEGE

Duration: December 2010 – May 2015

Coordinator: Tranef

Partners:

ENS

UVSQ

Oberthur Technologies

Ingenico

Gemalto

Tranef

Local coordinator: Michel Abdalla

We aim to undertake research in the field of leakage-resilient cryptography with a practical point of view. Our goal is to design efficient leakage-resilient cryptographic algorithms and invent new countermeasures for non-leakage-resilient cryptographic standards. These outcomes shall realize a provable level of security against side-channel attacks and come with a formally verified implementation. For this every practical aspect of the secure implementation of cryptographic schemes must be taken into account, ranging from the high-level security protocols to the cryptographic algorithms and from these algorithms to their implementation on specific devices which hardware design may feature different leakage models.

7.1.2. SIMPATIC

Title: SIM and PAiring Theory for Information and Communications security

Program: ANR INS

Duration: February 2013 – July 2016

Coordinator: Orange Labs

Partners:

Orange Labs

ENS

INVIA

Oberthur Technologies

STMicroelectronics

Université Bordeaux 1

Université de Caen Basse-Normandie

Université de Paris VIII

Local coordinator: David Pointcheval

We aim at providing the most possible efficient and secure hardware/software implementation of a bilinear pairing in a SIM card.

7.1.3. *CryptoComp*

Program: FUI

Duration: October 2014 – September 2017

Coordinator: CryptoExperts

Partners:

CEA

CNRS

Kalray

Inria

Dictao

Université de Limoges

VIACCESS

Bertin technologies

GEMALTO

Local coordinator: Vadim Lyubashevsky (until July 2015) and David Pointcheval (from August 2015)

We aim at studying delegation of computations to the cloud, in a secure way.

7.2. National Collaborations within Academics

7.2.1. *ROMAnTIC*

Title: Randomness in Mathematical Cryptography

Program: ANR JCJC

Duration: October 2012 – September 2016

PI: Damien Vergnaud

Partners:

ANSSI

Univ. Paris 7

Univ. Limoges

The goal of this project is to get a better understanding of the interplay between randomness and cryptography and to study the security of various cryptographic protocols at different levels (information-theoretic and computational security, number-theoretic assumptions, design and provable security of new and existing constructions).

7.2.2. *CLE*

Title: Cryptography from Learning with Errors

Program: ANR JCJC

Duration: October 2013 – December 2015

PI: Vadim Lyubashevsky

Partners:

UVSQ

Univ. Paris 8

Inria/SECRET

The main objective of this project is to explore the potential practical implications of the Learning with Errors problem and its variants. The plan is to focus on the constructions of essential primitives whose use is prevalent in the real world. Toward the end of the project, the hope is to propose and standardize several public key and symmetric key schemes that have specific advantages over ones that are currently deployed.

7.2.3. EnBiD

Title: Encryption for Big Data

Program: ANR JCJC

Duration: October 2014 – September 2018

PI: Hoeteck Wee

Partners:

Univ. Paris 2

Univ. Limoges

The main objective of this project is to study techniques for efficient and expressive functional encryption schemes. Functional encryption is a novel paradigm for public-key encryption that enables both fine-grained access control and selective computation on encrypted data, as is necessary to protect big, complex data in the cloud.

7.3. European Initiatives

7.3.1. CryptoAction

Title: Cryptography for Secure Digital Interaction

Program: H2020 ICT COST

Duration: April 2014 – April 2018

Local coordinator: Vadim Lyubashevsky (until July 2015) and Michel Abdalla (from August 2015)

The aim of this COST CryptoAction is to stimulate interaction between the different national efforts in order to develop new cryptographic solutions and to evaluate the security of deployed algorithms with applications to the secure digital interactions between citizens, companies and governments.

7.3.2. CryptoCloud

Title: Cryptography for the Cloud

Program: FP7 ERC Advanced Grant

Duration: June 2014 – May 2019

PI: David Pointcheval

The goal of the CryptoCloud project is to develop new interactive tools to provide privacy to the Cloud.

7.3.3. SAFEcrypto

Title: Secure Architectures of Future Emerging Cryptography

Program: H2020

Duration: January 2015 - January 2019

Coordinator: The Queen's University of Belfast

Partners:

Inria/ENS (France)

Emc Information Systems International (Ireland)

Hw Communications (United Kingdom)
The Queen's University of Belfast (United Kingdom)
Ruhr-Universitaet Bochum (Germany)
Thales Uk (United Kingdom)
Universita della Svizzera italiana (Switzerland)

Local coordinator: Vadim Lyubashevsky (until July 2015) and Michel Abdalla (from August 2015)

SAFEcrypto will provide a new generation of practical, robust and physically secure post quantum cryptographic solutions that ensure long-term security for future ICT systems, services and applications. Novel public-key cryptographic schemes (digital signatures, authentication, public-key encryption, identity-based encryption) will be developed using lattice problems as the source of computational hardness. The project will involve algorithmic and design optimisations, and implementations of the lattice-based cryptographic schemes addressing the cost, energy consumption, performance and physical robustness needs of resource-constrained applications, such as mobile, battery-operated devices, and of real-time applications such as network security, satellite communications and cloud. Currently a significant threat to cryptographic applications is that the devices on which they are implemented on leak information, which can be used to mount attacks to recover secret information. In SAFEcrypto the first analysis and development of physical-attack resistant methodologies for lattice-based cryptographic implementations will be undertaken. Effective models for the management, storage and distribution of the keys utilised in the proposed schemes (key sizes may be in the order of kilobytes or megabytes) will also be provided. This project will deliver proof-of-concept demonstrators of the novel lattice-based public-key cryptographic schemes for three practical real-world case studies with real-time performance and low power consumption requirements. In comparison to current state-of-the-art implementations of conventional public-key cryptosystems (RSA and Elliptic Curve Cryptography (ECC)), SAFEcrypto's objective is to achieve a range of lattice-based architectures that provide comparable area costs, a 10-fold speed-up in throughput for real-time application scenarios, and a 5-fold reduction in energy consumption for low-power and embedded and mobile applications.

7.3.4. ECRYPT-NET

Title: Advanced Cryptographic Technologies for the Internet of Things and the Cloud

Program: H2020 ITN

Duration: March 2015 – February 2019

Coordinator: KU Leuven (Belgium)

Partners:

KU Leuven (Belgium)
École Normale Supérieure (France)
Ruhr-Universität Bochum (Germany)
Royal Holloway, University of London (UK)
University of Bristol (UK)
CryptoExperts (France)
NXP Semiconductors (Belgium)
Technische Universiteit Eindhoven (the Netherlands)

Local coordinator: Michel Abdalla

ECRYPT-NET is a research network of six universities and two companies, as well as 7 associated companies, that intends to develop advanced cryptographic techniques for the Internet of Things and the Cloud and to create efficient and secure implementations of those techniques on a broad range of platforms.

7.3.5. aSCEND

Title: Secure Computation on Encrypted Data

Program: H2020 ERC Starting Grant

Duration: June 2015 – May 2020

PI: Hoeteck Wee

The goals of the aSCEND project are (i) to design pairing and lattice-based functional encryption that are more efficient and ultimately viable in practice; and (ii) to obtain a richer understanding of expressive functional encryption schemes and to push the boundaries from encrypting data to encrypting software.

7.4. Other Grants

- **Google: Google Research Award.**
Participant: Hoeteck Wee.

On the security of TLS. The goal of this project is to initiate a formal cryptographic treatment of new mechanisms and proposals for reducing the latency in the TLS Handshake Protocol and to enhance our cryptographic understanding of the TLS Handshake Protocol.

7.5. International Research Visitors

- Dennis Hofheinz (KIT, Germany)
- Melissa Chase (MSR Redmond)
- Mariana Raykova (Yale University)
- Phil Rogaway (UC Davis)
- Alexandra Boldyreva (Georgia Tech)

CRYPT Team

5. Partnerships and Cooperations

5.1. National Initiatives

5.1.1. MOST's 973 Grant

Grant 2013CB834205

PIs Phong Nguyen and Xiaoyun Wang

Duration 2013-17

MOST is China's Ministry of Science and Technology.

5.1.2. NSFC Grant

Grant NSFC Key Project 61133013

PIs Phong Nguyen and Xiaoyun Wang

Duration 2013-16

NSFC is the National Natural Science Foundation of China.

5.2. European Initiatives

5.2.1. Collaborations with Major European Organizations

CWI: Cryptography team of Ronald Cramer (Netherlands). This team is officially a partner of LIAMA's CRYPT international project.

5.3. International Initiatives

5.3.1. Inria International Labs

- CRYPT is an international project from LIAMA in China, hosted by Tsinghua University in Beijing. It is a joint project between Inria, Tsinghua University, CAS Academy of Mathematics and System Sciences, and CWI (Netherlands).
- Phong Nguyen was the European director of LIAMA until October 2015.

5.3.2. Inria International Partners

5.3.2.1. Informal International Partners

- Univ. Oklahoma, USA
- Univ. Wisconsin, USA

5.4. International Research Visitors

5.4.1. Visits of International Scientists

Cheng Qi (Univ. Oklahoma, USA)

Guangwu Xu (Univ. Wisconsin, USA)

5.4.2. Visits to International Teams

5.4.2.1. Research stays abroad

Yang Yu visited CWI for 3 months in Fall 2015.

DEDUCTEAM Team

8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. ANR Locali

We are coordinators of the ANR-NFSC contract Locali with the Chinese Academy of Sciences.

8.1.2. ANR BWare

We are members of the ANR BWare, which started on September 2012 (David Delahaye is the national leader of this project). The aim of this project is to provide a mechanized framework to support the automated verification of proof obligations coming from the development of industrial applications using the B method. The methodology used in this project consists in building a generic platform of verification relying on different theorem provers, such as first-order provers and SMT solvers. We are in particular involved in the introduction of Deduction modulo in the first-order theorem provers of the project, i.e. Zenon and iProver, as well as in the backend for these provers with the use of Dedukti.

8.1.3. ANR Tarmac

We are members of the ANR Tarmac on models of computation, coordinated by Pierre Valarcher.

8.2. International Research Visitors

8.2.1. Visits of International Scientists

Jim Lipton, professor at Wesleyan University (USA) has visited Deducteam from 9 to 14 March 2015.

8.2.1.1. Internships

Gaetan Gilbert did an internship with Arnaud Spiwack and Olivier Hermant.

Shuai Wang did an internship with Gilles Dowek.

Éric Uzena did an internship with Arnaud Spiwack and David Delahaye.

8.2.2. Visits to International Teams

8.2.2.1. Sabbatical programme

Olivier Hermant is a visiting professor at Wesleyan University (USA) since September 2015.

GALLIUM Project-Team

9. Partnerships and Cooperations

9.1. National Initiatives

9.1.1. ANR projects

9.1.1.1. BWare

Participants: Damien Doligez, Fabrice Le Fessant.

The “BWare” project (2012–2016) is coordinated by David Delahaye at Conservatoire National des Arts et Métiers and funded by the *Ingénierie Numérique et Sécurité* programme of *Agence Nationale de la Recherche*. BWare is an industrial research project that aims to provide a mechanized framework to support the automated verification of proof obligations coming from the development of industrial applications using the B method and requiring high guarantees of confidence.

9.1.1.2. Verasco

Participants: Jacques-Henri Jourdan, Xavier Leroy.

The “Verasco” project (2012–2016) is coordinated by Xavier Leroy and funded by the *Ingénierie Numérique et Sécurité* programme of *Agence Nationale de la Recherche*. The objective of this 4.5-year project is to develop and formally verify a static analyzer based on abstract interpretation, and interface it with the CompCert C verified compiler.

9.1.1.3. Vocal

Participants: Xavier Leroy, François Pottier.

The “Vocal” project (2015–2020) aims at developing the first mechanically verified library of efficient general-purpose data structures and algorithms. It is funded by *Agence Nationale de la Recherche* under its “appel à projets générique 2015”.

The library will be made available to all OCaml programmers and will be of particular interest to implementors of safety-critical OCaml programs, such as Coq, Astrée, Frama-C, CompCert, Alt-Ergo, as well as new projects. By offering verified program components, our work will provide the essential building blocks that are needed to significantly decrease the cost of developing new formally verified programs.

9.1.2. FSN projects

9.1.2.1. ADN4SE

Participants: Damien Doligez, Martin Riener.

The “ADN4SE” project (2012–2016) is coordinated by the Sherpa Engineering company and funded by the *Briques Génériques du Logiciel Embarqué* programme of *Fonds national pour la Société Numérique*. The aim of this project is to develop a process and a set of tools to support the rapid development of embedded software with strong safety constraints. Gallium is involved in this project to provide tools and help for the formal verification in TLA+ of some important aspects of the PharOS real-time kernel, on which the whole project is based.

9.1.2.2. CEEC

Participants: Maxime Dénès, Xavier Leroy.

The “CEEC” project (2011–2015) is coordinated by the Prove & Run company and also involves Esterel Technologies and Trusted Labs. It is funded by the *Briques Génériques du Logiciel Embarqué* programme of *Fonds national pour la Société Numérique*. The CEEC project develops an environment for the development and certification of high-security software, centered on a new domain-specific language designed by Prove & Run. Our involvement in this project focuses on the formal verification of a C code generator for this domain-specific language, and its interface with the CompCert C verified compiler.

9.1.3. FUI Projects

9.1.3.1. Secur-OCaml

Participants: Damien Doligez, Fabrice Le Fessant.

The “Secur-OCaml” project (2015–2018) is coordinated by the OCamlPro company, with a consortium focusing on the use of OCaml in security-critical contexts, while OCaml is currently mostly used in safety-critical contexts. Gallium is involved in this project to integrate security features in the OCaml language, to build a new independent interpreter for the language, and to update the recommendations for developers issued by the former LaFoSec project of ANSSI.

9.2. European Initiatives

9.2.1. FP7 & H2020 Projects

9.2.1.1. Deepsea

Participants: Umut Acar, Vitalii Aksenov, Arthur Charguéraud, Mike Rainey, Filip Sieczkowski.

The Deepsea project (2013–2018) is coordinated by Umut Acar and funded by FP7 as an ERC Starting Grant. Its objective is to develop abstractions, algorithms and languages for parallelism and dynamic parallelism, with applications to problems on large data sets.

9.2.2. ITEA3 Projects

9.2.2.1. Assume

Participants: Xavier Leroy, Luc Maranget.

ASSUME (2015–2018) is an ITEA3 project involving France, Germany, Netherlands, Turkey and Sweden. The French participants are coordinated by Jean Souyris (Airbus) and include Airbus, Kalray, Sagem, ENS Paris, and Inria Paris. The goal of the project is to investigate the usability of multicore and manycore processors for critical embedded systems. Our involvement in this project focuses on the formalisation and verification of memory models and of automatic code generators from reactive languages.

9.3. International Initiatives

9.3.1. Inria International Partners

9.3.1.1. Informal International Partners

- Princeton University: interactions between the CompCert verified C compiler and the Verified Software Toolchain developed at Princeton.
- Cambridge University and Microsoft Research Cambridge: formal modeling and testing of weak memory models.

9.4. International Research Visitors

9.4.1. Visits of International Scientists

9.4.1.1. Research stays abroad

From November 2014 to June 2015, Damien Doligez was on a sabbatical at Jane Street (New York, USA), a financial company (a member of the Caml Consortium) that invests considerable R&D in the OCaml language and system.

MUTANT Project-Team

8. Partnerships and Cooperations

8.1. National Projects

8.1.1. ANR INEDIT Project

Title: Interactivity in the Authoring of Time and Interactions

Project acronym: INEDIT

Type: ANR Contenu et Interaction 2012 (CONTINT)

Instrument: ANR Grant

Duration: September 2012 - November 2015

Coordinator: IRCAM (France)

Other partners: **Grame** (Lyon, France), **LaBRI** (Bordeaux, France).

Abstract: The INEDIT project aims to provide a scientific view of the interoperability between common tools for music and audio productions, in order to open new creative dimensions coupling *authoring of time* and *authoring of interaction*. This coupling allows the development of novel dimensions in interacting with new media. Our approach lies within a formal language paradigm: An interactive piece can be seen as a virtual interpreter articulating locally synchronous temporal flows (audio signals) within globally asynchronous event sequence (discrete timed actions in interactive composition). Process evaluation is then to respond reactively to signals and events from an environment with heterogeneous actions coordinated in time and space by the interpreter. This coordination is specified by the composer who should be able to express and visualize time constraints and complex interactive scenarios between mediums. To achieve this, the project focuses on the development of novel technologies: dedicated multimedia schedulers, runtime compilation, innovative visualization and tangible interfaces based on augmented paper, allowing the specification and realtime control of authored processes. Among posed scientific challenges within the INEDIT project is the formalization of temporal relations within a musical context, and in particular the development of a GALS (Globally Asynchronous, Locally Synchronous) approach to computing that would bridge in the gap between synchronous and asynchronous constraints with multiple scales of time, a common challenge to existing multimedia frameworks.

8.1.2. ANR EFFICACE Project

Florent Jacquemard participates actively in the **Efficace ANR Project**. This project explores the relations between computation, time and interactions in computer-aided music composition, using OpenMusic and other technologies developed at IRCAM and at CNMAT (UC Berkeley). The participant consider computer-aided composition out of its traditional "offline" paradigm, and try to integrate compositional processes in structured interactions with their external context. These interactions can take place during executions or performances, or at the early compositional stages (in the processes that lead to the creation of musical material). There are particular focus on a number of specific directions, such as the reactive approaches for computer-aided composition, the notion of dynamic time structures in computation and music, rhythmic and symbolic time structures, or the interactive control, visualisation and execution of sound synthesis and spatialization processes [23].

8.1.3. Other National Initiatives

Jean-Louis Giavitto participates in the **SynBioTIC** ANR Blanc project (with IBISC, University of Evry, LAC University of Paris-Est, ISC - Ecole Polytechnique).

The MuTant team is also an active member of the [ANR CHRONOS Network](#) by Gérard Berry, Collège de France).

8.2. European Initiatives

8.2.1. Collaborations in European Programs, except FP7 & H2020

Program: PHC Amadeus ()

Project acronym: LETITBE

Project title: Logical Execution Time for Interactive And Composition Assistance Music Systems

Duration: 01/2015 - 12/2016

Coordinator: Florent Jacquemard, Christoph Kirsch

Other partners: Department of Computer Sciences University of Salzburg, Austria

Abstract: The objective of this project is to contribute to the development of computer music systems supporting advanced temporal structure in music and advanced dynamics in interactivity. For this purpose we are proposing to re-design and re-engineer computer music systems (from IRCAM at Paris) using advanced notions of time and their software counterparts developed for safety-critical embedded systems (from University of Salzburg). In particular, we are applying the so-called logical execution time paradigm as well as its accompanying time safety analysis, real-time code generation, and portable code execution to computer music systems. Timing in music is obviously very important. Advanced treatment of time in safety-critical embedded systems has helped address extremely challenging problems such as predictability and portability of real-time code. We believe similar progress can be made in computer music systems potentially enabling new application areas. The objective of the project is ideally suited for a collaboration of partners with complementary expertise in computer music and real-time systems.

8.3. International Initiatives

8.3.1. Inria International Labs projects

MuTant team hosted a Master Level student from the [Inria Chile Center](#) in partnership with the *Pontificia Universidad Catolica de Chile*. The project, undertaken by Nicolas Schmidt Gubbins and supervised by Arshia Cont and Jean-Louis Giavitto, ended in the first prototype of an embedded *Antescofo* engine (see [7.7](#)) with internal audio processing on Raspberry PI and UDOO mini-computers ([See Presentation Video](#)). A publication of preliminary results is underway and early results reported in [\[29\]](#).

8.3.2. Informal International Partners

- We are pursuing a long term collaboration with Masahiko Sakai (U. Nagoya) on term rewriting techniques and applications (in particular applications related to rhythm notation) [\[14\]](#), [\[17\]](#).
- We are collaborating with Slawek Staworko (LINKS, currently on leave at U. Edinburgh), and more generally the Algomus group at Lille, in the context of our projects on rhythm transcription described at [Sections 6.4](#) and [7.10](#).
- MuTant team collaborates with *Bucharest Polytechnic University*, in the framework of Grig Burloiu's PhD Thesis on *AscoGraph* UIX design which has resulted in a the new design of *AscoGraph* (see [6.2](#)) and two publications [\[12\]](#), [\[13\]](#).
- MuTant team collaborated with researchers at National Institute of Informatics of Tokyo on real-time Symbolic Alignment of music data resulting in the publication in [\[19\]](#).

8.4. International Research Visitors

Masahiko Sakai (Professor at the University of Nagoya) visited MuTant for two weeks in September 20154, for collaboration on term rewriting techniques applied to tree-structured symbolic representations of rhythm.

Slawek Staworko (LINKS, on leave at U. of Edinburgh) visited MuTant for two weeks in September and December 2015, for collaborations on the problem of automatic rhythm transcription.

Professor Miller Puckette (UCSD) visited MuTant for two weeks in May 2015, participating in the PhD defense of José Echeveste and collaborating with the team on the new Audio Processing engine for embedded mini-computers.

8.4.1. Internships

The MuTant team hosted an International Internship from *Pontificia Universidad Catolica de Chile*, Nicolas Schmidt, working on the first instances of embedded Antescofo Audio Engine ([See Presentation Video](#)) (see also [7.7](#)) [[29](#)].

PARKAS Project-Team

8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. ANR

ANR WMC project (program “jeunes chercheuses, jeunes chercheurs”), 2012–2016, 200 Keuros. F. Zappa Nardelli is the main investigator.

ANR Boole project (program “action blanche”), 2009-2014.

ANR CAFEIN, 2013-2015. Marc Pouzet.

8.1.2. Investissements d’avenir

Sys2Soft contract (Briques Génériques du Logiciel Embarqué). Partenaire principal: Dassault-Systèmes, etc. Inria contacts are Benoit Caillaud (HYCOMES, Rennes) and Marc Pouzet (PARKAS, Paris).

ManycoreLabs contract (Briques Génériques du Logiciel Embarqué). Partenaire principal: Kalray. Inria contacts are Albert Cohen (PARKAS, Paris), Alain Darté (COMPSYS, Lyon), Fabrice Rastello (CORSE, Grenoble).

8.1.3. Others

Marc Pouzet is scientific advisor for the Esterel-Technologies/ANSYS company.

8.2. European Initiatives

8.2.1. FP7 & H2020 Projects

8.2.1.1. Eurolab-4-HPC

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

Program: H2020

Duration: September 2015 - September 2017

Coordinator: CHALMERS TEKNISKA HOEGSKOLA AB

Partners:

Barcelona Supercomputing Center - Centro Nacional de Supercomputacion (Spain)

Chalmers Tekniska Hoegskola (Sweden)

Ecole Polytechnique Federale de Lausanne (Switzerland)

Eidgenoessische Technische Hochschule Zuerich (Switzerland)

Foundation for Research and Technology Hellas (Greece)

Universitaet Stuttgart (Germany)

Rheinisch-Westfaelische Technische Hochschule Aachen (Germany)

Technion - Israel Institute of Technology (Israel)

Universitaet Augsburg (Germany)

The University of Edinburgh (United Kingdom)

Universiteit Gent (Belgium)

The University of Manchester (United Kingdom)

Inria contact: Albert Cohen

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

8.2.1.2. TETRACOM

Title: Technology Transfer in Computing Systems

Program: FP7

Duration: September 2013 - August 2016

Coordinator: RHEINISCH-WESTFAELISCHE TECHNISCHE HOCHSCHULE AACHEN

Partners:

Imperial College of Science, Technology and Medicine (United Kingdom)

Rheinisch-Westfaelische Technische Hochschule Aachen (Germany)

Technische Universiteit Delft (Netherlands)

Tty-Saatio (Finland)

Universita di Pisa (Italy)

Inria contact: Albert Cohen

The mission of the TETRACOM Coordination Action is to boost European academia-to-industry technology transfer (TT) in all domains of Computing Systems. While many other European and national initiatives focus on training of entrepreneurs and support for start-up companies, the key differentiator of TETRACOM is a novel instrument called Technology Transfer Project (TTP). TTPs help to lower the barrier for researchers to make the first steps towards commercialisation of their research results. TTPs are designed to provide incentives for TT at small to medium scale via partial funding of dedicated, well-defined, and short term academia-industry collaborations that bring concrete R&D results into industrial use. This will be implemented via competitive Expressions-of-Interest (EoI) calls for TTPs, whose coordination, prioritization, evaluation, and management are the major actions of TETRACOM. It is expected to fund up to 50 TTPs. The TTP activities will be complemented by Technology Transfer Infrastructures (TTIs) that provide training, service, and dissemination actions. These are designed to encourage a larger fraction of the R&D community to engage in TTPs, possibly even for the first time. Altogether, TETRACOM is conceived as the major pilot project of its kind in the area of Computing Systems, acting as a TT catalyst for the mutual benefit of academia and industry. The projects primary success metrics are the number and value of coordinated TTPs as well as the amount of newly introduced European TT actors. It is expected to acquire around more than 20 new contractors over the project duration. TETRACOM complements and actually precedes the use of existing financial instruments such as venture capital or business angels based funding.

8.2.1.3. COPCAMS

Title: COgnitive & Perceptive CAMeraS

Program: FP7

Duration: April 2013 - March 2016

Coordinator: __COORDINATOR__???

Partners:

Aselsan Elektroniknayi Ve Ticaret A.S. (Turkey)
 Application Solutions (electronics and Vision) Ltd (United Kingdom)
 Bs Spolka Z Ograniczona Odpowiedzialnoscia Spolka Komandytowa (Poland)
 Concatel SI (Spain)
 Commissariat A L Energie Atomique et Aux Energies Alternatives (France)
 Centre Tecnologic de Telecomunicacions de Catalunya (Spain)
 Politechnika Gdanska (Poland)
 Information and Image Management Systems (Spain)
 Institut Jozef Stefan (Slovenia)
 Iquadrat Informatica SI (Spain)
 "kolektor Group D.O.O., Vodenje in Upravljanje Družb" (Slovenia)
 Queen Mary University of London (United Kingdom)
 Danmarks Tekniske Universitet (Denmark)
 Sogilis (France)
 Squadrone System (France)
 Stmicroelectronics Grenoble 2s (France)
 Fundacion Tecnalía Research & Innovation (Spain)
 Tedesys Global Sociedad Limitada (Spain)
 Thales Communications & Securitys (France)
 Thales (France)
 Thales Research & Technology (uk) (United Kingdom)
 Universidad de Cantabria (Spain)
 Wavelens (France)

Inria contact: Albert Cohen

'Vision systems are becoming ubiquitous in our daily lives. Complex analysis of images from multiple cameras will become the norm in the future, from cars to industrial systems, from smart cities to facility monitoring, aimed at extracting meaningful, context-dependent information. Today's market is dominated by a combination of relatively simple, fixed function, configurable cameras that stream video to PC-based (and in some cases small embedded) gateways. These systems cannot scale beyond a certain size because of power consumption and the aggregate networking bandwidth required to stream videos to servers, where aggregated video analysis is performed. So the trend for visual analytics functions is that they get executed at the edge of these complex vision systems, e.g. in the cameras themselves. The Cognitive and Perceptive Camera Systems (COPCAMS) proposal leverages recent advances in embedded computing platforms to design, prototype and field-test full large-scale vision systems. It aims at exploiting a new many-core programmable accelerator platform to power a new generation of vision related devices (smart cameras and gateways), able to extract relevant information from captured images and autonomously react to the sensed environment by interoperating at large scale in a distributed manner. Date of approval by ARTEMIS JU: 7/04/2015.'

8.2.1.4. EMC2

Title: Embedded Multi-Core Systems for Mixed Criticality Applications in Dynamic and Changeable Real-Time Environments

Program: FP7

Duration: April 2014 - March 2017

Coordinator: Infineon Technologies

Partners:

Aicas (Germany)
Avl Software and Functions (Germany)
Denso Automotive Deutschland (Germany)
Elektrobit Automotive (Germany)
Evision Systems (Germany)
Nxp Semiconductors Germany (Germany)
Tttech Computertechnik (Austria)
"kompetenzzentrum - Das Virtuelle Fahrzeug, Forschungsgesellschaft Mbh" (Austria)
Frequentis (Austria)
Thales Austria (Austria)
Blueice Bvba (Belgium)
Freescale Polovodice Ceska Republika Sro (Czech Republic)
Institut Mikroelektronických Aplikací S.R.O. (Czech Republic)
Sysgo Sro (Czech Republic)
Silkan Rt (France)
"united Technologies Research Centre Ireland," (Ireland)
Mbd Italia Spa (Italy)
Fornebu Consulting As (Norway)
Westerngeco As (Norway)
Simula Research Laboratory As (Norway)
Ixion Industry and Aerospace SI (Spain)
Visure Solutions SI (Spain)
Seven Solutions SI (Spain)
Telvent Energia (Spain)
Instituto Tecnológico de Informática (Spain)
Ambar Telecomunicaciones SI (Spain)
Sics Swedish Ict (Sweden)
Arcticus Systems (Sweden)
Arccore (Sweden)
Xdin Stockholm (Sweden)
Systemite (Sweden)
Stichting Imec Nederland (Netherlands)
Tomtom International Bv (Netherlands)
Infineon Technologies Uk Ltd (United Kingdom)
Sundance Multiprocessor Technology Ltd (United Kingdom)
Systemomy (United Kingdom)
Ensilica Ltd (United Kingdom)
Test and Verification Solutions Ltd (United Kingdom)
Abb (Sweden)
Ait Austrian Institute of Technology (Austria)

Alenia Aermacchi Spa (Italy)
Avl List (Austria)
Airbus Defence and Space (Germany)
Bayerische Motoren Werke Aktiengesellschaft (Germany)
Consorzio Interuniversitario Nazionale Per l'Informatica (Italy)
Critical Software (Portugal)
Chalmers Tekniska Hoegskola (Sweden)
Danfoss Power Electronics As (Denmark)
Ericsson (Sweden)
Centro Ricerche Fiat (Italy)
Fraunhofer-Gesellschaft Zur Foerderung Der Angewandten Forschung E.V (Germany)
Hi Iberia Ingenieria Y Proyectos SI (Spain)
Harokopio University (Greece)
Infineon Technologies Austria (Austria)
"inesc Id - Instituto de Engenhariade Sistemas E Computadores, Investigacao E Desenvolvimento Em Lisboa Associacao" (Portugal)
Infineon Technologies (Germany)
Integrasys (Spain)
Instituto Superior de Engenharia Do Porto (Portugal)
Kungliga Tekniska Hoegskolan (Sweden)
Lulea Tekniska Universitet (Sweden)
Magillem Design Servicess (France)
Nxp Semiconductors Netherlands Bv (Netherlands)
Offis E.V. (Germany)
Politecnico di Torino (Italy)
Philips Medical Systems Nederland Bv (Netherlands)
Quobis Networks SI (Spain)
Rockwell Collins France (France)
Rigas Tehniska Universitate (Latvia)
Selex Es Spa (Italy)
Siemens Aktiengesellschaft (Germany)
Systematic Paris Region Association (France)
Sysgo (Germany)
Thales Alenia Space Italia Spa (Italy)
"thales Alenia Space Espana," (Spain)
Technolution B.V. (Netherlands)
Thales Avionicss (France)
Nederlandse Organisatie Voor Toegepast Natuurwetenschappelijk Onderzoek Tno (Netherlands)
Technische Universitaet Wien (Austria)
Technische Universiteit Eindhoven (Netherlands)
Technische Universitat Braunschweig (Germany)

Technische Universiteit Delft (Netherlands)
 Technische Universität Dortmund (Germany)
 Universitetet I Oslo (Norway)
 Technische Universität Kaiserslautern (Germany)
 University of Limerick (Ireland)
 Università Degli Studi di Genova (Italy)
 Università Degli Studi Dell'aquila (Italy)
 University of Bristol (United Kingdom)
 The University of Manchester (United Kingdom)
 "ústav Teorie Informace A Automatizace Av Cr, V.V.I." (Czech Republic)
 Vector Fabrics Bv (Netherlands)
 Volvo Technology (Sweden)
 Vysoke Ucení Technické V Brně (Czech Republic)

Inria contact: Albert Cohen

Embedded systems are the key innovation driver to improve almost all mechatronic products with cheaper and even new functionalities. Furthermore, they strongly support today's information society as inter-system communication enabler. Consequently boundaries of application domains are alleviated and ad-hoc connections and interoperability play an increasing role. At the same time, multi-core and many-core computing platforms are becoming available on the market and provide a breakthrough for system (and application) integration. A major industrial challenge arises facing (cost) efficient integration of different applications with different levels of safety and security on a single computing platform in an open context. The objective of the EMC² project (Embedded multi-core systems for mixed criticality applications in dynamic and changeable real-time environments) is to foster these changes through an innovative and sustainable service-oriented architecture approach for mixed criticality applications in dynamic and changeable real-time environments. The EMC2 project focuses on the industrialization of European research outcomes and builds on the results of previous ARTEMIS, European and National projects. It provides the paradigm shift to a new and sustainable system architecture which is suitable to handle open dynamic systems. EMC² is part of the European Embedded Systems industry strategy to maintain its leading edge position by providing solutions for: . Dynamic Adaptability in Open Systems . Utilization of expensive system features only as Service-on-Demand in order to reduce the overall system cost. . Handling of mixed criticality applications under real-time conditions . Scalability and utmost flexibility . Full scale deployment and management of integrated tool chains, through the entire lifecycle Approved by ARTEMIS-JU on 12/12/2013 for EoN. Minor mistakes and typos corrected by the Coordinator, finally approved by ARTEMIS-JU on 24/01/2014. Amendment 1 changes approved by ECSEL-JU on 31/03/2015.

8.2.2. Collaborations in European Programs, except FP7 & H2020

8.2.2.1. EMC2

Title: Affordable Safe & Secure Mobility Evolution – ASSUME

Program: Eureka ITEA3

Duration: April 2014 - March 2017

Coordinator: Siemens

Partners:

Inria

ENS Paris

Thales RT

Airbus

Esterel Technologies

Kalray

And many European partners

Inria contact: Dumitru Potop-Butucaru

Future mobility solutions will increasingly rely on smart components that continuously monitor the environment and assume more and more responsibility for a convenient, safe and reliable operation. In order to realize this vision, the need for computing power will drastically increase beyond what can be provided by conventional sequential single-core hardware. While the required efficiency and scalability makes it mandatory for future embedded micro-controllers to rely on multi- and many-core architectures, the change in hardware architecture also entails fundamental changes to state of the art software development methodology. Replacing today's essentially sequential technology by omnipresent communication between cores poses the tremendous challenge in software development to identify and exploit opportunities for concurrency in a way which still guarantees reliable and predictable behavior. Aside from the evolution of new hardware architectures, software development must address the increasing level of complexity of new highly automatic mobility solutions. For automotive, the self-driving car is the next big revolution and it is still unclear how functional and non-functional guarantees can be given for this new class of assistance functions. European industry heavily relies on the premium market segments. In these segments, innovative functions are the most important factor to influence buying decisions. New competitors, e.g. Google, enter the stage and challenge the established industry with eager visions. However, the single most important roadblock for this market is the ability to come up with an affordable, safe multi-core development methodology that allows industry to deliver trustworthy new functions at competitive prices. The ASSUME algorithm portfolio will be the key technology to bring innovative solutions from sandboxes into consumers' daily lives. ASSUME provides a seamless engineering methodology to overcome this roadblock. The problem is addressed on the constructive and on the analytic side. For efficient construction and synthesis of embedded systems, the project provides new tools, standards and methodologies to cover most of the challenges by design. In addition, ASSUME provides a well-integrated sound static analysis solution that allows proving the absence of problems even in a multi-core environment. New algorithms will be integrated in exploitable tools. New interoperability standards and requirements formalization standards will facilitate cooperation between different market players. The ASSUME consortium includes leading European industry partners for mobility solutions, tool and service providers for embedded system development as well as leading research institutes for static analysis for model-driven and traditional embedded systems development.

8.2.3. Collaborations with Major European Organizations

Albert Cohen is an external member of the ARTEMIS-IA Working Group. Collaborating on the writing of the association's Strategic Research Agenda (SRA), and the ECSEL JU Multi-Annual Research and Innovation Agenda (MASRIA).

<https://artemis-ia.eu>

8.3. International Initiatives

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

8.3.1.1. POLYFLOW

Title: Polyhedral Compilation for Data-Flow Programming Languages

International Partner (Institution - Laboratory - Researcher):

IISc Bangalore (India) - Department of Computer Science and Automation (CSA) - Uday Kumar Reddy Bondhugula

Start year: 2013

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

Polyhedral techniques for program transformation are now used in several proprietary and open source compilers. However, most of the research on polyhedral compilation has focused on imperative languages such as C, where computation is specified in terms of statements with zero or more nested loops and other control structures around them. Graphical data-flow languages, where there is no notion of statements or a schedule specifying their relative execution order, have so far not been studied using a powerful transformation or optimization approach. These languages are extremely popular in system analysis, modeling and design, in embedded reactive control. They also underline the construction of many domain-specific languages and compiler intermediate representations. The copy and execution semantics of data-flow languages impose a different set of challenges. We plan to bridge this gap by studying techniques that could enable extraction of a polyhedral representation from data-flow programs, transform them, and synthesize them from their equivalent polyhedral representation.

An extension for 3 more years has been requested. It may be partly funded by CEFIPRA.

8.3.2. Inria International Partners

8.3.2.1. Informal International Partners

Prof. Uday Bondhugula, CSA department, Indian Institute of Science, India. See POLYFLOW associate team for details.

Prof. P. Sadayappan, CS department, Ohio State University, USA. Joint publications, frequent visits, occasionally for several weeks.

Prof. M. Sheeran, Computer Science and Engineering Department, Chalmers University of Technology, Sweden. Regular visits. Continuing exchanges on languages and compilation for synchronous and hybrid systems.

Prof. C. Tinelli, CS department, University of IOWA, USA. Regular visits. Continuing exchanges on the verification of synchronous languages and programs.

Prof. R. von Hanxleden, Director at the Department of Computer Science, Head of the Real-Time and Embedded Systems Group, Kiel University, Germany. Regular visits and scientific collaboration.

Prof. M. Mandler, Head of the Informatics Theory Group, Bamberg University, Germany. Regular visits and scientific collaboration.

Dr. Sven Verdoolaege, CS department, K. U. Leuven, Belgium. Joint steering of the Polly Labs initiative and contractual cooperation in this context.

Dr. Tobias Grosser in the group of Prof. Torsten Hoeffler, ETH Zürich. Joint steering of the Polly Labs initiative. See Polly Labs for details.

Pr. Peter Sewell, Computer Laboratory, University of Cambridge, UK. Regular visits and scientific collaboration.

Pr. Jan Vitek, College of Computer & Information Science Northeastern University, USA. Regular visits and scientific collaboration.

8.3.3. Participation In other International Programs

The POLYFLOW associate team has been extended for up to 3 years on January 1st 2016, in collaboration with CEFIPRA (<http://cefipraonline.in>).

8.4. International Research Visitors

8.4.1. Visits of International Scientists

Prof. Michael Mandler, Univ. Bamberg, Germany, spent one month as an invited professor in the team in March 2015.

Dr. Artjoms Sinkarovs, Heriot Watt University, UK, spent 2 months as an visiting scholar in Summer 2015.

8.4.1.1. Internships

Abhishek Jain, 4th year student from IIT Delhi, visited us for 1 and a half months in January 2015.

Chaitanya Malaviya, 3rd year student from Nanyang Technological University, visited us for 2 months in July and August 2015.

8.4.2. Visits to International Teams

8.4.2.1. Research stays abroad

Marc Pouzet spent 15 days in the group of Prof. M. Mendler at Bamberg University in July 2015.

Albert Cohen spent 1 month in the group of Prof. P. Sadayappan at Ohio State University, in April–May 2015. One paper was accepted to the ACM PLDI 2016 conference as a result of this collaboration.

Timothy Bourke spent 1 week in the group of Prof. C. Tinelli at The University of Iowa in December 2015.

PI.R2 Project-Team

7. Partnerships and Cooperations

7.1. National Initiatives

Alexis Saurin (coordinator) and Yann Régis-Gianas are members of the four-year RAPIDO ANR project accepted in 2014 and starting in January 2015. RAPIDO aims at investigating the use of proof-theoretical methods to reason and program on infinite data objects. The goal of the project is to develop logical systems capturing infinite proofs (proof systems with least and greatest fixed points as well as infinitary proof systems), to design and to study programming languages for manipulating infinite data such as streams both from a syntactical and semantical point of view. Moreover, the ambition of the project is to apply the fundamental results obtained from the proof-theoretical investigations (i) to the development of software tools dedicated to the reasoning about programs computing on infinite data, *e.g.* stream programs (more generally coinductive programs), and (ii) to the study of properties of automata on infinite words and trees from a proof-theoretical perspective with an eye towards model-checking problems. Other permanent members of the project are Christine Tasson from PPS, David Baelde from LSV, ENS-Cachan, and Pierre Clairambault, Damien Pous and Colin Riba from LIP, ENS-Lyon.

Pierre-Louis Curien (coordinator), Yves Guiraud and Philippe Malbos are members of the three-year Focal project of the IDEX Sorbonne Paris Cité, started in June 2013. This project, giving the support for the PhD grant of Cyrille Chenavier, concerns the interactions between higher-dimensional rewriting and combinatorial algebra. This project is joint with members of the LAGA (Laboratory of Mathematics, Univ. Paris 13).

Pierre-Louis Curien (coordinator), Yves Guiraud and Philippe Malbos are members of the four-year Cathre ANR project, started in January 2014. This project, giving the support for the PhD grant of Maxime Lucas, investigates the general theory of higher-dimensional rewriting, the development of a general-purpose library for higher-dimensional rewriting, and applications in the fields of combinatorial algebra, combinatorial group theory and theoretical computer science. This project is joint with members of the LAGA (Univ. Paris 13), the LIX (École Polytechnique), the ICJ (Univ. Lyon 1 and Univ. Saint-Étienne), the I2M (Univ. Aix-Marseille) and the IMT (Univ. Toulouse 3).

Pierre-Louis Curien, Yves Guiraud (local coordinator) and Matthieu Sozeau are members of the Groupement de Recherche Topologie Algébrique, federating French researchers working on classical topics of algebraic topology and homological algebra, such as homotopy theory, group homology, K-theory, deformation theory, and on more recent interactions of topology with other themes, such as higher categories, motivic homotopy, string theory.

Matthieu Sozeau, Hugo Herbelin, Lourdes del Carmen González Huesca and Yann Régis-Gianas were members of the ANR Paral-ITP, which started in November 2011 and ended in June 2015, and aimed at preparing the Coq and Isabelle interactive theorem provers to a new generation of user interfaces thanks to massive parallelism and incremental type-checking.

Hugo Herbelin is the coordinator of the PPS site for the ANR Récré accepted in 2011, which started in January 2012 and will end mid 2016. Récré is about realisability and rewriting, with applications to proving with side-effects and concurrency.

Yann Régis-Gianas collaborates with Mitsubishi Rennes on the topic of differential semantics. This collaboration led to the CIFRE grant for the PhD of Thibaut Girka.

Yann Régis-Gianas is a member of the ANR COLIS dedicated to the verification of Linux Distribution installation scripts. This project is joint with members of VALS (Univ Paris Sud) and LIFL (Univ Lille).

Matthieu Sozeau is a member of the CoqHoTT project led by Nicolas Tabareau (Ascola team, École des Mines de Nantes), funded by an ERC Starting Grant. The PhD grant of Gabriel Lewertowski is funded by the CoqHoTT ERC.

7.2. European Initiatives

7.2.1. Collaborations in European Programs, except FP7 & H2020

Pierre-Louis Curien, Yves Guiraud and Philippe Malbos are collaborators of the Applied and Computational Algebraic Topology (ACAT) networking programme of the European Science Foundation.

7.3. International Initiatives

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

Pierre-Louis Curien and Claudia Faggian (external collaborator) participate to the Associated Team CRECOGI (Concurrent, Resourceful and Effectful Computation, by Geometry of Interaction) between the project-team Focus (Bologna) and the University of Tokyo (principal investigators Ugo dal Lago and Ichiro Hasuo) (started in 2015).

7.3.2. Inria International Partners

7.3.2.1. Informal International Partners

The project-team has collaborations with University of Aarhus (Denmark), University of Oregon, University of Tokyo, University of Novi Sad and the Institute of Mathematics of the Serbian Academy of Sciences, University of Nottingham, Institute of Advanced Study, MIT, the University of Cambridge, and Universidad Nacional de Córdoba.

7.3.3. Participation In other International Programs

Pierre-Louis Curien participates to the ANR International French-Chinese project LOCALI (Logical Approach to Novel Computational Paradigms), coordinated by Gilles Dowek.

7.4. International Research Visitors

7.4.1. Visits of International Scientists

Andrej Bauer (University of Novi Sad) visited πr^2 and PPS for one month in September 2015 to collaborate with Matthieu Sozeau.

7.4.2. Internships

Akira Yoshimizu had a six-month Inria international internship (Nov 2014 - April 2015). He worked on abstract machines for the geometry of synchronisation, a variation of Girard's geometry of interaction that incorporates synchronisation and that is fit for dealing with quantum primitives added to a functional language, and coauthored a paper at LICS 2015 with Ugo Dal Lago, Claudia Faggian, and Benoît Valiron [56].

POLSYS Project-Team

8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. ANR

- **ANR Grant HPAC: High Performance Algebraic Computing (2012-2016).** The pervasive ubiquity of parallel architectures and memory hierarchy has led to a new quest for parallel mathematical algorithms and software capable of exploiting the various levels of parallelism: from hardware acceleration technologies (multi-core and multi-processor system on chip, GPGPU, FPGA) to cluster and global computing platforms. For giving a greater scope to symbolic and algebraic computing, beyond the optimization of the application itself, the effective use of a large number of resources (memory and specialized computing units) is expected to enhance the performance multi-criteria objectives: time, resource usage, reliability, even energy consumption. The design and the implementation of mathematical algorithms with provable, adaptive and sustainable performance is a major challenge. In this context, this project is devoted to fundamental and practical research specifically in exact linear algebra and system solving that are two essential "dwarfs" (or "killer kernels") in scientific and algebraic computing. The project should lead to progress in matrix algorithms and challenge solving in cryptology, and should provide new insights into high performance programming and library design problems (J.-C. Faugère [contact], L. Perret, G. Renault, M. Safey El Din).
- **ANR Grant GeoLMI: Geometry of Linear Matrix Inequalities (2011-2015).** GeoLMI project aims at developing an algebraic and geometric study of linear matrix inequalities (LMI) for systems control theory. It is an interdisciplinary project at the border between information sciences (systems control), pure mathematics (algebraic geometry) and applied mathematics (optimisation). The project focuses on the geometry of determinantal varieties, on decision problems involving positive polynomials, on computational algorithms for algebraic geometry, on computational algorithms for semi-definite programming, and on applications of algebraic geometry techniques in systems control theory, namely for robust control of linear systems and polynomial optimal control (Participants: J.-C. Faugère, M. Safey El Din [contact], E. Tsigaridas).

8.2. European Initiatives

8.2.1. FP7 & H2020 Projects

8.2.1.1. A3

Type: PEOPLE

Instrument: Career Integration Grant

Duration: May 2013 - April 2017

Coordinator: Jean-Charles Faugère

Partner: Institut National de Recherche en Informatique et en Automatique (Inria), France

Inria contact: Elias Tsigaridas

Abstract: The project Algebraic Algorithms and Applications (A3) is an interdisciplinary and multidisciplinary project, with strong international synergy. It consists of four work packages. The first (Algebraic Algorithms) focuses on fundamental problems of computational (real) algebraic geometry: effective zero bounds, that is estimations for the minimum distance of the roots of a polynomial system from zero, algorithms for solving polynomials and polynomial systems, derivation of non-asymptotic bounds for basic algorithms of real algebraic geometry and application of polynomial system solving techniques in optimization. We propose a novel approach that exploits

structure and symmetry, combinatorial properties of high dimensional polytopes and tools from mathematical physics. Despite the great potential of the modern tools from algebraic algorithms, their use requires a combined effort to transfer this technology to specific problems. In the second package (Stochastic Games) we aim to derive optimal algorithms for computing the values of stochastic games, using techniques from real algebraic geometry, and to introduce a whole new arsenal of algebraic tools to computational game theory. The third work package (Non-linear Computational Geometry), we focus on exact computations with implicitly defined plane and space curves. These are challenging problems that commonly arise in geometric modeling and computer aided design, but they also have applications in polynomial optimization. The final work package (Efficient Implementations) describes our plans for complete, robust and efficient implementations of algebraic algorithms.

8.2.2. Collaborations in European Programs, except FP7 & H2020

Program: ICT COST Action IC1403

Project acronym : CRYPTACUS)

Project title: Cryptanalysis of ubiquitous computing systems

Duration: 12/2014 – 12/2018

Coordinator: Prof Gildas AVOINE

Abstract: Recent technological advances in hardware and software have irrevocably affected the classical picture of computing systems. Today, these no longer consist only of connected servers, but involve a wide range of pervasive and embedded devices, leading to the concept of "ubiquitous computing systems".

The objective of the Action is to improve and adapt the existent cryptanalysis methodologies and tools to the ubiquitous computing framework. Cryptanalysis, which is the assessment of theoretical and practical cryptographic mechanisms designed to ensure security and privacy, will be implemented along four axes: cryptographic models, cryptanalysis of building blocks, hardware and software security engineering, and security assessment of real-world systems.

Researchers have only recently started to focus on the security of ubiquitous computing systems. Despite the critical flaws found, the required highly-specialized skills and the isolation of the involved disciplines are a true barrier for identifying additional issues. The Action will establish a network of complementary skills, so that expertise in cryptography, information security, privacy, and embedded systems can be put to work together.

The outcome will directly help industry stakeholders and regulatory bodies to increase security and privacy in ubiquitous computing systems, in order to eventually make citizens better protected in their everyday life.

Program: COST Action IC1306

Project acronym : CryptoAction

Project title: Cryptography for Secure Digital Interaction

Duration: 04/2014 – 04/2018

Coordinator: Dr. Claudio ORLANDI

Abstract: As increasing amounts of sensitive data are exchanged and processed every day on the Internet, the need for security is paramount. Cryptography is the fundamental tool for securing digital interactions, and allows much more than secure communication: recent breakthroughs in cryptography enable the protection - at least from a theoretical point of view - of any interactive data processing task. This includes electronic voting, outsourcing of storage and computation, e-payments, electronic auctions, etc. However, as cryptography advances and becomes more complex, single research groups become specialized and lose contact with "the big picture". Fragmentation in this field can be dangerous, as a chain is only as strong as its weakest link. To ensure that the ideas

produced in Europe's many excellent research groups will have a practical impact, coordination among national efforts and different skills is needed. The aim of this COST Action is to stimulate interaction between the different national efforts in order to develop new cryptographic solutions and to evaluate the security of deployed algorithms with applications to the secure digital interactions between citizens, companies and governments. The Action will foster a network of European research centers thus promoting movement of ideas and people between partners.

8.3. International Initiatives

8.3.1. Inria International Labs

8.3.1.1. Inria@SiliconValley

See <https://project.inria.fr/siliconvalley/fr/>

Associate Team involved in the International Lab:

GOAL

Title: Geometry and Optimization with ALgebraic methods.

International Partner (Institution - Laboratory - Researcher):

University of California Berkeley (United States) - Dept. of Mathematics - Bernd Sturmfels

Start year: 2015

See also: <http://www-polsys.lip6.fr/GOAL/index.html>

Polynomial optimization problems form a subclass of general global optimization problems, which have received a lot of attention from the research community recently; various solution techniques have been designed. One reason for the spectacular success of these methods is the potential impact in many fields: data mining, big data, energy savings, etc. More generally, many areas in mathematics, as well as applications in engineering, biology, statistics, robotics etc. require a deeper understanding of the algebraic structure of their underlying objects.

A new trend in the polynomial optimization community is the combination of algebraic and numerical methods. Understanding and characterizing the algebraic properties of the objects occurring in numerical algorithms can play an important role in improving the efficiency of exact methods. Moreover, this knowledge can be used to estimate the quality (for example the number of significant digits) of numerical algorithms. In many situations each coordinate of the optimum is an algebraic number. The degree of the minimal polynomials of these algebraic numbers is the Algebraic Degree of the problem. From a methodological point of view, this notion of Algebraic Degree emerges as an important complexity parameter for both numerical and the exact algorithms. However, algebraic systems occurring in applications often have special algebraic structures that deeply influence the geometry of the solution set. Therefore, the (true) algebraic degree could be much less than what is predicted by general worst case bounds (using Bézout bounds, mixed volume, etc.), and would be very worthwhile to understand it more precisely.

The goal of this proposal is to develop algorithms and mathematical tools to solve geometric and optimization problems through algebraic techniques. As a long-term goal, we plan to develop new software to solve these problems more efficiently. These objectives encompass the challenge of identifying instances of these problems that can be solved in polynomial time with respect to the number of solutions and modeling these problems with polynomial equations.

The kickoff workshop was held at UC Berkeley in May 2015, see <https://math.berkeley.edu/~bernd/GOALworkshop.html>.

Both Carlos Améndola Cerón and Kaies Kubjas visited the team one month through the associated team.

8.3.1.2. Sino-European Laboratory of Informatics, Automation and Applied Mathematics (LIAMA)

See <http://liama.ia.ac.cn/>.

Associate Team involved in the International Lab:

ECCA

Title: Exact/Certified Computation with Algebraic Systems

International Partner (Institution - Laboratory - Researcher):

KLMM – Chinese Academy of Sciences, Lihong Zhi.

Start year: 2012

See also: <http://liama.ia.ac.cn/research/liama-projects/current/265-ecca-project-description-and-achievements.html>

Exact/Certified Computation with Algebraic Systems (ECCA) is a project run within the LIAMA Consortium as a cooperation project between CNRS/Inria/LIP6, KLMM, SKLOIS and LMIB. The main scientific objective of this project is to study and compute the solutions of nonlinear algebraic systems and their structures and properties with target applications to computational geometry, algebraic cryptanalysis, global optimization, and algebraic biology.

8.4. International Research Visitors

8.4.1. Visits of International Scientists

Carlos Améndola Cerón

Date: Sept. 2015

Institution: Technische Universität Berlin, Germany

Kaie Kubjas

Date: Oct. 2015

Institution: Aalto Science Institute, Finland

Cordian Riener

Date: May 2015

Institution: Aalto Science Institute, Finland

Igor Shparlinski

Date: Sept. 2015

Institution: The University of New South Wales, Australia

Rekha Thomas

Date: Feb. 2015

Institution: University of Washington, USA.

8.4.1.1. Internships

Matías Bender

Date: Sep 2014 - Feb 2015

Institution: Universidad de Buenos Aires (Argentina)

Supervisor: Jean-Charles Faugère

Jérôme Govinden

Date: Feb. 2015 - Sept. 2015

Institution: UPMC

Supervisors: Jean-Charles Faugère, Ludovic Perret

PROSECCO Project-Team

9. Partnerships and Cooperations

9.1. National Initiatives

9.1.1. ANR

9.1.1.1. ProSe

Title: ProSe: Security protocols : formal model, computational model, and implementations (ANR VERSO 2010.)

Other partners: Inria/Cascade, ENS Cachan-Inria/Secsi, LORIA-Inria/Cassis, Verimag.

Duration: December 2010 - December 2014.

Coordinator: Bruno Blanchet, Inria (France)

Abstract: 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: the symbolic level, in which messages are terms; the computational level, in which messages are bitstrings; the implementation level: the program itself.

9.1.1.2. AJACS

Title: AJACS: Analyses of JavaScript Applications: Certification and Security

Other partners: Inria-Rennes/Celtique, Inria-Saclay/Toccatà, Inria-Sophia Antipolis/INDES, Imperial College London

Duration: October 2014 - March 2019.

Coordinator: Alan Schmitt, Inria (France)

Abstract: The goal of the AJACS project is to provide strong security and privacy guarantees for web application scripts. To this end, we propose to define a mechanized semantics of the full JavaScript language, the most widely used language for the Web, to develop and prove correct analyses for JavaScript programs, and to design and certify security and privacy enforcement mechanisms.

9.1.2. FUI

9.1.2.1. Pisco

Title: PISCO

Partners: Bull, Cassadian, CEA, CS, Saferiver, Serpikom, Telecom Paristech

Duration: January 2013 - December 2014.

Coordinator: Liliana Calabanti, Bull (France)

Abstract: The goal of the project is to develop a prototype of a new secure appliance based on a virtual machine architecture accessing an HSM. The role of PROSECCO is to contribute to the analysis of security <http://www.systematic-paris-region.org/en/projets/pisco>

9.2. European Initiatives

9.2.1. FP7 & H2020 Projects

9.2.1.1. CRYSP

Title: CRYSP: A Novel Framework for Collaboratively Building Cryptographically Secure Programs and their Proofs

Programm: FP7

Duration: November 2010 - October 2015

Coordinator: Inria

Inria contact: Anne-Lise Chenet-Pflieger

The goal of CRYSP is to use recent advances in software verification and dependent type systems and apply them to the verification of cryptographic protocol implementations written in a variety of languages. We want to enable the collaborative development of such programs and their specifications. Our target is to be able to verify mainstream implementations of the Transport Layer Security Protocol.

9.3. International Initiatives

9.3.1. Inria International Partners

9.3.1.1. Informal International Partners

We have a range of long- and short-term collaborations with various universities and research labs. We summarize them by project:

- **F***: Microsoft Research (Cambridge, Redmond), IMDEA (Madrid)
- **TLS analysis**: Microsoft Research (Cambridge), Johns Hopkins University, University of Michigan, University of Pennsylvania
- **Web Security**: Microsoft Research (Cambridge, Redmond), Imperial College (London)
- **Micro-Policies**: University of Pennsylvania, Portland State University

9.4. International Research Visitors

9.4.1. Visits of International Scientists

- Deepak Garg from the Max Planck Institute for Software Systems in Saarbruecken visited the group from 10-12 June and gave a seminar.
- Udit Dhawan from the University of Pennsylvania visited the group from 10-14 March and gave a seminar.
- Cedric Fournet and Nikhil Swamy from Microsoft Research visited the group multiple times to work on joint projects.

SECRET Project-Team

8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. ANR

- **ANR BLOC** (10/11 → 03/16)
Design and Analysis of block ciphers dedicated to constrained environments
ANR program: Ingénierie numérique et sécurité
Partners: INSA Lyon, Inria (project-team SECRET), University of Limoges (XLIM), CryptoExperts
446 kEuros
<http://bloc.project.citi-lab.fr>
The BLOC project aims at providing strong theoretical and practical results in the domain of cryptanalysis and design of block ciphers.
- **ANR KISS** (12/11 → 02/16)
Keep your personal Information Safe and Secure
ANR program: Ingénierie numérique et sécurité
Partners: Inria (project-teams SMIS and SECRET), LIRIS, Gemalto, University of Versailles-St Quentin, Conseil Général des Yvelines
64 kEuros
The KISS project builds upon the emergence of new portable and secure devices known as Secure Portable Tokens (e.g., mass storage SIM cards, secure USB sticks, smart sensors) combining the security of smart cards and the storage capacity of NAND Flash chips. The idea promoted in KISS is to embed, in such devices, software components capable of acquiring, storing and managing securely personal data.
- **ANR CLE** (10/13 → 12/15)
Cryptography from learning with errors
ANR program: Jeunes Chercheurs, SIMI2
Coordinator: Vadim Lyubashevsky (Inria, project-team Cascade)
The aim of this project is to combine algorithmic and algebraic techniques coming from asymmetric and symmetric cryptology in order to improve some attacks and to design some symmetric primitives which have a good resistance to side-channel attacks.
- **ANR BRUTUS** (10/14 → 09/18)
Authenticated Ciphers and Resistance against Side-Channel Attacks
ANR program: Défi Société de l'information et de la communication
Partners: ANSSI, Inria (project-team SECRET and project-team MARELLE), Orange, University of Lille, University of Rennes, University Versailles-Saint Quentin
160 kEuros
The Brutus project aims at investigating the security of authenticated encryption systems. We plan to evaluate carefully the security of the most promising candidates to the Caesar competition, by trying to attack the underlying primitives or to build security proofs of modes of operation. We target the traditional black-box setting, but also more "hostile" environments, including the hardware platforms where some side-channel information is available.

8.1.2. Others

- **French Ministry of Defense** (10/12 → 09/15)
Funding for the supervision of Audrey Tixier's PhD.
30 kEuros.

- **DGA-MI** (09/15 → 09/16)
Analysis of binary streams: reconstructing LDPC codes.
28.6 kEuros.
The objective of this contract was to examine the code reconstruction problem (from noisy observation) for LDPC codes.

8.2. European Initiatives

8.2.1. FP7 & H2020 Projects

8.2.1.1. PQCRYPTO

Title: Post-quantum cryptography for long-term security

Programm: H2020

Duration: March 2015 - March 2018

Coordinator: TECHNISCHE UNIVERSITEIT EINDHOVEN

Partners:

Academia Sinica (Taiwan)

Bundesdruckerei (Germany)

Danmarks Tekniske Universitet (Denmark)

Katholieke Universiteit Leuven (Belgium)

Nxp Semiconductors Belgium Nv (Belgium)

Ruhr-Universitaet Bochum (Germany)

Stichting Katholieke Universiteit (Netherlands)

Technische Universiteit Eindhoven (Netherlands)

Technische Universitaet Darmstadt (Germany)

University of Haifa (Israel)

Inria contact: Nicolas Sendrier

Online banking, e-commerce, telemedicine, mobile communication, and cloud computing depend fundamentally on the security of the underlying cryptographic algorithms. Public-key algorithms are particularly crucial since they provide digital signatures and establish secure communication without requiring in-person meetings. Essentially all applications today are based on RSA or on the discrete-logarithm problem in finite fields or on elliptic curves. Cryptographers optimize parameter choices and implementation details for these systems and build protocols on top of these systems; cryptanalysts fine-tune attacks and establish exact security levels for these systems. Alternative systems are far less visible in research and unheard of in practice. It might seem that having three systems offers enough variation, but these systems are all broken as soon as large quantum computers are built. The EU and governments around the world are investing heavily in building quantum computers; society needs to be prepared for the consequences, including cryptanalytic attacks accelerated by these computers. Long-term confidential documents such as patient health-care records and state secrets have to guarantee security for many years, but information encrypted today using RSA or elliptic curves and stored until quantum computers are available will then be as easy to decipher as Enigma-encrypted messages are today. PQCRYPTO will allow users to switch to post-quantum cryptography: cryptographic systems that are not merely secure for today but that will also remain secure long-term against attacks by quantum computers. PQCRYPTO will design a portfolio of high-security post-quantum public-key systems, and will improve the speed of these systems, adapting to the different performance challenges of mobile devices, the cloud, and the Internet of Things. PQCRYPTO will provide efficient implementations of high-security post-quantum cryptography for a broad spectrum of real-world applications.

8.2.2. Collaborations in European Programs, except FP7 & H2020

Program: COST

Project acronym: ICT COST Action IC1306

Project title: Cryptography for Secure Digital Interaction

Duration: January 2014 - November 2017

Coordinator: Claudio Orlandi, Aarhus University, Denmark

Other partners: see http://www.cost.eu/domains_actions/ict/Actions/IC1306

Abstract: The aim of this COST action is to stimulate interaction between the different national efforts in order to develop new cryptographic solutions and to evaluate the security of deployed algorithms with applications to the secure digital interactions between citizens, companies and governments.

Anne Canteaut is co-leader of the working group on cryptographic primitives.

8.3. International Initiatives

8.3.1. Inria International Partners

8.3.1.1. Declared Inria International Partners

Title: Discrete Mathematics, Codes and Cryptography

International Partner (Institution): Indian Statistical Institute, Kolkata (India)

Start year: 2014

This collaboration investigates the three following topics: Quantum information and cryptography; Design and maintenance of primitives for symmetric cryptography; Low-cost cryptography designs from coding theory and combinatorics.

8.3.1.2. Informal International Partners

- Otto-von-Guericke Universität Magdeburg, Institut für Algebra und Geometrie (Germany): Study of Boolean functions for cryptographic applications
- Nanyang Technological University (Singapore): cryptanalysis of symmetric primitives.

8.4. International Research Visitors

8.4.1. Visits of International Scientists

- Georgi Ivanov, Bulgarian Academy of Science, Sofia, Bulgaria, visiting PhD student (COST CryptoAction), Jan.-Feb. 2015
- Sumanta Sarkar, ISI Kolkata, India, visiting scientist, Feb.-March 2015
- Dimitrios Simos, SBA Research, Vienna, Austria, visiting scientist, July 2015
- Nastja Cepak, University of Primoska, Koper, Slovenia, visiting PhD student, from Sept. 2015.
- Enes Pasalic, University of Primoska, Koper, Slovenia, visiting scientist, Oct. 2015.

8.4.1.1. Internships

- Rodolfo Canto Torres, Univ. Bordeaux (M2), March-Aug. 2015
- Yann Rotella, MPRI and Telecom ParisTech (M2), March-Sept. 2015
- Aurélie Phesso, Univ. Bordeaux (M1), June-Aug. 2015
- Victoire Dupont de Dinechin, HEC (L3), June 2015

GAMMA3 Project-Team

7. Partnerships and Cooperations

7.1. National Initiatives

7.1.1. ANR

F. Alauzet, N. Barral, V. Menier and A. Loseille are part of the MAIDESC ANR (2013-2015) on mesh adaptation for moving interfaces in CFD.

7.2. European Initiatives

7.2.1. FP7 & H2020 Projects

P. Laug participates in the GEOPRISM (GEOlogical resources PRotection and exploitation using Innovative Simulation Methods - Towards new generations of simulation technologies) project, submitted to H2020-FETOPEN-2014-2015-RIA. This project involves several Inria teams (Sage, Gamma3, Pomdapi, Coffee) and several European research centers and universities.

7.3. International Initiatives

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

7.3.1.1. AM2NS

Title: Advanced Meshing Methods for Numerical Simulations

International Partner (Institution - Laboratory - Researcher):

Mississippi State University (United States) - Center for Advanced Vehicular Systems -
Computational Fluid Dynamics Dept. (CAVS-CFD) - Marcum David

Start year: 2014

See also: https://www.rocq.inria.fr/gamma/gamma/Membres/CIPD/Frederic.Alauzet/AssociateTeam_AM2NS/AT_am2ns.html

Numerical simulation is now mature and has become an integral part of design in science and engineering applications. Meshing, i.e., discretizing the computational domain, is at the core of the computational pipeline and a key element to significant improvements. The AM2NS Associate Team focus on developing the next generation of automated meshing methods to improve their robustness and the mesh quality to solve the ever increasing complexity of numerical simulations. Four major meshing issues are targeted: (i) more robustness for mesh generation methods in recovering a given data set, (ii) higher quality for anisotropic adapted meshes via constraint alignment, (iii) higher quality for boundary layer meshes near geometry singularities, and (iv) more robustness in handling complex displacement for moving mesh methods. The impact of this collaborative research will be to provide more reliable solution output predictions in an automated manner by using these new meshing methods.

7.4. International Research Visitors

7.4.1. Visits to International Teams

7.4.1.1. Sabbatical programme

Laug Patrick

Date: Sep 2014 - Aug 2015

Institution: **Polytechnique Montréal** (Canada)

MATERIALS Project-Team

8. Partnerships and Cooperations

8.1. National Initiatives

The project-team is involved in several ANR projects:

- E. Cancès is involved in the ANR BECASIM, which is concerned with the numerical simulation of Bose-Einstein condensates. This ANR has been accepted in June 2012, and is coordinated by I. Danaila (Université de Rouen).
- T. Lelièvre is member of the ANR-project "STAB" (PI: I. Gentil, Université de Lyon).
- S. Boyaval's ANR proposal SEDIFLO, about the improvement of current numerical models of solid transport in rivers operating at large-scale for industrial purposes, by means of new non-Newtonian rheology equations, has been selected for funding as a JCJC (Jeunes Chercheuses Jeunes Chercheurs) grant.
- F. Legoll is a member of the ANR project CINE-PARA (PI: Y. Maday, Paris 6)
- the ANR COSMOS (PI: G. Stoltz) focuses on the development of efficient numerical techniques to simulate high-dimensional systems in molecular dynamics and computational statistics. It includes research teams from Institut Mines-Telecom, Inria Rennes and IBPC Paris.

In addition, the project-team is participating in

- the GdR Quantum dynamics. This interdisciplinary research network is focused on physical and mathematical problems related to the time evolution of quantum systems (transport problems, nonequilibrium systems, etc),
- the GdR Shocks,
- the GdR Maths et entreprise,
- the GdR correl (correlated methods in electronic structure computations),
- the GdR Rest (rencontres de spectroscopie théorique).
- the GdR CoDFT (electronic structure computations using density functional theory).
- the GdR EGRIN
- the GdR MASCOT-NUM (stochastic methods for the analysis of numerical codes),

The MATERIALS project-team is involved in two Labex, namely the Labex Bezout (started in 2011) and the Labex MMCD (started in 2012).

8.2. European Initiatives

The ERC consolidator Grant MSMATH (ERC Grant Agreement number 614492, PI T. Lelièvre) has started in June 2014.

8.3. International Initiatives

S. Boyaval has obtained a *Germaine de Staël* grant to pursue his research with A. Caboussat (Lausanne) about 3D numerical simulation of free-surface flows.

T. Lelièvre, G. Stoltz and F. Legoll participate in the Laboratoire International Associé (LIA) CNRS / University of Illinois at Urbana-Champaign on complex biological systems and their simulation by high performance computers. This LIA involves on the French side research teams from Université de Nancy, Université de Lyon and Inria Rennes.

MATHRISK Project-Team

9. Partnerships and Cooperations

9.1. National Initiatives

9.1.1. ANR

- ANR Stab 2013-2016, Participant : B. Jourdain, Partners : Lyon 1, Paris-Dauphine
- ANR Cosmos 2015-2018, Participant: B. Jourdain ; Partners : Ecole des Ponts, Telecom, INIRIA Rennes and IBPC

9.1.2. Competitvity Clusters

Pôle Finance Innovation.

9.2. International Initiatives

9.2.1. Inria International Partners

9.2.1.1. Informal International Partners

- Center of Excellence program in Mathematics and Life Sciences at the Department of Mathematics, University of Oslo, Norway, (B. Øksendal).
- Department of Mathematics, University of Manchester (Tusheng Zhang, currently in charge of an EU-ITN program on BSDEs and Applications).
- Kensas University (Yaozhong Hu)
- Mannheim University (Alexander Schied, Chair of Mathematics in Business and Economics, Department of Mathematics)
- Roma Tor Vergata University (Lucia Caramellino)
- Ritsumeikan University (A. Kohatsu-Higa).

9.3. International Research Visitors

9.3.1. Visits of International Scientists

- Oleg Kudryavtsev, Rostov University (Russia), 2 months
- Xiao Wei, Beijing university, 2 months

9.3.1.1. Internships

- Houzhi Li (April to July 2015): Study and implementation in Premia of the $4/2$ stochastic volatility model proposed by M. Grasselli; adviser A. Alfonsi

9.3.2. Visits to International Teams

9.3.2.1. Research stays abroad

- A. Alfonsi IPAM, UC Los Angeles , invited by René Carmona (April 13- 23)
- A. Sulem: Participation to the "Stochastics in Environmental and Financial Economics" program, Centre of Advanced Studies of the Norwegian Academy of Sciences and Letters, Oslo, Spring 2015.

MOKAPLAN Project-Team

8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. ANR

J-D. Benamou is the coordinator of the ANR ISOTACE (Interacting Systems and Optimal Transportation, Applications to Computational Economics) ANR-12-MONU-0013 (2012-2016). The consortium explores new numerical methods in Optimal Transportation AND Mean Field Game theory with applications in Economics and congested crowd motion. Check <https://project.inria.fr/isotace/>.

8.1.2. CNRS Mission pour l'interdisciplinarité (Défi Imag'In)

V. Duval and F-X. Vialard are members of the CAVALIERI project (CALcul des VARIations pour L'Imagerie, l'Édition et la Recherche d'Images). This project, coordinated by V. Duval, aims at proposing new methods for comparing and reconstructing images relying on recent progress in the calculus of variations. Typical applications are co-segmentation, statistics transfer and interpolation, as well as tomographic reconstruction. A major emphasis is given on methods derived from (generalized) Optimal Transportation. See <http://image.math.u-bordeaux1.fr/cavalieri/>

8.2. European Initiatives

8.2.1. FP7 & H2020 Projects

Gabriel Peyré is the principal investigator of the ERC project SIGMA-Vision (<http://gpeyre.github.io/sigma-vision/>), running in 2011-2016. This project tackles theory, numerics and applications at the interface between imaging sciences, optimization and neurosciences. It features in particular several contributions on sparse regularization techniques for inverse problems, and optimal transport approaches for color and texture image processing. This theoretical and numerical contributions are applied to compute vision, computer graphics and neurosciences of the visual brain.

8.3. International Initiatives

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

8.3.1.1. MOKALIEN

Title: Numerical Optimal Transportation in (Mathematical) Economics

International Partner (Institution - Laboratory - Researcher):

McGill University (Canada) - mathematics - Oberman Adam

Start year: 2014

See also: <https://team.inria.fr/mokaplan/mokalien/>

The team investigate new modelization and numerical resolution methods i using the theory of Optimal Transportation.

8.4. International Research Visitors

8.4.1. Visits of International Scientists

Jun Kitagawa (University of Toronto) visited Q. Mérigot and B. Thibert from June 1st to 10th, 2015. They worked on theoretical properties of Newton's algorithm for semi-discrete optimal transport problems arising in geometric optics.

Marco Cuturi (Kyoto Univ.) visited MOKAPLAN as invited professor at Paris-Dauphine during the summer 2015 (2 months), to work on applications of optimal transport to machine learning.

8.4.1.1. Internships

Kévin Degraux, a PhD candidate from the Université Catholique de Louvain (Belgium) has visited MOKAPLAN from November 2015 to January 2016. His work focusses on sparse signal reconstruction.

8.4.2. Visits to International Teams

8.4.2.1. Research stays abroad

Q. Mérigot visited Jose-Antonio Carrillo at Imperial College, to start a collaboration on the discretization of Wasserstein gradient flows using Voronoi diagrams.

F.-X. Vialard was invited for one month at the semester on geometric mechanics and stochastic analysis at EPFL Bernoulli institute in april to work with Darryl D. Holm and other researchers.

F.-X. Vialard was invited for the semester on Riemannian geometry in infinite dimension in Vienna in january and february.

G. Carlier has spent six month at U. Victoria visiting Prof. Martial Agueh.

Gabriel Peyré visited the laboratory of Marco Cuturi (Kyoto Univ.) as invited professor during April 2015, to work on applications of optimal transport to machine learning.

QUANTIC Project-Team

7. Partnerships and Cooperations

7.1. Regional Initiatives

7.1.1. Emergences-Ville de Paris program, QuMotel project

This project, entitled “Quantum memory for microwaves: towards quantum error correction and quantum state teleportation” and led by François Mallet, started on september 2013 and will run till september 2016. It is composed of the members of the QUANTIC project-team. In this project we plan to develop a decoherence free quantum memory with the tools of circuit quantum electrodynamics. This crucial device is still missing in any implementations of quantum information processing. It aims at capturing, in an efficient manner, the quantum information encoded by flying photons, protect this information over long times, and release it on demand towards a desired channel. The realization of this memory is based on a high quality factor cavity connected to a superconducting circuit performing three-wave mixing. We will entangle the memory state with a propagating microwave signal, then use it to perform quantum teleportation from one memory to another, generate Schrödinger cat states in the memory and realize quantum error correction protocols in order to stabilize a cat state in the memory for an arbitrary time.

7.1.2. PSL* structuring project TOCOSUQI

In the framework of the creation of the QUANTIC project-team, we have benefited from a 2-year PSL* funding from september 2013 to August 2015. The PSL* project TOCOSUQI (Tools of the control of superconducting quantum circuits) aims at developing new system theory tools for preparing, manipulating and protecting non-classical states of a microwave field in the framework of quantum Josephson circuits and circuit quantum electrodynamics, and applying them directly in the experiments. This project was led by Benjamin Huard.

7.2. National Initiatives

7.2.1. ANR project GEARED

This three-year collaborative ANR project, entitled “Reservoir engineering quantum entanglement in the microwave domain” and coordinated by Mazyar Mirrahimi, started on October 2014. The participants of the project are Mazyar Mirrahimi, François Mallet and Benjamin Huard (QUANTIC project-team), Daniel Esteve and Fabien Portier (Quantronics group, CEA Saclay), Nicolas Roch and Olivier Buisson (Institut Neel, Grenoble). This project deals with robust generation of entanglement as a key resource for quantum information processing (quantum simulation, computation and communication). The entangled states are difficult to generate and sustain as interaction with a noisy environment leads to rapid loss of their unique quantum properties. Through Geared we intend to investigate different complementary approaches to master the entanglement of microwave photons coupled to quantum superconducting circuits.

7.2.2. ANR project TIQS

This three-year young researcher ANR project, entitled “Thermodynamics of quantum information with superconducting circuits” and led by Benjamin Huard was run between September 2012 and August 2015. We realized two versions of Maxwell’s demon either classical or quantum, and based on superconducting circuits. This opens the way to different types of thermal machines in the quantum regime. In addition, we developed the best amplifier that is non-degenerate at radiofrequency in terms of noise and bandwidth. Finally, we have demonstrated experimentally the duality between preparation and post-selection in quantum mechanics.

7.2.3. ANR project EMAQS

Pierre Rouchon is a participant to this "Projet Blanc" entitled "Evaluation and Manipulation At Quantum Scale" EMAQS. This 4-year project started on January 2012. The participants of the project are Karine Beauchard (coordinator, ENS-Rennes), Vahagn Nersesyan and Jean-Pierre Puel (univ. Versailles), Gabriel Turinici and Julien Salomon (univ. Paris-Dauphine), Grigoriu Andrea and Yvon Maday (univ Pierre et Marie Curie), Michel Brune (College de France) and Claude Le Bris (Ecole des Ponts, Matherials project-team). The project is based on 3 thematic axis: open loop control, feedback stabilization and estimation with a specific effort towards quantum systems of infinite dimension and/or subject to decoherence.

7.3. European Initiatives

7.3.1. Collaborations with Major European Organizations

Partner 1: University of Padova

Alain Sarlette has been pursued a fruitful collaboration with the group of Francesco Ticozzi on "dynamical systems aspects of quantum systems". A novel line of work in the direction of quantum thermalization and quantum random walks has been explored, in the framework of the PhD of S. Apers (Ghent University) supervised by A. Sarlette. Further joint work for the future is planned about among others generalized Markovian feedback and, reservoir engineering, and linear Lyapunov functions for quantum systems. F. Ticozzi has visited us for one week.

Partner 2: Ghent University.

A. Sarlette is collaborating with applied mathematicians interested in quantum control at UGent (Dirk Aeyels, Lode Wylleman, Gert De Cooman) in the framework of thesis co-supervisions. One PhD student is co-supervised with Dirk Aeyels in the framework of Belgian Inter-University Attraction Poles "Dynamical Systems, Control and Optimization" network 2013-2017. A second PhD student is also co-supervised with Dirk Aeyels in the framework of Chinese Scholarship Council and Flanders Research Fund grant "Developing control mechanisms to counter biases and drifts in coordination", 2013-2016. Finally, benefiting from a UGent starting grant on "Coordination control algorithms inspired from nonlinear PDEs and lattices", 2013-2017, Alain Sarlette also supervises a third PhD student at Ghent University.

Partner 3: University of Liverpool.

P. Rouchon is collaborating with Jason Ralph from the Department of Electrical Engineering and Electronics at the University of Liverpool on the numerical schemes for efficient quantum filtering in real-time feedback strategies. These collaborations have recently led to a publication in Physical Review A [23].

7.4. International Initiatives

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

Pierre Rouchon is a participant to the Inria associate Team CDSS with principal Inria investigator, François Dufour of the Inria Team Project CQFD on the topic "Control of dynamic systems subject to stochastic jumps".

7.4.2. Inria International Partners

7.4.2.1. Informal International Partners

Partner 1: University of Yale

The long-term collaborations with the teams of Michel H. Devoret, Robert J. Schoelkopf, Liang Jiang and Steven M. Girvin, enforced through a two year sabbatical visit of Mazyar Mirrahimi at Yale university, have led to a set of contributions ranging from the theoretical analysis and performance optimization of ongoing experiments on weak quantum measurements [74] and preparation of non-classical field states through single photon Kerr effect [77] to the design of new experiments on single qubit cooling [69] and stabilization of maximally entangled states of superconducting qubits [8] by reservoir engineering techniques. Through these collaborations, Zaki Leghtas and Mazyar Mirrahimi have introduced a new direction for hardware-efficient universal quantum computation [84], [93]. These theoretical proposals have already led to groundbreaking experiments [10], [9], [4]. We are intending to formalize these collaborations through the creation of an Inria associated team in the framework of Inria@EastCoast program.

Partner 2: University of SaoPaulo and Federal University of Santa Catarina

Pierre Rouchon is collaborating with P. S. Pereira da Silva (Escola Politécnica – PTC, University of SaoPaulo, Brazil) and H. B. Silveira Federal (University of Santa Catarina (UFSC), Florianópolis, Brazil) on the system theory problems behind the experiment on the feedback stabilization of the photon box. These collaborations have recently led to a publication in IEEE Conference on Decision and Control [33].

7.5. International Research Visitors

7.5.1. Visits to International Teams

7.5.1.1. Research stays abroad

Mazyar Mirrahimi spent four months in the Quantronics Laboratory of Michel H. Devoret and in the Rob Schoelkopf Lab at Yale University. In this framework Joachim Cohen also spent three months in the same group. Finally, Nicolas Didier also spent two weeks at Yale University and two weeks at the Kavli Institute for Theoretical Physics at the University of California, Santa Barbara.

SIERRA Project-Team

9. Partnerships and Cooperations

9.1. National Initiatives

9.1.1. ANR: Calibration

Participant: Sylvain Arlot.

Titre: Statistical calibration

Coordinator: University Paris Dauphine

Leader: Vincent Rivoirard

Other members: 34 members, mostly among CEREMADE (Paris Dauphine), Laboratoire Jean-Alexandre Dieudonné (Université de Nice) and Laboratoire de Mathématiques de l'Université Paris Sud

Instrument: ANR Blanc

Duration: Jan 2012 - Dec 2015

Total funding: 240 000 euros

Webpage: <https://sites.google.com/site/anrcalibration/>

9.1.2. CNRS: BeFast

Participant: Sylvain Arlot.

Titre: BeFast

Coordinator: University Lille 1

Leader: Alain Celisse

Other members: Tristan Mary-Huard, Guillem Rigail, Guillemette Marot, and Julien Chiquet.

Instrument: PEPS

Duration: Mar 2015 – Dec 2015

Total funding: 9 000 euros

9.2. European Initiatives

9.2.1. FP7 & H2020 Projects

9.2.1.1. SIPA

Type: FP7

Defi: NC

Instrument: ERC Starting Grant

Duration: May 2011 - May 2016

Coordinator: A. d'Aspremont (CNRS)

Abstract: Interior point algorithms and a dramatic growth in computing power have revolutionized optimization in the last two decades. Highly nonlinear problems which were previously thought intractable are now routinely solved at reasonable scales. Semidefinite programs (i.e. linear programs on the cone of positive semidefinite matrices) are a perfect example of this trend: reasonably large, highly nonlinear but convex eigenvalue optimization problems are now solved efficiently by reliable numerical packages. This in turn means that a wide array of new applications for semidefinite programming have been discovered, mimicking the early development of linear programming. To cite only a few examples, semidefinite programs have been used to solve collaborative filtering problems (e.g. make personalized movie recommendations), approximate the solution of combinatorial programs, optimize the mixing rate of Markov chains over networks, infer dependence patterns from multivariate time series or produce optimal kernels in classification problems. These new applications also come with radically different algorithmic requirements. While interior point methods solve relatively small problems with a high precision, most recent applications of semidefinite programming in statistical learning for example form very large-scale problems with comparatively low precision targets, programs for which current algorithms cannot form even a single iteration. This proposal seeks to break this limit on problem size by deriving reliable first-order algorithms for solving large-scale semidefinite programs with a significantly lower cost per iteration, using for example subsampling techniques to considerably reduce the cost of forming gradients. Beyond these algorithmic challenges, the proposed research will focus heavily on applications of convex programming to statistical learning and signal processing theory where optimization and duality results quantify the statistical performance of coding or variable selection algorithms for example. Finally, another central goal of this work will be to produce efficient, customized algorithms for some key problems arising in machine learning and statistics.

9.2.1.2. *SpaRTaN*

Title: Sparse Representations and Compressed Sensing Training Network

Type: FP7

Defi: NC

Instrument: Initial Training Network

Duration: October 2014 to October 2018

Coordinator: Mark Plumbley (University of Surrey)

Inria contact: Francis Bach

Abstract: The *SpaRTaN* Initial Training Network will train a new generation of interdisciplinary researchers in sparse representations and compressed sensing, contributing to Europe's leading role in scientific innovation.

By bringing together leading academic and industry groups with expertise in sparse representations, compressed sensing, machine learning and optimisation, and with an interest in applications such as hyperspectral imaging, audio signal processing and video analytics, this project will create an interdisciplinary, trans-national and inter-sectorial training network to enhance mobility and training of researchers in this area.

SpaRTaN is funded under the FP7-PEOPLE-2013-ITN call and is part of the Marie Curie Actions — Initial Training Networks (ITN) funding scheme: Project number - 607290

9.2.1.3. *MacSeNet*

Title: Machine Sensing Training Network

Type: H2020

Instrument: Initial Training Network

Duration: January 2015 - January 2019

Coordinator: Mark Plumbley (University of Surrey)

Inria contact: Francis Bach

Abstract: The aim of this Innovative Training Network is to train a new generation of creative, entrepreneurial and innovative early stage researchers (ESRs) in the research area of measurement and estimation of signals using knowledge or data about the underlying structure.

We will develop new robust and efficient Machine Sensing theory and algorithms, together methods for a wide range of signals, including: advanced brain imaging; inverse imaging problems; audio and music signals; and non-traditional signals such as signals on graphs. We will apply these methods to real-world problems, through work with non-Academic partners, and disseminate the results of this research to a wide range of academic and non-academic audiences, including through publications, data, software and public engagement events.

MacSeNet is funded under the H2020-MSCA-ITN-2014 call and is part of the Marie Skłodowska-Curie Actions — Innovative Training Networks (ITN) funding scheme.

9.3. International Research Visitors

9.3.1. Visits of International Scientists

Visit from Chiranjib Bhattacharyya, Indian Institute of Science, Bangalore, May 2014.

9.3.1.1. Internships

Visit from Raman Sankaran, Indian Institute of Science, Bangalore, January 2014.

ANGE Project-Team

9. Partnerships and Cooperations

9.1. Regional Initiatives

9.1.1. *Instabilities in Hydrodynamics (2011-2015)*

Participant: Nicolas Seguin.

The Emergence project (Ville de Paris and FSMP) “Instabilities in Hydrodynamics” is related to theoretical, applied, and numerical mathematics for the study of hydrodynamical turbulence phenomena.

9.1.2. *Plasticity of geophysical flows and seismic emissions (2013-2016)*

Participant: Anne Mangeney.

This project is funded by Sorbonne Paris Cité (80.000 euros) and is a collaboration between IPGP and Univ. Paris 13.

9.1.3. *LRC Manon (2014-2018)*

Participants: Edwige Godlewski, Yohan Penel, Nicolas Seguin.

CEA and Laboratory Jacques-Louis Lions launched a collaboration in order to carry out studies about complex fluids (modelling, numerical simulations and optimisation), in particular about compressible two-phase flows. This includes the derivation of strategies for model coupling, for instance in the case of an asymptotic hierarchy of models.

9.2. National Initiatives

9.2.1. *ANR SEDIFLO (2015-2019)*

Participants: Emmanuel Audusse, Martin Parisot.

Program: ANR Défi 1 “Gestion sobre des ressources et adaptation au changement climatique” (JCJC)

Project acronym: SEDIFLO

Project title: Modelling and simulation of solid transport in rivers

Coordinator: Sébastien Boyaval (LHSV/ENPC)

Based on recent theoretical and experimental results, this project is aimed at modelling transport of sediments within rivers. It will rely on innovations from the point of view of rheology as well as advanced mathematical tools (asymptotic model reduction, PDE discretisation).

9.2.2. *ANR Hyflo-Eflu (2016-2020)*

Participants: Martin Parisot, Jacques Sainte-Marie, Julien Salomon.

Appel à projets ANR : Energies marines renouvelables

Project acronym: Hyflo-Eflu

Project title: Hydroliennes flottantes et énergie fluviale

Coordinator: Julien Salomon

The objective of the project HyFlo-EFlu is to deliver a numerical software able to simulate the dynamic of a floating water turbine in real context. Thanks to the collaboration between a team of mathematician specialist of free surface flow and optimization and the industrial developers of the turbine. For the academic partner, the main challenge is in the simulation of the floating structure at the scale of the river, and the modelling of the vertical and horizontal axis turbine. For the industrial partner, the objective is the validation of the stability of the structure and the performance in term of energy production.

9.2.3. ANR MIMOSA (2014–2017)

Participants: Nora Aïssiouene, Marie-Odile Bristeau, Anne Mangeney, Bernard Di Martino, Jacques Sainte-Marie.

Program: ANR Défi 1 “Gestion sobre des ressources et adaptation au changement climatique”

Project acronym: MIMOSA

Project title: MICroseism MODEling and Seismic Applications

Coordinator: Eleonore Stutzmann (IPGP)

Seismic noise is recorded by broadband seismometers in the absence of earthquakes. It is generated by the atmosphere-ocean system with different mechanisms in the different frequency bands. Even though some mechanisms have been known for decades, an integrated understanding of the noise in the broadband period band 1-300sec is still missing. Using novel theoretical, numerical and signal processing methods, this project will provide a unified understanding of the noise sources and quantitative models for broadband noise. Conversely, we will be able to interpret seismic noise in terms of ocean wave properties. This first analysis step will lead to the identification and characterization of source events, which we will use to improve noise tomography, and seismic monitoring.

9.2.4. ANR LANDQUAKES (2012–2016)

Program: ANR Blanc “Mathématiques et interactions”

Project acronym: LANDQUAKES

Project title: Modélisation des glissements de terrain et des ondes sismiques générées pour détecter et comprendre les instabilités gravitaires

Coordinator: Anne Mangeney

Within the ANR domain “Mathematics and Interfaces”, this ANR project (between Univ. Paris-Est – LAMA, Univ. Denis Diderot Paris 7 – IPGP, Univ. Nantes – LPGN, Univ. Strasbourg EOST, 180.000 euros) deals with the mathematical and numerical modelling of landslides and generated seismic waves.

A. Mangeney is also involved in the CARIB ANR program (2014–2017) entitled “Comprendre les processus de construction et de destruction des volcans de l’Arc des Petites Antilles”.

9.2.5. GdR EGRIN (2013–2017)

Participants: Emmanuel Audusse, Bernard Di Martino, Nicole Goutal, Cindy Guichard, Anne Mangeney, Martin Parisot, Jacques Sainte-Marie.

EGRIN stands for Gravity-driven flows and natural hazards. J. Sainte-Marie is the head of the scientific committee of this CNRS research group and A. Mangeney is a member of the committee. Other members of the team involved in the project are local correspondents. The scientific goals of this project are the modelling, analysis and simulation of complex fluids by means of reduced-complexity models in the framework of geophysical flows.

9.2.6. Inria Project Lab “Algae in Silico” (2015-2018)

Participants: Nora Aïssiouene, Marie-Odile Bristeau, David Froger, Raouf Hamouda, Jacques Sainte-Marie.

In the framework of the ADT Inlgae (2013–2015), we developed in collaboration with the BIOCORE Inria project-team a simulation tool for microalgae culture. An Inria Project Lab “Algae in Silico” has started in collaboration with several Inria teams, many BIOCORE and DYLISS. It concerns microalgae culture for biofuel production and the aim is to provide an integrated platform for numerical simulation “from genes to industrial processes”.

9.2.7. ANR project HJnet (2013–2015)

Participant: Edwige Godlewski.

This research project consists in studying Hamilton-Jacobi equations on networks, and more generally on heterogeneous structures. This theoretical problem has several potential applications, in particular to traffic flow theory.

9.2.8. Hydraulics for environment and sustainable development (HED²)

The scientific group (GIS in French), which includes Inria and the ANGE team, brings together scientists and engineers involved in hydraulics, risk management and sustainable development. It results in a continuum between fundamental research, applied research and engineering. On the one hand, the ANGE team can be provided with experimental measurements (erosion, long waves, fluid structure interactions,...) thanks to this collaboration; on the other hand, the GIS can favor the transfer of numerical tools and scientific results.

9.3. European Initiatives

9.3.1. ERC Consolidator Grant (2013-2018)

Participant: Anne Mangeney.

The project SLIDEQUAKES is about detection and understanding of landslides by observing and modelling gravitational flows and generated earthquakes and is funded by the European Research Council (2 million euros). More precisely, it deals with the mathematical, numerical and experimental modelling of gravitational flows and generated seismic waves coupled with field measurements to better understand and predict these natural hazards and their link with volcanic, seismic and climatic activities.

9.4. International Research Visitors

9.4.1. Visits of International Scientists

Spanish collaborators – Enrique Fernández-Nieto (Univ. Sevilla) and Tomás Morales de Luna (Univ. Córdoba) – spent one week in Paris (UPMC and Inria) in September.

ARAMIS Project-Team

9. Partnerships and Cooperations

9.1. National Initiatives

9.1.1. ANR

9.1.1.1. ANR PREV-DEMALS

Participants: Olivier Colliot [Correspondant], Marie Chupin, Stanley Durrleman, Anne Bertrand.

Project acronym: PREV-DEMALS

Project title: Predict to prevent frontotemporal lobar degeneration (FTLD) and amyotrophic lateral sclerosis (ALS)

Duration: Avr 2015 - Avr 2019

Amount: 487k€

Coordinator: Isabelle Le Ber

Other partners: ICM, AP-HP, CHR de Lille, CHU Limoges, CHU Rouen, Laboratory of Biomedical Imaging

Abstract: The project focuses on C9ORF72, the most frequent genetic form of frontotemporal lobar degeneration (FTLD) and amyotrophic lateral sclerosis (ALS). Since 2006, major discoveries have helped elucidate the pathological bases and linked FTLD and ALS: 1) TDP-43 aggregates in neurons and 2) C9ORF72 mutations in both disorders. Two major pathological subtypes are now defined in FTLD, FTLD-TDP and FTLD-TAU. C9ORF72 mutations (associated to FTLD-TDP) are the most frequent genetic causes of FTLD (15%), FTLD-ALS (65%) and ALS (40%). No curative treatment actually exists, but therapeutics emerged against tau aggregation. The objectives of the project are to develop appropriate cognitive, brain imaging markers and peripheral biomarkers of the early phase of FTLD, to follow disease progression and to guide future targeted therapeutic trials. To address this questions, we will conduct a multimodal study (cognition, brain structural MRI, brain metabolism - FDG-PET) in C9ORF72 families. The cohort will be followed at 3-time points (M0, M18, M36). Longitudinal analyses will aim at characterizing the trajectory of decline across time. Brain structural changes will be evaluated by 1) morphometric analysis to assess global brain atrophy, cortical thickness and study of the cortical sulci; 2) functional connectivity analysis of resting-state MR data; 3) structural connectivity analysis of diffusion-weighted MRI. Brain metabolism will be evaluated with FDG-PET. We will use the most recent RNA sequencing technology to detect gene expression and RNA splicing alterations in lymphocytes of patients and presymptomatic carriers. The discovery of new markers involved in FTLD will have practical consequences for early and accurate diagnosis of FLD and ALS disease.

9.1.2. IHU

9.1.2.1. General program

Participants: Olivier Colliot, Mario Chavez, Stanley Durrleman, Marie Chupin, Didier Dormont, Dominique Hasboun, Damien Galanaud, Fabrizio de Vico Fallani.

Project acronym: IHU-A-ICM

Project title: Institute of Translational Neuroscience

Founded in 2011

General Director: Bertrand Fontaine

The IHU-A-ICM program was selected, in 2011, in a highly competitive national call for projects. A 10-year, 55M€ program, has been implemented by a recently created foundation for scientific cooperation. Based on the clinical and scientific strengths of the ICM and the hospital Department of Nervous System Diseases, it mainly supports neuroscience research, but is also invested in improving care and teaching. ARAMIS is strongly involved in the IHU-A-ICM project, in particular in WP6 (neuroimaging and electrophysiology), WP7 (biostatistics), WP2 (Alzheimer) and WP5 (epilepsy). We have started collaborations with the new bioinformatics/biostatistics platform (IHU WP7, head: Ivan Moszer), in particular through a joint project on the integration of imaging and genomics data.

9.1.2.2. ICM-Internal Research projects

Participants: Mario Chavez [Correspondant], Fabrizio de Vico Fallani [Correspondant].

Project title: Non-invasive manipulation of brain synchrony to enhance brain function and rehabilitate faulty cognition in humans: A proof of concept

Founded in 2014

Coordinator: Antoni Valero Cabre (ICM-team “Dynamiques Cérébrales, Plasticité et Rééducation”)

Other partners: Service des Urgences Cérébro-Vasculaires de l’Hôpital Pitié-Salpêtrière, Paris.

The long-term goal of this project is to develop the use of non-invasive manipulation of abnormal cerebral oscillations underlying cognitive activity to restore brain function in neurological patients. Cognitive functions emerge from large distributed networks organized in space and time. The short-term goal of this application is to study the causal role played by oscillatory activity in visual awareness and test whether their manipulation by non-invasive brain stimulation has the potential to restore its function in stroke patients.

9.1.2.3. IFR49-Internal Research projects

Participants: Mario Chavez [Correspondant], Fabrizio de Vico Fallani [Correspondant].

Project title: Exploring the impact and time frequency signature of rhythmic patterns of Transcranial Magnetic Stimulation (TMS) on network activity by Magneto-Encephalography (MEG)

Founded in 2014

Coordinator: Antoni Valero Cabre (ICM-team “Dynamiques Cérébrales, Plasticité et Rééducation”)

Other partners: TMS, EEG and MEG technical platforms of the ICM at the Hopital Pitié-Salpêtrière; and Service des Urgences Cérébro-Vasculaires de l’Hôpital Pitié-Salpêtrière, Paris.

The long-term goal of this project is to better understand the ability of non invasive neurostimulation to induce lasting local and distributed reorganization effects in the human brain to better plan and document therapies for patients. The short-term goal of this application is to develop a new mapping procedure to be able to capture and characterize in terms of oscillatory activity the lasting impact of repetitive Transcranial Magnetic Stimulation (TMS) on specific brain regions and associated networks.

9.1.3. CATI (Alzheimer Plan)

Participants: Olivier Colliot [Correspondant], Marie Chupin [Correspondant], Stanley Durrelman, Didier Dormont, Chabha Azouani, Ali Bouyahia, Johanne Germain, Kelly Martineau, Sonia Djobeir, Hugo Dary, Ludovic Fillon, Takoua Kaaouana, Alexandre Routier, Mathieu Dubois.

Project acronym: CATI

Project title: Centre d’Acquisition et de Traitement des Images

Founded in 2011

Amount: 9M€

Coordinator: Jean-François Mangin

Other partners: Neurospin, CENIR, Inserm U678, IM2A

Abstract: The CATI project (funded by the National Alzheimer Plan for 9M€, 2.1M€ for ARAMIS) aims at creating a national platform for multicenter neuroimaging studies. CATI aims to be a national resource for the scientific, medical and industrial research community and will provide a wide range of services: access to a national acquisition network, standardization of acquisitions, image quality control, image analysis, databasing/archiving, meta-analyses. Through CATI, our team coordinates a large network composed of over 30 image acquisition centers. CATI already supports over 15 multicenter projects including the national cohort MEMENTO (2300 subjects). CATI is integrated with France Life Imaging (PI: F. Lethimonnier) and the Neugrid for you (N4U, PI: G. Frisoni) network.

9.1.4. National Networks

- GdR Statistics and Medicine - <http://gdr.statsante.fr/Accueil.html>

9.1.5. Other National Programs

9.1.5.1. Programme Hospitalier de Recherche Clinique (PHRC)

Participants: Olivier Colliot, Marie Chupin, Stanley Durrleman, Didier Dormont, Damien Galanaud.

- PHRC PredictPGRN, co-funding by Alzheimer Plan, *Caractérisation multimodale prospective de la démence frontotemporale due à des mutations du gène PGRN à un stade symptomatique et présymptomatique.* (Coordinator : A. Brice)
- PHRC ImaBio3, co-funding by Roche (pharmaceutical industry), *Rôle des réactions cellulaires sanguines, inflammatoires et immunitaires anti-amyloïde centrales et périphériques dans la maladie d'Alzheimer débutante.* (Coordinator : M. Sarazin)
- PHRC CAPP, *Caractérisation linguistique, anatomique/métabolique et biologique des différentes formes d'aphasie primaire progressive : vers le rationnel pour des essais pharmacologiques et des rééducations du langage ciblées.* (Coordinator: M. Teichmann)

9.1.5.2. Institut Universitaire d'Ingénierie pour la Santé (IUIS)

Participants: Mario Chavez, Xavier Navarro.

Project acronym: DYSPEV

Project title: Dépistage de la dyspnée par potentiels évoqués visuels

Founded in 2014

Amount: 38K€

Coordinator: Thomas Similowski

Other partners: UPMC, Inserm UMR 1158

Abstract: Steady state visual evoked potentials (SSVEP) have been widely utilized in brain computer interfacing (BCI) in last years. In this project, we explore the possibilities of SSVEP to manage the communication between patients suffering from respiratory disorders and health care providers. By imposing different breathing constraints, we use a SSVEP-based brain computer interface to help those subjects to communicate their breathing sensations (breathing well/breathing bad).

9.2. European Initiatives

9.2.1. FP7 & H2020 Projects

Participants: Stefan Thurner, Vito Latora, Albert Diaz-Guilera, Maxi San Miguel, Cecilia Mascolo, Mirco Murolesi, Mario Chavez [Correspondant].

Project acronym: LASAGNE

Project title: multi-LAyer SpAtiotemporal Generalized NEtworks

Dates: 2012-2015

Amount: 1.6M€

Coordinator: Stefan Thurner

Other partners: Medical University of Vienna, Queen Mary University of London, Universitat de Barcelona, Universitat de les Illes Balears, University of Cambridge, University of Birmingham.

Abstract: The aim of the LASAGNE project is to provide a novel and coherent theoretical framework for analyzing and modelling dynamic and multi-layer networks in terms of multi-graphs embedded in space and time. To do this, we will treat time, space and the nature of interactions not as additional dimensions of the problem, but as natural, inherent components of the very same generalized network description. The theory will be validated on real-world applications involving large and heterogeneous data sets of brain networks, on- and off-line social systems, healthcare systems, and transportation flows in cities. The LASAGNE project will provide new quantitative opportunities in different fields, ranging from the prediction of pathologies to the diffusion of ideas and trends in societies, and for the management of socio-technological systems.

9.3. International Initiatives

9.3.1. Inria International Partners

9.3.1.1. Informal International Partners

S. Durrleman has an enduring collaboration with the Scientific Computing and Imaging (SCI) Institute at the University of Utah (USA). He is consultant for NIH Grant "4D shape analysis for modeling spatiotemporal change trajectories in Huntington's Disease "predict-HD". He is part of the PhD committees of J. Fishbaugh and A. Sharma supervised by professor Guido Gerig.

M. Chupin and O. Colliot have an enduring collaboration with the Center for Magnetic Resonance Research, University of Minnesota, USA (P-F Van de Moortele, T. Henry, M. Marjanska, K. Ugurbil) a leading center in 7T MRI.

S. Durrleman and O. Colliot have a collaboration with the Center for Medical Image Computing (CMIC) at University College London (UCL), London, UK (S. Ourselin, D. Alexander, M. Modat).

D. Galanaud has an enduring collaboration with the Massachusetts General Hospital, Harvard University, USA (R. Gupta).

M. Chavez has different collaborations with the Mathematics Department of the Queen Mary University of London, UK (Prof. V. Latora); and the Physics Department of the Universitat de Barcelona, Spain (Prof. Albert Diaz-Guilera)

F. De Vico Fallani has a collaboration with the University Sapienza, Rome, Italy (Profs. Fabio and Claudio Babiloni) and with the IRCCS Fondazione Santa Lucia, Rome, Italy (M. Molinari and D. Mattia).

CLIME Project-Team

8. Partnerships and Cooperations

8.1. National Initiatives

- The ANR project Estimair aims at quantifying the uncertainties of air quality simulations at urban scale. The propagation of uncertainties requires the use of model reduction and emulation. A key uncertainty source lies in the traffic emissions, which will be generated using a dynamic traffic assignment model. Ensembles of traffic assignments will be calibrated and used in the uncertainty quantification. Estimair is led by Clime.
- The IPSL project "AVES" (Ensemble Variational Assimilation applied to a shallow-water model) aims at estimating the quality of an ensemble produced by a variational ensemble algorithm applied on a shallow-water numerical model. A focus is made on the bayesian properties of the ensemble, i.e. its capacity to sample the a-posteriori probability law of the model state.

8.2. European Initiatives

8.2.1. FP7 & H2020 Projects

Program: e-Infrastructures

Project acronym: EoCoE

Project title: Energy oriented Centre of Excellence for computer applications

Duration: 3 years

Coordinator: CEA (Commissariat à l'énergie atomique et aux énergies alternatives)

Other partners: Forschungszentrum Jülich GMBH and 11 other partners. Inria is third-linked party of CEA.

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

8.2.2. Collaborations with Major European Organizations

Partner: ERCIM working group "Environmental Modeling".

The working group gathers laboratories of ERCIM working on developing models, processing environmental data or data assimilation.

8.3. International Initiatives

8.3.1. Inria International Partners

8.3.1.1. Informal International Partners

Partner: Marine Hydrophysical Institute, Sevastopol.

The collaboration concerns the study of the Black Sea surface circulation and the issue of image assimilation in forecasting models.

Partner: IBM Research, Dublin, Ireland

The collaboration addresses the assimilation of classical observations as well as images, with application to geophysics. New assimilation methods are developed, mainly based on minimax filtering.

LIFEWARE Project-Team

8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. ANR Projects

- ANR Blanc HYCLOCK (2014-2018) on “Hybrid modeling of time for Circadian Clock Biology and Chronopharmacology”, coordinated by F. Delaunay (CNRS, Nice), F. Lévi (INSERM Paris-Sud), G. Bernot (CNRS I3S, Nice), O. Roux (Ecole Centrale Nantes).
- ANR Blanc **STOCH-MC** (2014-2018) on “Stochastic Models: Scalable Model Checking”, coordinated by Blaise Genest (Inria Rennes), with Grégory Batt, Wieslaw Zielonka (LIAFA), and Hugo Gimbert (LaBRI).
- ANR Investissement Avenir **ICEBERG** project (2011-2016) “From population models to model populations”, coordinated by Grégory Batt, with Pascal Hersen (MSC lab, Paris Diderot Univ./CNRS), Reiner Veitia (Institut Jacques Monod, Paris Diderot Univ./CNRS), Olivier Gandrillon (BM2A lab, Lyon Univ./CNRS), Cédric Lhoussaine (LIFL/CNRS), and Jean Krivine (PPS lab, Paris Diderot Univ./CNRS).
- ANR Blanc **NET-WMS-2** (2011-2015) on “constraint optimization in Warehouse Management Systems”, coordinated by F. Fages, with N. Beldiceanu (Ecole des Mines de Nantes, EPI TASC), and Abder Aggoun (KLS optim).

8.1.2. GENCI Contract

- GENCI (2009-) attribution of 300000 computation hours per year on the Jade cluster of 10000 cores of GENCI at CINES, Montpellier. Used for our hardest parameter search problems in BIOCHAM-parallel.

8.2. International Initiatives

8.2.1. Inria International Partners

8.2.1.1. Collaboration with National Taiwan University

Since 2012, we develop a collaboration with Prof. Jie-Hong Jiang, National Taiwan University which culminated this year with the defence of the PhD Thesis of Katherine Chiang [1], co-supervised by Jie-Hong Jiang and François Fages with two internships in 2012 and 2013, and with several publications [5], [11], [6]. Our aim is to pursue our collaboration on the concept of biochemical programming and the development of biochemical programming tools, in particular for the design of artificial biosensors in partnership with Franck Molina (CNRS, Sys2diag, Montpellier).

8.2.2. Participation In other International Programs

- French-German PROCOPE (2015-2017) grant on “Réduction de modèle et analyse de grands réseaux biochimiques par des méthodes stoechiométriques et tropicales”, coord. Prof Andreas Weber, University of Bonn, Germany, and Prof. Ovidiu Radulescu, Univ. Montpellier, France.

8.3. International Research Visitors

8.3.1. Visits of International Scientists

Our group received for short visits of a few days

- Prof. Hugo Fort, Univ. Montevideo, Uruguay
- Prof. Andreas Weber, Univ. Bonn, Germany
- Damien Woods, Caltech, USA

MAMBA Project-Team

8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. ANR

8.1.1.1. ANR 2011-2014 *Bimod*

It has been prolonged until March 2015, time at which an international workshop on “Multi-scale and hybrid modelling in cell and cell population biology” has been held at UPMC, Paris (J. Clairambault and V. Volpert organisers), with 25-30 speakers on invitations. Its proceedings under the form of extended abstracts are available on a dedicated website: <http://www.itm-conferences.org/articles/itmconf/abs/2015/02/contents/contents.html>

8.1.1.2. ANR Blanc 2014-2018 “Kibord”

This recently accepted project gathers several members of the Mamba team together with the ENS Cachan and Université Paris-Dauphine on the mathematical study of PDE models with application to biology.

8.1.1.3. ANR 2014-2017 *IFLOW*

Eric Vibert, Hopital Paul Brousse (coordinator). Partners: Inria REO, Hopital Toulouse, Dirk Drasdo. Objectives are simulation of liver perfusion after partial hepatectomy (PHx) with and without therapeutic manipulations to improve patients survival after PHx.

8.1.1.4. INSERM 2014 - 2016, *INVADE*.

Emmanuel Barillot, Institut Curie (coordinateur). Partners: Groups from Institut Curie, Dirk Drasdo. Objective is a model for a better understanding of breast cancer invasion.

8.2. European Initiatives

8.2.1. FP7 & H2020 Projects

8.2.1.1. ERC Starting Grant *SKIPPER^{AD}*, 2012-2017, Principal Investigator: M. Doumic.

This grant allowed to fund Sarah Eugène’s Ph.D and M. Tournus’s post-doc, as well as to develop the new collaborations with W-F. Xue in Canterbury and T. Teixeira in IBCP.

8.2.2. Collaborations in European Programs, except FP7 & H2020

8.2.2.1. *NOTOX*

Type: COOPERATION

Instrument: Integrated Project

Objectif: NC

Duration: January 2011 - December 2015

Inria contact: Dirk Drasdo

NOTOX developed and established a spectrum of systems biological tools including experimental and computational methods for (i) organotypic human cell cultures suitable for long term toxicity testing and (ii) the identification and analysis of pathways of toxicological relevance. NOTOX initially used available human HepaRG and primary liver cells as well as mouse small intestine cultures in 3D systems to generate own experimental data to develop and validate predictive mathematical and bioinformatic models characterizing long term toxicity responses. Cellular activities were monitored continuously by comprehensive analysis of released metabolites, peptides and proteins and by estimation of metabolic fluxes using ^{13}C labelling techniques (fluxomics). At selected time points a part of the cells was removed for in-depth structural (3D-optical and electron microscopy tomography), transcriptomic, epigenomic, metabolomic, proteomic and fluxomic characterisations. Together with curated literature and genomic data the toxicological data was organised in a toxicological database (cooperation with DETECTIVE, COSMOS and TOXBANK). Physiological data including metabolism of test compounds have been incorporated into large-scale computer models that are based on material balancing and kinetics. Various “-omics” data and 3D structural information from organotypic cultures will be integrated using correlative bioinformatic tools. These data also served as a basis for large scale mathematical models. The overall objectives are to identify cellular and molecular signatures allowing prediction of long term toxicity, to design experimental systems for the identification of predictive endpoints and to integrate these into causal computer models.

Inria contributions were multilevel and multiscale models of drug toxicity and its consequences on ammonia detoxification and are detailed in the result section on liver modeling. Webpage: <http://notox-sb.eu/fp7-cosmetics-europe/>

8.2.3. Collaborations with Major European Organisations

U. Klingmüller: DKFZ (German Cancer Research Centre), Department for Systems Biology (Germany)

Role of HGF in liver regeneration. Lung cancer.

K. Breuhahn: University Hospital of Heidelberg, Pathology (Germany)

Lung cancer invasion. Role of HGF in liver regeneration.

JG Hengstler: Leibniz Center, IfADo (Germany)

Liver research, toxicology, regeneration.

University of Leipzig, Interdisciplinary center for bioinformatics (Germany)

Projects on tissue regeneration, software

8.3. International Initiatives

8.3.1. Inria International Partners

8.3.1.1. Declared Inria International Partners

1. German Research Ministry (BMBF) funded project on the systems biology of lung cancer. The major aim is to better understand the early metastasis formation and invasion of lung cancer, including therapeutical options. Data on all levels ranging from intracellular up to organ level will be used to establish successively an integrated multiscale model of cellular and migration decisions in lung cancer. A particular focus will be on dissecting how cellular organisation and communication in spheroid cultures and co-cultures of lung cancer cell lines with selected endothelial cells affects information processing and the proliferation and migration decisions downstream. To reveal the inhomogeneous spatio-temporal organisation in these tumour growth models, specific probes for medical imaging, quantify extracellular cytokine concentrations will be used, and the effects of pharmacological inhibitors be monitored. By data and model integration, parameters should be identified that critically determine early spread and facilitate to predict possibilities for improved therapeutic options. The project coordinator is Ursula Klingmueller, German Cancer Research Centre (DKFZ), Heidelberg (<http://www.lungsys.de/>)

2. German Research Ministry (BMBF) funded project on the systems biology of liver (Virtual Liver Network). The aim of the VLN project is to set up multiscale models of liver. The Virtual Liver will be a dynamic model that represents, rather than fully replicates, human liver physiology morphology and function, integrating quantitative data from all levels of organisation. Our part ranges from the intracellular up to the level of groups of liver lobules. A liver lobule is the basic repetitive functional unit of liver. Applications are explained in the text. The networks has 69 Principle Investigators organised in about 10 work packages, each of which have a number of sub-projects (<http://www.virtual-liver.de>).

8.3.2. Participation In other International Programs

8.3.2.1. EuroMed3+3 programme

The M3CD network (https://www.rocq.inria.fr/bang/M3CD_website/), coordinated by J. Clairambault, has led in 2015 as usual to bilateral visits (M. Adimy, J. Clairambault, to Marrakesh and to Tlemcen, T. Touaoula to Lyon, visits of students to Paris and Lyon). It has terminated its activities in 2015 by a meeting in September in Rabat (Morocco) together with other EuroMed3+3 networks. The future of EuroMed3+3 (<http://www.inria.fr/en/europe-international/international-relations/international-calls-for-projects/euromediterranean-3-3>) will be discussed in June 2016 in a meeting at the Sophia-Antipolis Inria research centre.

8.3.2.2. CAPES-COFECUB project

“Modeling innovative control methods for dengue fever”, in collaboration with Fondation Oswaldo Cruz (FioCruz), Rio de Janeiro, Brazil.

8.3.2.3. Convergence SU/FAPERJ programme

“Control and identification for mathematical models of dengue epidemics” in collaboration with IMPA, Rio de Janeiro, Brazil.

8.4. International Research Visitors

8.4.1. Visits of International Scientists

Juan Calvo came for a one month visit in January and February, 2015, to work on a new model for long-term protein polymerisation (work in progress).

8.4.2. Internships

Andreas Buttenschön (Team of Thomas Hillen, University of Alberta, Canada) visits the team from December 2015 to May 2016 for be trained on agent-based modeling and the software tool TiSim.

Geert Peeters (Team Patrick Segers, University of Gent, Belgium) visited the German subgroup of the team in January 2015 for one week to be trained on the software tool TiQuant.

8.4.2.1. Research stays abroad

Nicolas Vauchelet stayed two months at IMPA, Rio de Janeiro, Brazil, in the framework of a teaching agreement between UPMC and IMPA.

MYCENAE Project-Team

7. Partnerships and Cooperations

7.1. National Initiatives

7.1.1. ANR

Jonathan Touboul is member of the **Kibord** (KInetic models in Biology Or Related Domains) project obtained in 2014.

Mathieu Desroches is the coordinator of the **SloFaDyBio** (SLOW-FAST Dynamics applied to the BIOsciences) network mounted in 2014.

7.1.2. National Networks

- **GdR REPRO** (member of the direction board, F. Clément)
- **MIA REM network**: Réduction de modèles (PI Béatrice Laroche, INRA Jouy)

7.1.3. National Collaborations

- **UMR Physiologie de la Reproduction et des Comportements**, INRA Tours (Bios and Bingo teams)
- **Jacques-Louis Lions Laboratory**, Pierre & Marie Curie University (Jean-Pierre François, Marie Postel)
- **Developmental Biology Laboratory**, Pierre & Marie Curie University (Alice Karam, Sylvie Schneider Maunoury), in the framework of the NeuroMathMod, Sorbonne-Universités Émergence call
- **Center for Interdisciplinary Research in Biology**, Collège de France (Alain Prochiantz)
- **Centre de Recherche en Mathématiques de la Décision**, Paris Dauphine University (Stéphane Mischler)
- **Computational Biology and Biomathematics**, Jacques Monod Institute, Paris Diderot University (Khashayar Pakdaman)
- **Département d'Informatique de l'ENS, équipe DATA**, Paris-Nord University (Gilles Wainrib)
- **Unité de Neurosciences, Information & Complexité (UNIC)**, CNRS Gif-sur-Yvette (Alain Des-
texhe)

7.2. International Initiatives

7.2.1. Informal International Partners

- **USA**: Florida State University (Richard Bertram, Patrick Fletcher, Joël Tabak), University of Pittsburgh (Bard Ermentrout, Jonathan Rubin), Princeton University (William Bialek, Thibault Taillefumier, Simon Levi)
- **Spain**: University of the Balearic Islands (Antonio .E. Teruel, Rafel Prohens), Polytechnic University of Catalunya (Toni Guillamon), University of Sevilla (Enrique Ponce)

REO Project-Team

9. Partnerships and Cooperations

9.1. National Initiatives

9.1.1. ANR

9.1.1.1. ANR Project “EXIFSI”

Participants: Benoit Fabrèges, Miguel Ángel Fernández Varela [Principal Investigator], Mikel Landajuela Larma, Marina Vidrascu.

Period: 2012-2016

The aim of this project, coordinated by Miguel Ángel Fernández Varela, is to study mathematically and numerically new numerical methods for incompressible fluid-structure interaction.

9.1.1.2. ANR LabCom “CARDIOXCOMP”

Participants: Muriel Boulakia, Damiano Lombardi, Jean-Frédéric Gerbeau [Principal Investigator], Fabien Raphel, Eliott Tixier.

Period: 2013-2016.

This project, coordinated by Jean-Frédéric Gerbeau, is carried out in the framework of a joint laboratory (“LabCom” call of ANR) with the software company NOTOCORD. The focus is the mathematical modeling of a device measuring the electrical activity of cardiomyocytes. The overall objective of CardioXcomp is to enrich NOTOCORD’s software with modelling and simulation solutions and provide to pharmacology research a completely new set incorporating state of the art signal processing and numerical simulation.

9.1.1.3. ANR Project “iFLOW”

Participants: Chloé Audebert, Jean-Frédéric Gerbeau, Irène Vignon-Clementel [co-Principal Investigator].

Period: 2013-2017.

This ANR-TecSan, co-managed by Eric Vibert (Paul Brousse Hospital) and Irène Vignon-Clementel, aims at developing an Intraoperative Fluorescent Liver Optimization Workflow to better understand the relationship between architecture, perfusion and function in hepatectomy.

Other partners: DHU Hepatinov - Hôpital Paul Brousse, Inria Mamba, Fluoptics, IfADo, MID.

9.1.1.4. ANR Project “IFSMACS”

Participants: Muriel Boulakia, Céline Grandmont [local coordinator].

Period: 2015-2019.

The objective of this project, coordinated by Takéo Takahashi (Inria Nancy Grand-Est), is the mathematical analysis of systems involving structures immersed in a fluid. This includes the asymptotic analysis, the study of the controllability and stabilization of fluid-structure interaction systems, the understanding of the motion of self-propelled structures and the analysis and development of numerical methods to simulate fluid-structure systems.

9.1.1.5. Participation to other ANR projects

- Laurent Boudin is a member of the ANR Blanc project Kibord on kinetic models in biology and related domains
- Laurent Boudin is a member of the ANR TecSan Oxhelease
- Céline Grandmont is a member of the ANR TecSan Oxhelease
- Marina Vidrascu is a member of the ANR ARAMIS

9.1.2. Inria initiatives

9.1.2.1. ADT Project “MENAMES ”

Participants: Miguel Ángel Fernández Varela [Principal Investigator], Axel Fourmont, Marina Vidrascu.

Period: 2014-2016

The aim of this project, coordinated by Miguel Ángel Fernández Varela, is to implement in the FELiScE library several algorithms included in the shelddon and Modulef library, in particular shell elements and domain decomposition methods.

9.2. European Initiatives

9.2.1. FP7 & H2020 Projects

9.2.1.1. REVAMMAD

Title: "Retinal Vascular Modeling, Measurement and Diagnosis"

Programm: FP7

Duration: April 2013 - March 2017

Coordinator: University of Lincoln

Partners: See the web site <http://revammad.blogs.lincoln.ac.uk/partners/>

Inria contact: J.-F. Gerbeau

REVAMMAD is a European Union project aimed at combatting some of the EU's most prevalent chronic medical conditions using retinal imaging. The project aims to train a new generation of interdisciplinary scientists for the academic, clinical and industrial sectors, and to trigger a new wave of biomedical interventions. The role of REO team within this consortium is to propose a mathematical model and a simulation tool for the retina hemodynamics. See <http://revammad.blogs.lincoln.ac.uk> for more details.

9.3. International Initiatives

9.3.1. Inria International Labs

Participants: Céline Grandmont, Jessica Oakes, Irène Vignon-Clementel [correspondant].

Period: 2014-2015

Jessica Oakes was awarded an Inria@SiliconValley Grant for a post-doc at UC Berkeley to work on aerosol deposition in the lung.

9.3.2. Trans-Atlantic Network of Excellence for Cardiovascular Research

Participants: Jean-Frédéric Gerbeau, Sanjay Pant, Irène Vignon-Clementel [correspondant].

Period: 2010-2015

This network, funded by the Leducq fondation, is working on the multi-scale modeling of single ventricle hearts for clinical decision support.

Other partners: see <http://modelingventricle.clemson.edu/home>.

9.3.3. German BMBF national project Lungsys II

Participant: Irène Vignon-Clementel.

Period: 2012-2015

"Systems Biology of Lung Cancer: Dynamic Properties of Early Spread and Therapeutic Options". In collaboration with Dirk Drasdo (EPI Mamba).

Other partners: see <http://www.lungsys.de>.

9.3.4. Participation In other International Programs

- Laurent Boudin
 - Member of the French-Italian Galileo PHC on the kinetic modelling and numerical simulation of gaseous mixtures and plasmas, supervised by F. Charles (UPMC) for France.
 - Member of a French-Serbian CNRS PICS on the kinetic modelling of gaseous mixtures, supervised by B. Grec (Université Paris-Descartes) for France.

9.4. International Research Visitors

9.4.1. Visits of International Scientists

9.4.1.1. Internships

Visiting PhD student: Stephanie Lindsey, Cornell University (May 4th - May 20th)

SERENA Team

9. Partnerships and Cooperations

9.1. Regional Initiatives

GT Elfic (Labex DigiCosme, 2014–2016): “Programmes d’éléments finis formellement vérifiés”, with **TOCCATA** (Inria Saclay - Île-de-France), **CEA LIST**, **LIPN** (Université de Paris 13), and **LMAC** (Université de Technologie de Compiègne).

The research on a posteriori error estimates, unified frameworks, robustness, adaptivity, and stopping criteria of M. Vohralík was carried out with Alexandre ERN from **CERMICS**, Ecole Nationale des Ponts et Chaussées, see [14], [24].

A posteriori error estimates for eigenvalue problems were derived in collaboration with Geneviève DUSSON, Yvon MADAY, and Benjamin STAMM from the **Laboratoire Jacques-Louis Lions** and Eric CANCÈS, **CERMICS**, see [21] and [22].

A posteriori error estimates for problems with sign-changing coefficients describing electromagnetism for interfaces between dielectrics and negative metamaterials have been derived in collaboration with P. Ciarlet from the project-team **POEMS**, see [23].

9.2. National Initiatives

9.2.1. ANR

ANR GEOPOR: “Geometrical approach for porous media flows: theory and numerics”, with **Laboratoire Jacques-Louis Lions** (University Paris VI).

ANR MANIF: “Mathematical and numerical issues in first-principle molecular simulation”, with **CERMICS** (Ecole Nationale des Ponts et Chaussées), and **Laboratoire Jacques-Louis Lions** (University Paris VI).

ANR DEDALES; ”Algebraic and Geometric Domain Decomposition for Subsurface Flow”. The project aims at developing high performance software for the simulation of two phase flow in porous media. The project will specifically target parallel computers where each node is itself composed of a large number of processing cores, such as are found in new generation many-core architectures.

The partners are **HIEPACS**, **Laboratoire Analyse, Géométrie et Application**, **Maison de la Simulation**, and **ANDRA**. The coordinator of the project is M. Kern.

C2S@Exa (Computer and Computational Sciences at Exascale) is an Inria Project Lab (IPL). This national initiative aims at the development of numerical modeling methodologies that fully exploit the processing capabilities of modern massively parallel architectures in the context of a number of selected applications related to important scientific and technological challenges for the quality and the security of life in our society. This project supports in particular the Ph.D. of N. Birgler (supervised by J. Jaffré) which is part of an Inria-Andra collaboration.

9.2.2. FUI

Projet P (2011–2015) is funded by the French FUI (*Fonds Unique Interministériel*). Project P aims at supporting the model-driven engineering of high-integrity embedded real-time systems by providing an open code generation framework. The contribution of team Serena is in the domain of language translation and block-schema modelization semantics. This project supports the work of C. Franchini, under the supervision of P. Weis.

9.3. European Initiatives

9.3.1. Collaborations in European Programs, except FP7 & H2020

Program: Research, Development and Innovation Council of the Czech Republic

Project acronym: MORE

Project title: Implicitly constituted material models: from theory through model reduction to efficient numerical methods

Duration: September 2012 – September 2017

Coordinator: Josef MÁLEK, Charles University in Prague

Other partners: Institute of Mathematics, Academy of Sciences of the Czech Republic; Oxford Centre for Nonlinear Partial Differential Equations, Great Britain.

Abstract: A multidisciplinary project on nonlinear Navier–Stokes flows with implicit constitutive laws. It focuses on development of accurate, efficient, and robust numerical methods for simulations of the new class of implicit models, see <http://more.karlin.mff.cuni.cz/>.

9.4. International Initiatives

9.4.1. Participation In International Programs

Serena is part of the EuroMediterranean 3+3 program with the project HYDRINV (2012–2015): Direct and inverse problems in subsurface flow and transport. Besides Inria, institutions participating in this project are: Universitat Politècnica de Catalunya (Barcelona, Spain), Universidad de Sevilla (Spain), École Mohamedia d’Ingénieurs (Rabat, Morocco), Université Ibn Tofaïl (Kenitra, Morocco), University Centre of Khemis Miliana (Algeria), and École Nationale d’Ingénieurs de Tunis (Tunisia).

9.5. International Research Visitors

9.5.1. Visits of International Scientists

Josef Málek, professor, Mathematical Institute, Charles University in Prague. February 2–6, 2015.

Iuliu Sorin Pop, professor, Department of Mathematics and Computer Science, Eindhoven University of Technology. March 2–6, 2015.

H. Ben Ameer, professor at IPEST and member of ENIT-Lamsin, Tunis, Tunisia. November 9–20, 2015.

Carol Woodward, computational mathematician in the Center for Applied Scientific Computing (CASC) at Lawrence Livermore National Laboratory, USA, December 4, 2015.

ALPINES Project-Team

9. Partnerships and Cooperations

9.1. National Initiatives

9.1.1. ANR

9.1.1.1. *Medimax*

ANR-MN (Modèles Numériques) October 2013 - September 2017

The main goal is the methodological and numerical development of a new robust inversion tool, associated with the numerical solution of the electromagnetic forward problem, including the benchmarking of different other existing approaches (Time Reverse Absorbing Condition, Method of Small-Volume Expansions, Level Set Method). This project involves the development of a general parallel open source simulation code, based on the high-level integrated development environment of FreeFem++, for modeling an electromagnetic direct problem, the scattering of arbitrary electromagnetic waves in highly heterogeneous media, over a wide frequency range in the microwave domain. The first applications considered here will be medical applications: microwave tomographic images of brain stroke, brain injuries, from both synthetic and experimental data in collaboration with EMTensor GmbH, Vienna (Austria), an Electromagnetic Medical Imaging company.

9.1.1.2. *Non-local DD*

ANR appel à projet générique October 2015 - September 2020

This project in scientific computing aims at developing new domain decomposition methods for massively parallel simulation of electromagnetic waves in harmonic regime. The specificity of the approach that we propose lies in the use of integral operators not only for solutions local to each subdomain, but for coupling subdomains as well. The novelty of this project consists, on the one hand, in exploiting multi-trace formalism for domain decomposition and, on the other hand, considering optimized Schwarz methods relying on Robin type transmission conditions involving quasi-local integral operators.

9.1.1.3. *Soil μ -3D*

ANR appel à projet générique October 2015 - September 2020

In spite of decades of work on the modeling of greenhouse gas emission such as CO₂ and N₂O and on the feedback effects of temperature and water content on soil carbon and nitrogen transformations, there is no agreement on how these processes should be described, and models are widely conflicting in their predictions. Models need improvements to obtain more accurate and robust predictions), especially in the context of climate change, which will affect soil moisture regime.

The goal of this new project is now to go further using the models developed in MEPSOM to upscale heterogeneities identified at the scale of microbial habitats and to produce macroscopic factors for biogeochemical models running at the field scale.

To achieve this aim, it will be necessary to work at different scales: the micro-scale of pores (μm) where the microbial habitats are localized, the meso-scale of cores at which laboratory measurements on CO₂ and N₂O fluxes can be performed, and the macro-scale of the soil profile at which outputs are expected to predict greenhouse gas emission. The aims of the project are to (i) develop new descriptors of the micro-scale 3D soil architecture that explain the fluxes measured at the macro-scale, (ii) Improve the performance of our 3D pore scale models to simulate both micro-and meso- scales at the same time. Upscaling methods like “homogeneization” would help to simulate centimeter samples which cannot be achieved now. The reduction of the computational time used to solve the diffusion equations and increase the number of computational units, (iii) develop new macro-functions describing the soil micro-heterogeneity and integrate these features into the field scale models.

9.2. European Initiatives

9.2.1. FP7 & H2020 Projects

9.2.1.1. NLAJET

Title: Parallel Numerical Linear Algebra for Future Extreme-Scale Systems

Programm: H2020

Duration: November 2015 - November 2018

Coordinator: UMEÅUniversitet

Partners:

Science and Technology Facilities Council (United Kingdom)

Computer Science Department, UmeåUniversitet (Sweden)

Mathematics Department, The University of Manchester (United Kingdom)

Inria contact: Laura Grigori

The NLAJET proposal is a direct response to the demands for new mathematical and algorithmic approaches for applications on extreme scale systems, as identified in the FETHPC work programme and call. This project will enable a radical improvement in the performance and scalability of a wide range of real-world applications relying on linear algebra software, by developing novel architecture-aware algorithms and software libraries, and the supporting runtime capabilities to achieve scalable performance and resilience on heterogeneous architectures. The focus is on a critical set of fundamental linear algebra operations including direct and iterative solvers for dense and sparse linear systems of equations and eigenvalue problems. Achieving this requires a co-design effort due to the characteristics and overwhelming complexity and immense scale of such systems. Recognized experts in algorithm design and theory, parallelism, and auto-tuning will work together to explore and negotiate the necessary tradeoffs. The main research objectives are: (i) development of novel algorithms that expose as much parallelism as possible, exploit heterogeneity, avoid communication bottlenecks, respond to escalating fault rates, and help meet emerging power constraints; (ii) exploration of advanced scheduling strategies and runtime systems focusing on the extreme scale and strong scalability in multi/many-core and hybrid environments; (iii) design and evaluation of novel strategies and software support for both offline and online auto-tuning. The validation and dissemination of results will be done by integrating new software solutions into challenging scientific applications in materials science, power systems, study of energy solutions, and data analysis in astrophysics. The deliverables also include a sustainable set of methods and tools for cross-cutting issues such as scheduling, auto-tuning, and algorithm-based fault tolerance packaged into open-source library modules.

9.2.1.2. EXA2CT

Title: EXascale Algorithms and Advanced Computational Techniques

Programm: FP7

Duration: September 2013 - August 2016

Coordinator: IMEC

Partners:

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

Interuniversitair Micro-Electronica Centrum Vzw (Belgium)

Intel Corporations (France)

Numerical Algorithms Group Ltd (United Kingdom)

T-Systems Solutions for Research (Germany)

Universiteit Antwerpen (Belgium)

Universita della Svizzera italiana (Switzerland)

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

Vysoka Skola Banska - Technicka Univerzita Ostrava (Czech Republic)

Inria contact: Luc Giraud

Numerical simulation is a crucial part of science and industry in Europe. The advancement of simulation as a discipline relies on increasingly compute intensive models that require more computational resources to run. This is the driver for the evolution to exascale. Due to limits in the increase in single processor performance, exascale machines will rely on massive parallelism on and off chip, with a complex hierarchy of resources. The large number of components and the machine complexity introduce severe problems for reliability and programmability. The former of these will require novel fault-aware algorithms and support software. In addition, the scale of the numerical models exacerbates the difficulties by making the use of more complex simulation algorithms necessary, for numerical stability reasons. A key example of this is increased reliance on solvers. Such solvers require global communication, which impacts scalability, and are often used with preconditioners, increasing complexity again. Unless there is a major rethink of the design of solver algorithms, their components and software structure, a large class of important numerical simulations will not scale beyond petascale. This in turn will hold back the development of European science and industry which will fail to reap the benefits from exascale. The EXA2CT project brings together experts at the cutting edge of the development of solvers, related algorithmic techniques, and HPC software architects for programming models and communication. It will take a revolutionary approach to exascale solvers and programming models, rather than the incremental approach of other projects. We will produce modular open source proto-applications that demonstrate the algorithms and programming techniques developed in the project, to help boot-strap the creation of genuine exascale codes.

9.3. International Initiatives

9.3.1. Inria International Labs

Inria@SiliconValley

Associate Team involved in the International Lab:

9.3.1.1. COALA

Title: Communication Optimal Algorithms for Linear Algebra

International Partner (Institution - Laboratory - Researcher):

University of California Berkeley (United States) - Electrical Engineering and Computer Science (EECS) - James Demmel

Start year: 2010

See also: <https://who.rocq.inria.fr/Laura.Grigori/COALA2010/coala.html>

Our goal is to continue COALA associated team that focuses on the design and implementation of numerical algorithms for today's large supercomputers formed by thousands of multicore processors, possibly with accelerators. We focus on operations that are at the heart of many scientific applications as solving linear systems of equations or least squares problems. The algorithms belong to a new class referred to as communication avoiding that provably minimize communication, where communication means the data transferred between levels of memory hierarchy or between processors in a parallel computer. This research is motivated by studies showing that communication costs can already exceed arithmetic costs by orders of magnitude, and the gap is growing exponentially over time. An important aspect that we consider here is the validation of the algorithms in real applications through our collaborations. COALA is an Inria associate team that focuses on the design and implementation of numerical algorithms for today's large supercomputers formed by thousands of multicore processors, possibly with accelerators. We focus on operations that are at the heart of

many scientific applications as solving linear systems of equations or least squares problems. The algorithms belong to a new class referred to as communication avoiding that provably minimize communication, where communication means the data transferred between levels of memory hierarchy or between processors in a parallel computer. This research is motivated by studies showing that communication costs can already exceed arithmetic costs by orders of magnitude, and the gap is growing exponentially over time. An important aspect that we consider here is the validation of the algorithms in real applications through our collaborations.

9.4. International Research Visitors

9.4.1. Visits to International Teams

9.4.1.1. Sabbatical programme

Grigori Laura

Date: Aug 2014 - June 2015

Institution: **University of California Berkeley** (United States)

9.4.1.2. Research stays abroad

- Laura Grigori: long term mission at UC Berkeley, Computer Science Department, from September 2015 to June 2016.
- Xavier Claeys: Seminar of Applied Mathematics, ETH Zürich, Switzerland, June. 7th - 20th, 2015.
- Frédéric Hecht: Cours FreeFem++, Maths departement, Universty of Oxford, England, march 16th - 20th, 2015.
- Frédéric Hecht: FreeFem++, Cimpa Summer School on Current Research in FEM at IIT Bombay, India 6-17 July , 2015.

DYOGENE Project-Team

9. Partnerships and Cooperations

9.1. National Initiatives

9.1.1. GdR GeoSto

Members of Dyogene participate in Research Group GeoSto (Groupement de recherche, GdR 3477) <http://gdr-geostoch.math.cnrs.fr/> on Stochastic Geometry led by Pierre Calka [Université de Rouen]. This is a collaboration framework for all French research teams working in the domain of spatial stochastic modeling, both on theory development and in applications.

9.1.2. ANR

9.1.2.1. ANR GAP

Graphs, Algorithms and Probability - PI: Marc Lelarge; started in Jan 2012 - 48 months. <http://www.di.ens.fr/~lelarge/ANR-GAP.html>

Over the last few years, several research areas have witnessed important progress through the fruitful collaboration of mathematicians, theoretical physicists and computer scientists. One of them is the cavity method. Originating from the theory of mean field spin glasses, it is key to understanding the structure of Gibbs measures on diluted random graphs, which play a key role in many applications, ranging from statistical inference to optimization, coding and social sciences.

The objective of this project is to develop mathematical tools in order to contribute to a rigorous formalization of the cavity method:

- From local to global, the cavity method on diluted graphs. We will study the extent to which the global properties of a random process defined on some graph are determined by the local properties of interactions on this graph. To this end, we will relate the cavity method to the analysis of the complex zeros of the partition function, an approach that also comes from statistical mechanics. This will allow us to apply new techniques to the study of random processes on large diluted graphs and associated random matrices.
- Combinatorial optimization, network algorithms, statistical inference and social sciences. Motivated by combinatorial optimization problems, we will attack long-standing open questions in theoretical computer science with the new tools developed in the first project. We expect to design new distributed algorithms for communication networks and new algorithms for inference in graphical models. We will also analyze networks from an economic perspective by studying games on complex networks.

9.1.2.2. ANR MARMOTE

Markovian Modeling Tools and Environments - coordinator: Alain Jean-Marie (Inria Maestro); local coordinator (for partner Inria Paris-Rocquencourt): A. Bušić; Started: January 2013; Duration: 48 months; partners: Inria Paris-Rocquencourt (EPI DYOGENE), Inria Sophia Antipolis Méditerranée (EPI MAESTRO), Inria Grenoble Rhône-Alpes (EPI MESCAL), Université Versailles-St Quentin, Telecom SudParis, Université Paris-Est Creteil, Université Pierre et Marie Curie.

The aim of the project is to realize a modeling environment dedicated to Markov models. One part will develop the Perfect Simulation techniques, which allow to sample from the stationary distribution of the process. A second one will develop parallelization techniques for Monte Carlo simulation. A third one will develop numerical computation techniques for a wide class of Markov models. All these developments will be integrated into a programming environment allowing the specification of models and their solution strategy. Several applications will be studied in various scientific disciplines: physics, biology, economics, network engineering.

9.2. International Initiatives

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

9.2.1.1. PARIS

Title: Probabilistic Algorithms for Renewable Integration in Smart Grid

International Partner (Institution - Laboratory - Researcher):

University of Florida (United States) - Department of Electrical and Computer Engineering
- Sean Meyn

Start year: 2015

See also: <http://www.di.ens.fr/~busic/PARIS/>

The importance of statistical modeling and probabilistic control techniques in the power systems area is now evident to practitioners in both the U.S. and Europe. Increased introduction of renewable generation has brought unforeseen volatility to the grid that require new techniques in distributed and probabilistic control. This Associate Team brings together the complementary skills in optimization, Markov modeling, simulation, and stochastic networks with aim to help solving some pressing open problems in this area. This collaboration also opens many exciting new scientific questions in the broad area of stochastic modeling and control.

9.3. International Research Visitors

9.3.1. Visits of International Scientists

- Venkatachalam Anantharam [Professor, University of California, Jul 2015]
- Bruce Hajek [Professor, CSL, from Feb 2015 until Mar 2015]
- Holger Keeler [Post-Doctoral Fellow, Weierstrass Institute, Mar 2015]
- Armand Makowski [Professor, University of Maryland, Jul 2015]
- Peter Marbach [Professor, University of Toronto, from Jan until Jul 2015]
- Piotr Markowski [PhD Student, University of Wroclaw, Jun 2015]
- Sean Meyn [Professor, University of Florida, Feb 2015 and Jul 2015]

9.3.2. Visits to International Teams

9.3.2.1. Research stays abroad

Bartek Blaszczyszyn was visiting Mathematical Department of Wroclaw University for two weeks in April and October 2015 giving a series of lectures on stochastic geometry and modeling of communication networks.

EVA Team

9. Partnerships and Cooperations

9.1. National Initiatives

9.1.1. Competitiveness Clusters

9.1.1.1. SAHARA

Participants: Pascale Minet, Erwan Livolant.

Period: 2011 - 2015.

Partners: EADS (coordinator), Astrium, BeanAir, CNES, ECE, EPMI, Eurocopter, GlobalSys, Inria, LIMOS, Oktal SE, Reflex CES, Safran Engineering Systems.

SAHARA is a FUI project, labelled by ASTECH and PEGASE, which aims at designing a wireless sensor network embedded in an aircraft. The proposed solution should improve the embedded mass, the end-to-end delays, the cost and performance in the transfers of non critical data.

During year 2015, we provided support to the SMEs in the SAHARA project for the implementation of network algorithms and protocols.

9.1.1.2. CONNEXION

Participants: Pascale Minet, Ines Khoufi, Erwan Livolant.

Period: 2012 - 2016.

Partners: EDF (coordinator), All4Tec, ALSTOM, AREVA, Atos WorldGrid, CEA, CNRS / CRAN, Corys TESS, ENS Cachan, Esterel Technologies, Inria, LIG, Predict, Rolls-Royce Civil Nuclear, Telecom ParisTech.

The Cluster CONNEXION (Digital Command Control for Nuclear EXport and renovatION) project aims to propose and validate an innovative architecture platforms suitable control systems for nuclear power plants in France and abroad. This architecture integrates a set of technological components developed by the academic partners (CEA, Inria, CNRS / CRAN, ENS Cachan, LIG, Telecom ParisTech) and based on collaborations between major integrators such as ALSTOM and AREVA, the operator EDF in France and “techno-providers” of embedded software (Atos WorldGrid, Rolls-Royce Civil Nuclear, Corys TESS, Esterel Technologies, All4Tec, Predict). With the support of the competitiveness clusters System@tic, Minalogic and Burgundy Nuclear Partnership, the project started in April 2012. The key deliverables of the project covered several topics related demonstration concern-driven engineering models for the design and validation of large technical systems, design environments and evaluation of HMI, the implementation of Wireless Sensor Network context-nuclear, buses business object or real-time middleware facilitating the exchange of heterogeneous data and distributed data models standardized to ensure consistency of digital systems.

The EVA team focuses more particularly on the interconnection of the OCARI wireless sensor network with the industrial facility backbone and deployment algorithms of wireless sensors. In May and June 2015, we contributed with our Connexion partners to a demonstration showing that OCARI:

- supports wireless sensors of various types (e.g. temperature sensor PT100, smoke detector produced by CEA, fire alarm produced by ADWAVE, various types of flowmeters by Krohne);
- supports mobile nodes and collects their data using router nodes depending on the location of the node embedded in a mobile robot.

All the chain ranging from the physical sensors, the OCARI wireless network, the OPC/UA bus to the KASEM software was integrated to build a Service-Oriented Architecture where new services are created when new sensor nodes are deployed. Services corresponding to sensor nodes that are no longer available, are suppressed. After a service discovery, clients can select the types of measurements made by the sensor nodes they want to visualize.

In June 2015, the CONNEXION project organized an open workshop where EXERA (group of users of instrumentation and systems) was invited. **Pascal Minet** and Erwan Livolant contributed to a demonstration illustrating the integration of the OCARI wireless sensor network, the OPC-UA/ROSA middleware and the KASEM predictive maintenance system in an industrial application. A video presenting this integration was made with the participation of EDF, Inria, Telecom ParisTech, KASEM and CEA.

We also focused on deployment algorithms for mobile wireless sensor networks in temporary worksites or after a disaster. These deployments must meet coverage and connectivity requirements. In 2015 we studied solutions to ensure full coverage of the area to monitor as well as network connectivity. We proposed the OA-DVFA distributed algorithm to deploy autonomous and mobile wireless sensor nodes in a 2D area in the presence of unknown obstacles that are progressively discovered. This distributed algorithm combines the advantages of virtual forces for a fast spreading of sensor nodes and those of a virtual grid avoiding node oscillations and allowing a simple detection of redundant nodes. We also tackled the problem of deploying static sensor nodes, assisted by mobile robots that place the sensor nodes at the positions computed. The solution proposed, called MRDS, solves a multi-objective optimization problem by using a genetic algorithm.

We also studied network connectivity, more particularly how to ensure a reliable connectivity of the sink with each sensor node located at some point of interest (PoI). Our goal was to find the best trade-off between the number of relay nodes deployed and the length of the paths connecting each PoI to the sink.

9.1.2. Other collaborations

EVA has a collaboration with Vedecom. **Paul Muhlethaler** supervises Younes Bouchaala's PhD funded by Vedecom. This PhD aims at studying vehicle-to-vehicle communication to improve roads safety.

9.2. European Initiatives

9.2.1. FP7 & H2020 Projects

9.2.1.1. F-INTEROP

Type: H2020

Objective: Design and implement a cloud-based interoperability testing platform for low-power wireless standards.

Duration: Nov 2015 - Oct 2017

Coordinator: UPMC (FR)

Other partners: iMinds (BE), ETSI (FR), EANTC (DE), Mandat International (CH), DigiCat (UK), UL (LU), Inria (FR), Device Gateway (CH)

Inria contact: **Thomas Watteyne**

9.2.1.2. ARMOUR

Type: H2020

Objective: Security for the IoT

Duration: Dec 2015 – Nov 2017

Coordinator: UPMC (FR)

Other partners: Inria (FR), Synelixis (EL), Smartesting (FR), Unparallel (PT), JRC (BE), Ease Global Market (FR), Odin Solutions (ES)

Inria-EVA contact: **Thomas Watteyne**

9.2.1.3. Project Reviewing

- **Paul Muhlethaler** was reviewer for the TROPIC (Distributed computing, storage and radio resource allocation over cooperative femtocells) project.

9.2.2. Collaborations with Major European Organizations

European Telecommunications Standards Institute (ETSI)

Co-organization First ETSI 6TiSCH plugtest (interop event) in Prague, Czech Republic, 17-18 July 2015.

9.3. International Initiatives

9.3.1. Inria International Labs

9.3.1.1. REALMS

Type: Associate Team

Inria International Lab: Inria@SiliconValley

Associate teams: Inria-EVA, Prof. Glaser's team (UC Berkeley), Prof. Kerkez's team (University of Michigan, Ann Arbor)

Duration: 2015-2017

Objective: Prof. Glaser's and Prof. Kerkez's teams are revolutionizing environmental monitoring by using low power wireless TSCH networks to produce continuous environmental data accessible in real time. They are successfully deploying these networks to study mountain hydrology, observe water quality in urban watersheds, and build intelligent urban stormwater grids. The REALMS associate team conducts research across the environmental engineering and networking research domains. Its 3-year goal is to develop easy-to-use real-world network monitoring solutions to provide real-time data for environmental and urban applications. This goal leads to the following objectives: building a long-term large-scale public connectivity dataset of the networks deployed; using that dataset to model TSCH networks; and building an ecosystem of tools around this technology.

website: <https://realms-team.github.io/>

Inria contact: **Thomas Watteyne**

9.3.2. Inria International Partners

9.3.2.1. Declared Inria International Partners

Inria-EVA has a strong relationship with ENSI (Tunisia) and ENSIAS (Morocco). A significant part of our PhD students come from these engineering schools.

University of California, Berkeley, CA, USA

- Collaboration with Prof. Steven Glaser, Ziran Zhang, Carlos Oroza, Sami Malek and Zeshi Zheng through the REALMS associate team, see Section 9.3.1.1 .

University of Michigan, Ann Arbor, MI, USA

- Collaboration with Prof. Branko Kerkez through the REALMS associate team, see Section 9.3.1.1 .

KU Leuven, Belgium

- Collaboration with Prof. Danny Hughes, Prof. Wouter Joosen, Dr. Nelson Matthys, Fan Yang, Wilfried Daniels on MicroPnP and on security for the IoT.
- Dr. Malisa Vucinic, postdoctoral researcher at KU Leuven, works part time in the Inria-EVA team.
- We won Third Place in the IPSO CHALLENGE 2015 for common project MicroPnP, see Section 5.1 .
- Joint publication(s) in 2015: [35].

Linear Technology/Dust Networks, Silicon Valley, USA

- Collaboration with Prof. Kris Pister, Dr. Brett Warneke, Dr. Lance Doherty, Dr. Jonathan Simon and Joy Weiss on SmartMesh IP and 6TiSCH standardization.

- We won the IPSO CHALLENGE 2015 People's Choice Award for common project HeadsUp!, see Section 5.1 .
- Joint publication(s) in 2015: [44].

9.3.2.2. Informal International Partners

University of California, Berkeley, CA, USA

- Collaboration with Prof. Kris Pister, Dr. Nicola Accettura, Dr. Kazuki Muraoka and David Burnett on OpenWSN and 6TiSCH standardization.
- Joint publication(s) in 2015: [5], [16], [10].

Universitat Oberta de Catalunya, Barcelona, Spain

- Collaboration with Prof. Xavi Vilajosana and Dr. Pere Tuset on OpenWSN, 6TiSCH standardization and OpenMote technologies.
- We organized two OpenWSN/OpenMote tutorials together, see Section 5.1 .
- Joint publication(s) in 2015: [16], [17], [41], [15].

University of Luxembourg, Luxembourg

- Collaboration with Prof. Thomas Engel and Dr. Maria-Rita Palattella on 6TiSCH standardization.
- Joint publication(s) in 2015: [10], [13], [15]. Joint publications in 2015: TODO.

Universidad Diego Portales, Chile

- Collaboration with Prof. Diego Dujovne on OpenWSN and 6TiSCH standardization.
- Joint publication(s) in 2015: [10].

University of Science and Technology, Beijing, China

- Collaboration with Prof. Qin Wang and Tengfei Chang on 6TiSCH standardization and OpenWSN.
- Joint publication(s) in 2015: [5], [10].

University of Southern California, CA, USA

- Collaboration with Prof. Bhaskar Krishnamachari, Pedro Henrique Gomes and Pradipta Gosh on OpenWSN and 6TiSCH-based research.
- Joint publication(s) in 2015: [40].

University of Bari, Italy

- Collaboration with Prof. Alfredo Grieco, Prof. Gennaro Boggia, Dr. Giuseppe Piro and Savio Sciancalepore on security for the IoT.
- Joint publication(s) in 2015: [10].

Swedish Institute of Computer Science (SICS), Sweden

- Collaboration with Prof. Olaf Landsiedel, Dr. Simon Duquennoy and Beshr Al Nahas on distributed scheduling for TSCH networks.
- Joint publication(s) in 2015: [28].

University of Trento, Italy

- Collaboration with Dr. Oana Iova on routing in the IoT.
- Joint publication(s) in 2015: [9].

IMEC, Netherlands

- Collaboration with Dr. Pouria Zand on 6TiSCH standardization.
- Joint publication(s) in 2015: .

9.3.3. Participation In other International Programs

9.3.3.1. PEACH

Program: STIC-AmSud 2015

Title: PEACH - PrEcision Agriculture through Climate research

Inria principal investigator: **Thomas Watteyne**

International Partners (Institution - Laboratory - Researcher):

Escuela de Informática y Telecomunicaciones, Universidad Diego Portales, Santiago, Chile. Coordinator: Prof. Diego Dujovne

Universidad Tecnológica Nacional - Facultad Regional Mendoza, Grupo de I&D en Tecnologías de la Información y Comunicaciones (GridTICS). Coordinator: Prof. Gustavo Mercado

DHARMa Lab, Universidad Tecnológica Nacional, Facultad Regional Mendoza, Argentina.

Cátedra de Fisiología Vegetal, Facultad de Ciencias Agrarias, Universidad Nacional de Cuyo, Mendoza, Argentina.

Duration: 2016-2017

Goal: TPropose a design methodology for a lowpower wireless IoT sensing network, given the requirements and restrictions of a Machine Learning model to predict frost events in peach orchards and vineyards.

9.3.3.2. AWSN

Program: **Euromediterranean 3+3**

Title: Adaptive Wireless Sensor Networks

Inria principal investigator: **Pascale Minet**

International Partners (Institution - Laboratory - Researcher):

University of Catania (Italy) - DIEEI - Lucia Lo Bello

Ecole Nationale Supérieure d'Informatique et d'Analyse des Systèmes (Morocco) - ND-SRG - Mohamed Erradi

Ecole Nationale des Sciences de l'Informatique (Tunisia) - CRISTAL - Leila Azouz Saidane

Duration: Jan 2012 - Dec 2015

Wireless sensor networks (WSNs) allow the development of numerous applications in various domains, such as security and surveillance, environment protection, precision agriculture, intelligent transportation, homecare of elderly and disabled people... Communication in such WSNs has to cope with limited capacity resources, energy depletion of sensor nodes, important fluctuations of traffic in the network, changes in the network topology (radio link breakage, interferences ...) or new application requirements. In the AWSN project, we focus on the different techniques to be introduced in the WSNs to make them auto-adaptive with regard to these various changes, while meeting the application requirements. Thus, we address:

- network deployment and redeployment in order to fulfill the application requirements,
- QoS (Quality of Service) optimization taking into account real-time traffic and dynamic bandwidth allocation,
- energy efficiency and replacement of failed sensor node,
- component generation and dynamic adaptation of the application.

After the mid-term evaluation, the last topic has been replaced by the use of game theory in WSNs, where the Moroccan team is leader.

Three applications have been identified to apply the results obtained within the AWSN project: e-health, precision agriculture and Industrial WSNs with cooperative mobile robot applications. The first three topics previously defined have to be addressed in all these applications. A hierarchical architecture with different types of networks is present: WBAN and/or WSN, wireless or wired LAN, interconnected to the Internet. In addition, mobile nodes exist in these applications (e.g. mobile sinks with nurses and doctors as well tractors and farm machines, mobile robots).

In 2015, the AWSN project organized two workshops open to students and researchers:

- Workshop in Rabat in November 2015.
- Workshop in Rocquencourt in December 2015.

The AWSN project organized also open international workshops and conferences:

- RAWSN 2015: Agadir, May 2015, organized by the Moroccan team, <http://www.fsdmfes.ac.ma/rawsn/>
- WINCOM 2015: Marrakech, October 2015, organized by the Moroccan team, <http://www.wincom-conf.org/>
- the PEMWN 2015 conference in Hammamet in November 2015, 4th edition organized by the Tunisian and French teams, see the program on <https://sites.google.com/site/pemwn2015/final-program>

The outcomes of the AWSN project are multiple:

- Degrees obtained: 2 HDR, 5 PhD and 11 Masters.
- Hiring: 6 Assistant Professors in Tunisia.
- Internships: 5 internships of Tunisian students at Inria.
- Invited Professor: Leila saidane was invited at Inria for a month in 2015.
- Publications: 13 international journals and 49 international conferences

9.4. International Research Visitors

9.4.1. Visits of International Scientists

- **Carlos Oroza**, PhD student, UC Berkeley, USA, 19-30 October 2015
- **Prof. Diego Dujovne**, Professor, Universidad Diego Portales, Chile, 28-31 July 2015
- **Sami Malek**, PhD student, UC Berkeley, USA, 26 May - 12 June 2015
- **Leila Saidane**, ENSI, Tunis, Tunisia, October, November and December 2015
- **Mohammed Erradi**, ENSIAS, Rabat, Morocco, September 2015
- **Abdellatif Kobbane**, ENSIAS, Rabat, Morocco, September 2015

9.4.1.1. Internships

- **Kevin Tewouda**, internship on simulation of wireless networks with NS3, March-August 2015.

9.4.2. Visits to International Teams

9.4.2.1. Research stays abroad

- **Thomas Watteyne**, visits to Prof. Glaser's team at UC Berkeley, as part of the REALMS associate team (Section 9.3.1.1), 10-16 May, 1-17 August, 30 November-4 December 2015.

GANG Project-Team

9. Partnerships and Cooperations

9.1. National Initiatives

9.1.1. ANR *Displexity*

Participants: Carole Gallet Delporte, Hugues Fauconnier, Pierre Fraigniaud, Amos Korman, Adrian Kosowski, Laurent Viennot.

Managed by University Paris Diderot, C. Delporte and H. Fauconnier lead this project that grants 1 Ph. D.

Distributed computation keep raising new questions concerning computability and complexity. For instance, as far as fault-tolerant distributed computing is concerned, impossibility results do not depend on the computational power of the processes, demonstrating a form of undecidability which is significantly different from the one encountered in sequential computing. In the same way, as far as network computing is concerned, the impossibility of solving certain tasks locally does not depend on the computational power of the individual processes.

The main goal of DISPLEXITY (for DIStributed computing: computability and COMPLEXITY) is to establish the scientific foundations for building up a consistent theory of computability and complexity for distributed computing.

One difficulty to be faced by DISPLEXITY is to reconcile the different sub-communities corresponding to a variety of classes of distributed computing models. The current distributed computing community may indeed be viewed as two not necessarily disjoint sub-communities, one focusing on the impact of temporal issues, while the other focusing on the impact of spatial issues. The different working frameworks tackled by these two communities induce different objectives: computability is the main concern of the former, while complexity is the main concern of the latter.

Within DISPLEXITY, the reconciliation between the two communities will be achieved by focusing on the same class of problems, those for which the distributed outputs are interpreted as a single binary output: yes or no. Those are known as the yes/no-problems. The strength of DISPLEXITY is to gather specialists of the two main streams of distributed computing. Hence, DISPLEXITY will take advantage of the experience gained over the last decade by both communities concerning the challenges to be faced when building up a complexity theory encompassing more than a fragment of the field.

In order to reach its objectives, DISPLEXITY aims at achieving the following tasks:

- Formalizing yes/no-problems (decision problems) in the context of distributed computing. Such problems are expected to play an analogous role in the field of distributed computing as that played by decision problems in the context of sequential computing.
- Formalizing decision problems (yes/no-problems) in the context of distributed computing. Such problems are expected to play an analogous role in the field of distributed computing as that played by decision problems in the context of sequential computing.
- Revisiting the various explicit (e.g., failure-detectors) or implicit (e.g., a priori information) notions of oracles used in the context of distributed computing allowing us to express them in terms of decidability/complexity classes based on oracles.
- Identifying the impact of non-determinism on complexity in distributed computing. In particular, DISPLEXITY aims at a better understanding of the apparent lack of impact of non-determinism in the context of fault-tolerant computing, to be contrasted with the apparent huge impact of non-determinism in the context of network computing. Also, it is foreseen that non-determinism will enable the comparison of complexity classes defined in the context of fault-tolerance with complexity classes defined in the context of network computing.

- Last but not least, DISPLEXITY will focus on new computational paradigms and frameworks, including, but not limited to distributed quantum computing and algorithmic game theory (e.g., network formation games).

The project will have to face and solve a number of challenging problems. Hence, we have built the DISPLEXITY consortium so as to coordinate the efforts of those worldwide leaders in Distributed Computing who are working in our country. A successful execution of the project will result in a tremendous increase in the current knowledge and understanding of decentralized computing and place us in a unique position in the field.

The project has been extended until June 2016.

9.1.2. Laboratory of Information, Networking and Communication Sciences (LINCS)

Participants: François Durand, The-Dang Huynh, Leonardo Linguaglossa, Laurent Viennot.

Gang is participating to the LINCS, a research centre co-founded by Inria, Institut Mines-Télécom, UPMC and Alcatel-Lucent Bell Labs, dedicated to research and innovation in the domains of future information and communication networks, systems and services. Gang contributes to work on online social networks, content centric networking and forwarding information verification.

9.2. European Initiatives

9.2.1. FP7 & H2020 Projects

Amos Korman has received an ERC Consolidator Grant entitled “Distributed Biological Algorithms (DBA)”, started in May 2015. This project proposes a new application for computational reasoning. More specifically, the purpose of this interdisciplinary project is to demonstrate the usefulness of an algorithmic perspective in studies of complex biological systems. We focus on the domain of collective behavior, and demonstrate the benefits of using techniques from the field of theoretical distributed computing in order to establish algorithmic insights regarding the behavior of biological ensembles. The project includes three related tasks, for which we have already obtained promising preliminary results. Each task contains a purely theoretical algorithmic component as well as one which integrates theoretical algorithmic studies with experiments. Most experiments are strategically designed by the PI based on computational insights, and are physically conducted by experimental biologists that have been carefully chosen by the PI. In turn, experimental outcomes will be theoretically analyzed via an algorithmic perspective. By this integration, we aim at deciphering how a biological individual (such as an ant) “thinks”, without having direct access to the neurological process within its brain, and how such limited individuals assemble into ensembles that appear to be far greater than the sum of their parts. The ultimate vision behind this project is to enable the formation of a new scientific field, called algorithmic biology, that bases biological studies on theoretical algorithmic insights.

9.3. International Initiatives

9.3.1. Inria International Partners

9.3.1.1. Informal International Partners

Ofer Feinerman (Physics department of complex systems, Weizmann Institute of Science, Rehovot, Israel), is a team member in Amos Korman’s ERC project DBA.

Rachid Guerraoui (School of Computer and Communication Sciences, EPFL, Switzerland) maintains an active research collaboration with Gang team members (Carole Delporte, Hugues Fauconnier).

Pierluigi Crescenzi (University of Florence, Italy) is a frequent visitor to the team and maintains an active research collaboration with Gang team members (Pierre Fraigniaud).

Sergio Rajsbaum (UNAM, Mexico) is a regular collaborator of the team, also involved formally in a joint French-Mexican research project (see next subsection).

Boaz Patt-Shamir (Tel Aviv University, Israel) is a regular collaborator of the team, also involved formally in a joint French-Israeli research project (see next subsection).

9.3.2. Participation In other International Programs

Involvement in the bilateral Franco-Israeli project MAIMONIDE (2014-2015) on “Resource Allocation in the Cloud”. Pierre Fraigniaud was the project’s co-coordinator for the French side. Financed by Partenariats Hubert Curien.

Involvement in the bilateral Franco-Mexican project ECOS NORD (2013-2016) on “Distributed Verification”. Pierre Fraigniaud was the project’s co-coordinator for the French side. Partners: LIAFA and LaBRI (France), UNAM (Mexico).

9.4. International Research Visitors

9.4.1. Visits of International Scientists

Zvi Lotker (Ben Gurion University, Israel) is a long-term visitor of the team. He has also been awarded the Junior Chair of Fondation Sciences Mathématiques de Paris (FSMP) for 2015/2016.

Andrea Pietracaprina (Univ. Padova, Italy), 1 month’s visit, Fall 2015.

Geppino Pucci (Univ. Padova, Italy), 1 month’s visit, Fall 2015.

Eli Gafni (UCLA, USA), 2 months’ visit, June-July 2015.

Sam Toueg (Univ. Toronto, Canada), 1 month’s visit, January 2015.

Flavia Bonomo (Universidad de Buenos Aires, Argentina), 1 month’s visit, June 2015.

9.4.1.1. Internships

Rai Nishant

Date: May 2015 - Jul 2015

Institution: IITK (India)

Shah Parth

Date: May 2015 - Jul 2015

Institution: Indian Institute of Technology Bombay (India)

Ricardo De La Paz Guala

Date: Feb 2015 - May 2015

Institution: Universidad de Concepción (Chile)

Marc Heinrich

Date: Mar 2015 - Jun 2015

Institution: ENS Paris

Simon Collet

Date: Mar 2015 - Jun 2015

Institution: Paris VII

9.4.2. Visits to International Teams

9.4.2.1. Research stays abroad

Amos Korman made several monthly visits to Israel, collaborating with Weizmann Institute of Science and Tel-Aviv University.

MIMOVE Team

8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. Inria Support

8.1.1.1. Inria ADT iCONNECT

Participant: Nikolaos Georgantas [correspondent].

- **Name:** iConnect – *Emergent Middleware Enablers*
- **Related activities:** § 6.2
- **Period:** [October 2013 – December 2015]
- **Partners:** Inria MiMove.

The pervasive computing vision is hampered by the extreme level of heterogeneity in the underlying infrastructure, which impacts on the ability to seamlessly interoperate. Further, the fast pace at which technology evolves at all abstraction layers increasingly challenges the lifetime of networked systems in the digital environment.

Overcoming the interoperability challenge in pervasive computing systems has been at the heart of the FP7 FET IP CONNECT project (<http://www.connect-forever.eu/>), which ran from 2009 to 2012, and was coordinated by Inria ARLES (MiMove’s predecessor team). Specifically, CONNECT has been investigating the paradigm of *Emergent middleware*, where protocol mediators are dynamically synthesized so as to allow networked systems that provide complementary functionalities to successfully coordinate. The CONNECT project has in particular delivered prototype implementation of key enablers for emergent middleware, spanning discovery, protocol learning, and mediator synthesis and deployment. Further, while CONNECT focused on learning and reconciling interaction protocols at the application layer, the FP7 project CHOReOS (<http://www.choreos.eu>) to which ARLES contributed as well, investigated a complementary enabler that supports interoperability across systems implementing heterogeneous interaction paradigms (i.e., client-service, event-based and shared memory). The proposed enabler introduces the concept of XSB - eXtensible Service Bus, which revisits the notion of Enterprise Service Bus and features an end-to-end interaction protocol that preserves the interaction paradigms of the individual components, while still allowing interoperability.

The objective of the Inria iConnect ADT is to leverage and integrate the above complementary results, packaging and further enhancing enabler prototypes, for take-up of the results by the relevant open source community. The work will involve development effort focused on the following core enablers:

- Universal discovery of resources composing legacy discovery protocols,
- Dynamic synthesis and deployment of mediators specified as enhanced labelled transition systems,
- XSB as underlying run-time support for mediators so as to support interoperability across systems based on heterogeneous interaction paradigms,
- Experiment in the area of federated social networking.

We are releasing the software prototypes through the OW2 open source initiative FISSi (Future Internet Software and Services initiative – http://www.ow2.org/view/Future_Internet/), as our solutions are of direct relevance to sustaining interoperability in the Future Internet.

8.1.1.2. Inria ADT CityLab Platform

Participant: Valérie Issarny [correspondent].

- **Name:** CityLab Platform – *A Platform for Smarter Cities Promoting Social and Environmental Sustainability*
- **Related activities:** § 7.3 and § 6.3
- **Period:** [November 2014 – October 2016]
- **Partners:** Inria MiMove, Inria CLIME.

The CityLab Platform ADT is part of the CityLab Inria Project Lab focused on the study of ICT-based smart city systems from supporting “sensing” systems up to advanced data analytics and new services for the citizens. While the topic is broad, the lab leverages relevant effort within Inria project-teams that is further revisited as well as integrated to meet the challenges of smart cities

There is the promise of enabling radically new ways of living in, regulating, operating and managing cities through the increasing active involvement of citizens. The latest technology trends of crowd- sourcing/sensing (crowd-Xing) and location-based social networking have reignited citizen engagement, opening new perspectives for cost-effective ways of making local communities and cities more sustainable. However, this requires investigating supporting systems of systems from advanced sensing systems up to integrated data management and associated data analytics. This is specifically the objective of the CityLab Inria ProjectLab, where the related ADT is focused on the development and maintenance of the CityLab Platform. The platform integrates the software prototypes developed as part of the undertaken research and will be made available under open source license. It is further the objective of the ADT to deploy and experiment with the platform within cities.

8.2. European Initiatives

8.2.1. FP7 & H2020 Projects

8.2.1.1. H2020 ICT CHOReVOLUTION

Participants: Nikolaos Georgantas [correspondent], Valérie Issarny [correspondent].

Name: CHOReVOLUTION – *Automated Synthesis of Dynamic and Secured Choreographies for the Future Internet*

URL: <http://www.chorevolution.eu>

Type: Research & Innovation Action (ICT)

Topic: Tools and Methods for Software Development

Related activities: § 7.2 and § 6.2

Period: [January 2015 - December 2017]

Partners: CEFRIEL (Italy), Inria MiMove, OW2 Consortium (France), Thales Communications S.A. (France) [coordinator], Università degli Studi dell’Aquila (Italy) [scientific leader], Softeco Sismat Srl (Italy), Tirasa (Italy), Viktoria Swedish ICT (Sweden).

The Future Internet (FI) represents an age of unprecedented opportunities for social, economic, and business growth thanks to the global scale connectivity of the virtual as well as of the physical world. This indeed opens up a wealth of innovative and revolutionary real-life scenarios, as for instance illustrated by the smarter cities perspectives where envisioned scenarios significantly ease daily human activities and give support for the growth of new markets and employment opportunities. However, leveraging the FI for the development of innovative software applications remain a challenging task even though major enablers are readily available by ways of service-oriented and cloud computing. It is in particular our vision that enabling the choreography of FI services shall play a significant role in the provisioning of innovative applications. However, existing choreography-based service composition approaches are rather static and are poorly suited to the need of the FI that is a highly dynamic networking environment, further bringing together highly heterogeneous services ranging from Thing- to Business-based services that span different security domains. As a result, the technology is not mature enough for market take-up. CHOReVOLUTION elevates the Readiness Level of existing choreography technologies in order to drop the dynamism and cross-organization security barriers via the automated synthesis of dynamic and secured choreographies in the FI. To meet its objectives, CHOReVOLUTION undertakes both research and innovation tasks. The former concentrates on choreography modelling, synthesis, adaptation, service bus, security, and cloud; the latter focus on industrial validation, development support and integration platform, and the establishment of a CHOReVOLUTION community and market take- up. Last but not least CHOReVOLUTION outcomes are assessed by experimenting with new applications in the field of Intelligent Transportation Systems.

8.2.1.2. H2020 ICT FIESTA

Participants: Valérie Issarny [correspondent], Nikolaos Georgantas [correspondent].

Name: FIESTA – *Federated Interoperable Semantic IoT/cloud Testbeds and Applications*

URL: *Under construction*

Type: Research & Innovation Action (ICT)

Topic: FIRE+ (Future Internet Research & Experimentation)

Related activities: § 7.3 and § 6.3

Period: [February 2015 - January 2018]

Partners: Fraunhofer FOKUS (Germany) [**coordinator**], INSIGHT @ National University of Galway (Ireland) [**co-coordinator**], University of Southampton IT Innovation Centre (UK), Inria MiMove, University of Surrey (UK), Unparallel Innovation Lda (Portugal), Easy Global Market (France), NEC Europe Ltd (UK), University of Cantabria (Spain), Com4innov (France), Athens Information Technology (Greece), SOCIEDAD PARA EL DESARROLLO REGIONAL DE CANTABRIA (Spain), Ayuntamiento de Santander (Spain), Korea Electronics Technology Institute (Korea).

Despite the proliferation of IoT and smart cities testbeds, there is still no easy way to conduct large scale experiments that leverage data and resources from multiple geographically and administratively distributed IoT platforms. Recent advances in IoT semantic interoperability provide a sound basis for implementing novel cloud-based infrastructures that could allow testbed-agnostic access to IoT data and resources. FIESTA will open new horizons in IoT experimentation at a global scale, based on the interconnection and interoperability of diverse IoT testbeds. FIESTA will produce a first-of-a-kind blueprint experimental infrastructure (tools, techniques and best practices) enabling testbed operators to interconnect their facilities in an interoperable way, while at the same time facilitating researchers in deploying integrated experiments, which seamlessly transcend the boundaries of multiple IoT platforms. FIESTA will be validated and evaluated based on the interconnection of four testbeds (in Spain, UK, France and Korea), as well as based on the execution of novel experiments in the areas of mobile crowd-sensing, IoT applications portability, and dynamic intelligent discovery of IoT resources. In order to achieve global outreach and maximum impact, FIESTA will integrate an additional testbed and experiments from Korea, while it will also collaborate with IoT experts from USA. The participation of a Korean partner (based its own funding) will maximize FIESTA's value for EC money. Moreover, the project will take advantage of open calls processes towards attracting third-parties that will engage in the integration of their platforms within FIESTA or in the conduction of added-value experiments. As part of its sustainability strategy, FIESTA will establish a global market confidence programme for IoT interoperability, which will enable innovative platform providers and solution integrators to ensure/certify the openness and interoperability of their developments.

8.2.2. Collaborations in European Programs, except FP7 & H2020

8.2.2.1. EIT ICT Labs 3cixty

Participants: Animesh Pathak [correspondent], Rachit Agarwal [correspondent].

Name: 3cixty – *A Platform for Apps and Services that Offer Comprehensive Views of a City*

URL: <http://www.3cixty.com/>

Period: [January 2014 - December 2015]

Partners: Ambientic (F), CEFRIEL (IT), DFKI (DE) [**coordinator**], Eurecom (F) [**associate leader**], Fondazione Politecnico di Milano (IT), Innovalor (NL), Inria MiMove [**associate leader**], LocaliData (ES), Mobidot (NL), Politecnico di Milano (IT), Telecom Italia (IT) [**associate leader**], Thales (F), TU Delft (NL), UC London (UK).

3city is a platform, well motivated in business terms, for developing apps for city visitors that makes it easy for application developers to access and process comprehensive heterogeneous information about a city; and a Showcase App using the platform that demonstrates its added value. The project will result new opportunities to enable city visitors to exploit the transportation, business, cultural, and touristic opportunities offered by a city more fully and in a more personally and environmentally appropriate way, thereby benefiting cities, their visitors, and application and service developers.

8.3. International Initiatives

8.3.1. Inria International Labs

Valérie Issarny acts as scientific manager of the Inria@Silicon Valley program (<https://project.inria.fr/inria-siliconvalley/>) since summer 2013; she is visiting scholar at CITRIS, EECS, University of California, Berkeley.

Sara Hachem and Cristhian Parra have been carrying out their postdoc research at UC Berkeley in the context of the Inria@Silicon Valley program and CityLab@Inria.

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

8.3.2.1. Inria DRI/DST-CEFIPRA Associate Team: SARATHI

Participants: Animesh Pathak [correspondent], Nikolaos Georgantas [correspondent].

Name: SARATHI – *Personalized Mobility Services for Urban Travelers*

Instrument: Inria DRI/DST-CEFIPRA Associate Team

Period: [January 2014 - December 2016]

Partners: Indraprastha Institute of Information Technology (IIIT), Delhi (India), Inria MiMove.

Website: <https://saarathiproject.wordpress.com/>

The focus of the *Sarathi* project is on creating a personalized mobility service platform for urban travelers. The proposed work would require work on large scale mobile participatory sensing, urban transportation, location-aware services, machine learning, and software engineering. The individual strength of MiMove and IIIT provide complementary technical benefits for the project. MiMove leverages its work on large scale mobile participatory sensing (so far focused on EU-based transit contexts) addressing challenges brought to the fore by dynamic large scale systems in India; IIIT will build up on their previous work on mobile based system to provide route information and work on learning and mining techniques for inferring events of interest in transport systems.

Besides the complementary technical benefits, the collaboration will also help the project in evaluating the proposed solution in context of both developing and developed countries with different societal structure and preferences. Since personalized services are an integral part of the solution, the variety in social structures of India and France will help in developing solutions that are valid across continents. A deployment of the proposed solution in India will also test scalability and robustness of the solution in resource-constrained environments (e.g. intermittent network connectivity, low bandwidth) and will help in developing solutions that can be deployed in different working environments. Similarly, France (with already an advanced transit system) offers opportunities in verifying the requirements of a successful sustainable transport system.

8.3.3. Inria International Partners

8.3.3.1. Informal International Partners

We have a lasting collaboration with Prof. Fabio Costa at the Federal University of Goias (UFG), Brazil, on self-adaptive ubiquitous and cloud-based systems. This collaboration was funded by the Inria-Brazil International Scientific Cooperation Program during the period 2012-2014. In 2015, Raphael de Aquino Gomes, UFG PhD student, conducted an 1-year PhD internship with MiMove, funded by a scholarship of the CAPES/CNPq Brazilian Science without Borders program. A collaborative project proposal by Inria MiMove and UFG was submitted at the "Associate Teams with Brazil Program" 2016 Call, co-funded by Inria and the Brazilian Research Foundations (FAPs). The project was successfully evaluated and will be funded for three years, enabling further fruitful exchanges between UFG and Inria MiMove.

8.4. International Research Visitors

8.4.1. Visits of International Scientists

8.4.1.1. Internships

Raphael de Aquino Gomes (from Sep. 2014 until Aug. 2015)

PhD internship funded by a visitor PhD student scholarship of the Brazilian Science without Borders program provided by CAPES and CNPq.

Subject: *Self-Adaptive Use of Cloud Resources for Heterogeneous Dynamic Service Choreographies*

Institution: Federal University of Goiás - UFG (Brazil)

8.4.2. Visits to International Teams

8.4.2.1. Research stays abroad

Valérie Issarny is visiting scholar at CITRIS at UC Berkeley, in the context of which she carries out collaborative research in the area of smart cities and acts as scientific coordinator of the Inria@SiliconValley program.

MUSE Team

8. Partnerships and Cooperations

8.1. European Initiatives

8.1.1. User-Centric Networking (UCN)

Type: FP7

Instrument: Specific Targeted Research Project

Duration: October 2013 - September 2016

Coordinator: Technicolor

Other partners: Eurecom, Fraunhofer FOKUS, Intamac, University of Cambridge, University of Nottingham, Martel, NICTA, Portugal Telecom

Inria contact: Renata Teixeira

Abstract: This project introduces the concept of User Centric Networking (UCN), which is a new paradigm leveraging user information at large to deliver novel content recommendation systems and content delivery frameworks. UCN recommendation and content delivery systems will leverage in-depth knowledge about users to help them find relevant content, identify nearby network resources and plan how to deliver the actual content to the appropriate device at the desired time. These systems will additionally account for influences from users' social networks on their content consumption. The goal of this project is to design a UCN system architecture for user-centric connected media services. We will build UCN upon three complementary research pillars:

1. understanding user context: This data can be broadly categorized into three groups. First, the physical and environmental context A second category of data is that which can be extracted from social network interactions. The third category of data is behavioural
2. profiling and predicting user interests: By gaining a deep understanding of the user, we may be able to cast a much wider net in the content ocean and locate a richer catalogue of interesting content for the user
3. personalizing content delivery: Rather than the user (or the service provider) having to worry about the mode of connectivity, device, service, location, etc., the network intelligently directs and adapts the transport stream, or perhaps pre-fetches and replicates content chunks, to the particular and immediate needs of the user.

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

8.2. International Initiatives

8.2.1. Inria International Partners

8.2.1.1. Informal International Partners

- Princeton (Prof. Nick Feamster): We have a long-term collaboration on measuring the performance of residential broadband Internet access networks and more recently on home network diagnosis.
- ICSI (Dr. Srikanth Sundaresan, Dr. Christian Kreibich, Dr. Robin Sommer): With C. Kreibich, we have been developing Fathom, a browser-based network measurement platform. We are now adding home network diagnosis capabilities to Fathom. We are collaborating with S. Sundaresan on detecting last-mile bottlenecks. In addition, with Robin Sommer we are working on the potential of matching the profiles of a user across multiple online social networks.

- Northwestern University (Prof. Fabian Bustamante and his doctoral student Zachary Bischof): we are working on identifying user activity from network traffic.

8.3. International Research Visitors

8.3.1. Visits of International Scientists

8.3.1.1. Internships

- S. Mohammadyari, master intern, Politecnico di Torino, Italy, March to July 2015.
- Zachary Bischof, doctoral intern, Northwestern University, USA, July to September 2015.

RAP Project-Team

6. Partnerships and Cooperations

6.1. International Initiatives

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

6.1.1.1. RNA

An Associate Team between RAP and McGill university provides funding for a project on the theoretical and applied aspects of connectivity in random networks. The co-funding at McGill financed by the via the CARP FQRNT team grant of L. Addario-Berry, L. Devroye and B. Reed (2013-2015)

The bilateral project PHD Procope funded by Campus France (formerly Egide) obtained in 2014 jointly between the LIX at Ecole Polytechnique (PI Marie Albenque) and the Mathematics institute of Frankfurt's university is still running for 2015. The team RAP is associated to the LIX for this contract.

Title: Connectivity and distances in models of random networks and applications

International Partner (Institution - Laboratory - Researcher):

Start year: 2013

See also: <http://algo.inria.fr/broutin/aap-rna.html>

The projet will shed some new light on two complementary aspects of connectivity and the structure of distances in models of random networks. - We will first explore the nature and universality of phase transition and critical phenomena in random graphs, and more generally for high-dimensional percolation systems. Phase transitions are crucial in statistical physics, but also in the theory of computing where one observes that constraints satisfaction problem exhibit such a sudden change whose understanding is believed to yield important information about hardness of computation. - We will also investigate the connectivity of geometric models of random graphs which are at the core of modelling of wireless networks. In particular we will focus on some global aspects such as the quantification of connectivity, sparsity, and the behavior of diffusion algorithms. We will also design of distributed algorithms to initiate the network which guarantee efficiency and scalability.

6.2. International Research Visitors

6.2.1. Visits of International Scientists

- Louigi Addario-Berry (McGill)
- Cecile Mailler (Bath)
- Jean-Francois Marckert (LaBRI, Bordeaux)
- Leonardo Rolla (Buenos Aires)

6.2.1.1. Internships

- Plinio Santini Dester, M1 student at Polytechnique (Avril-July 2015).

6.2.2. Visits to International Teams

- *Nicolas Broutin* has visited the mathematics department of the University of Bath, the School of Computer Science at McGill University, the computer science laboratory in Bordeaux (LaBRI) and the NYU-ECNU institute for mathematical sciences at NYU Shanghai.

REGAL Project-Team

8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. Labex SMART - (2012–2019)

Members: ISIR (UPMC/CNRS), LIP6 (UPMC/CNRS), LIB (UPMC/INSERM), LJLL (UPMC/CNRS), LTCI (Institut Mines-Télécom/CNRS), CHArt-LUTIN (Univ. Paris 8/EPHE), L2E (UPMC), STMS (IRCAM/CNRS).

Funding: Sorbonne Universités, ANR.

Description: The SMART Labex project aims globally to enhancing the quality of life in our digital societies by building the foundational bases for facilitating the inclusion of intelligent artifacts in our daily life for service and assistance. The project addresses underlying scientific questions raised by the development of Human-centered digital systems and artifacts in a comprehensive way. The research program is organized along five axes and Regal is responsible of the axe “Autonomic Distributed Environments for Mobility.”

The project involves a PhD grant of 100 000 euros over 2,5 years.

8.1.2. InfraJVM - (2012–2015)

Members: LIP6 (Regal), Ecole des Mines de Nantes (Constraint), IRISA (Triskell), LaBRI (LSR).

Funding: ANR Infra.

Objectives: The design of the Java Virtual Machine (JVM) was last revised in 1999, at a time when a single program running on a uniprocessor desktop machine was the norm. Today’s computing environment, however, is radically different, being characterized by many different kinds of computing devices, which are often mobile and which need to interact within the context of a single application. Supporting such applications, involving multiple mutually untrusted devices, requires resource management and scheduling strategies that were not planned for in the 1999 JVM design. The goal of InfraJVM is to design strategies that can meet the needs of such applications and that provide the good performance that is required in an MRE.

The coordinator of InfraJVM is Gaël Thomas, who left the team in 2014. Infra-JVM brings a grant of 202 000 euros from the ANR to UPMC over three years.

8.2. European Initiatives

8.2.1. FP7 & H2020 Projects

8.2.1.1. SyncFree

Title: Large-scale computation without synchronisation

Programm: FP7

Duration: October 2013 - September 2016

Coordinator: Inria

Partners:

Basho Technologies (United Kingdom)

Faculdade de Ciencias e Tecnologia da Universidade Nova de Lisboa (Portugal)

Koç University (Turkey)

Rovio Entertainment Oy (Finland)

Trifork As (Denmark)

Université Catholique de Louvain (Belgium)

Technische Universitaet Kaiserslautern (Germany)

Inria contact: Marc Shapiro

The goal of SyncFree is to enable large-scale distributed applications without global synchronisation, by exploiting the recent concept of Conflict-free Replicated Data Types (CRDTs). CRDTs allow unsynchronised concurrent updates, yet ensure data consistency. This revolutionary approach maximises responsiveness and availability; it enables locating data near its users, in decentralised clouds. Global-scale applications, such as virtual wallets, advertising platforms, social networks, online games, or collaboration networks, require consistency across distributed data items. As networked users, objects, devices, and sensors proliferate, the consistency issue is increasingly acute for the software industry. Current alternatives are both unsatisfactory: either to rely on synchronisation to ensure strong consistency, or to forfeit synchronisation and consistency altogether with ad-hoc eventual consistency. The former approach does not scale beyond a single data centre and is expensive. The latter is extremely difficult to understand, and remains error-prone, even for highly-skilled programmers. SyncFree avoids both global synchronisation and the complexities of ad-hoc eventual consistency by leveraging the formal properties of CRDTs. CRDTs are designed so that unsynchronised concurrent updates do not conflict and have well-defined semantics. By combining CRDT objects from a standard library of proven datatypes (counters, sets, graphs, sequences, etc.), large-scale distributed programming is simpler and less error-prone. CRDTs are a practical and cost-effective approach. The SyncFree project will develop both theoretical and practical understanding of large-scale synchronisation-free programming based on CRDTs. Project results will be new industrial applications, new application architectures, large-scale evaluation of both, programming models and algorithms for large-scale applications, and advanced scientific understanding.

8.3. International Initiatives

8.3.1. Inria International Labs

Inria Chile

Associate Team involved in the International Lab:

8.3.1.1. ARMADA

Title: hARnessing MAssive DAta flows

International Partner (Institution - Laboratory - Researcher):

Universidad Tecnica Federico Santa Maria (Chile) - Department of Computer Science
(Department of Comput) - Xavier Bonnaire

Start year: 2014

See also: <http://web.inria-armada.org>

The ARMADA project aims at designing and implementing a reliable framework for the management and processing of massive dynamic dataflows. The project is two-pronged: fault-tolerant middleware support for processing massive continuous input, and a redundant storage service for mutable data on a massive scale.

8.3.2. Participation In other International Programs

8.3.2.1. PHC Maimonide

Title: Application dependent intrusion (byzantine) detection in Dynamic cloud systems

International Partner (Institution - Laboratory - Researcher):

Technion Haifa - Prof. Roy Friedman

Duration: 2014–2015

The goal of this project is to study the ability to tolerate Byzantine failures in dynamic environments. The Byzantine model allows arbitrary behaviour of a certain fraction of nodes. Our goal is to provide both a theoretical framework and performance evaluation to tolerate Byzantine behaviour in dynamic distributed environments. We consider "bag of tasks" (BoT) applications characterized by trivial parallelism where a large computational problem is broken into a large number of independent tasks. These tasks can be spread on commodity hardware and operating systems. We target different executions environments: (1) Clouds: tasks are submitted to virtual machines hosted at cloud providers, (2) Desktop grid: tasks are submitted to federate large pool of donated machines hosted at user home, (3) Hybrid cloud: combining both cloud and desktop nodes.

8.3.2.2. *CNRS-Inria-FAP's*

Title: Autonomic and Scalable Algorithms for Building Resilient Distributed Systems

International Partner (Institution - Laboratory - Researcher):

Universida de Federal do Paraná (UFPR), Brazil, Prof. Elias Duarte

Duration: 2015–2017

In the context of autonomic computing systems that detect and diagnose problems, self-adapting themselves, the VCube (Virtual Cube), proposed by Prof. Elias Duarte, is a distributed diagnosis algorithm that organizes the system nodes on a virtual hypercube topology. VCube has logarithmic properties: when all nodes are fault-free, processes are virtually connected to form a perfect hypercube; as soon as one or more failures are detected, links are automatically reconnected to remove the faulty nodes and the resulting topology, connecting only fault-free nodes, keeps the logarithmic properties. The goal of this project is to exploit the autonomic and logarithmic properties of the VCube by proposing self-adapting and self-configurable services.

8.4. International Research Visitors

8.4.1. *Visits of International Scientists*

8.4.1.1. *Internships*

Dastagiri Reddy MalikiReddy

Date: May—Aug. 2015

Institution: IITKGP (India)

Alvarez Colombo Santiago Javier

Date: Jul. 2015—Jan. 2016

Institution: Universidad de Buenos Aires (Argentina)

WHISPER Project-Team

9. Partnerships and Cooperations

9.1. National Initiatives

9.1.1. ANR

InfraJVM - (2012 - 2015)

Members: LIP6 (Regal-Whisper), Ecole des Mines de Nantes (Constraint), IRISA (Triskell), LaBRI (LSR).

Coordinator: Gaël Thomas

Whisper members: Julia Lawall, Gilles Muller

Funding: ANR Infra, 202 000 euros.

Objectives: The design of the Java Virtual Machine(JVM) was last revised in 1999, at a time when a single program running on a uniprocessor desktop machine was the norm. Today's computing environment, however, is radically different, being characterized by many different kinds of computing devices, which are often mobile and which need to interact within the context of a single application. Supporting such applications, involving multiple mutually untrusted devices, requires resource management and scheduling strategies that were not planned for in the 1999 JVM design. The goal of InfraJVM is to design strategies that can meet the needs of such applications and that provide the good performance that is required in an MRE. The PhD of Florian David was supported in part by InfraJVM.

Chronos network, Time and Events in Computer Science, Control Theory, Signal Processing, Computer Music, and Computational Neurosciences and Biology - (2015 - 2016)

Coordinator: Gerard Berry

Whisper member: Gilles Muller

Funding: ANR 2014, Défi "Société de l'information et de la communication".

The Chronos interdisciplinary network aims at placing in close contact and cooperation researchers of a variety of scientific fields: computer science, control theory, signal processing, computer music, neurosciences, and computational biology. The scientific object of study will be the understanding, modeling, and handling of time- and event-based computation across the fields.

Chronos will work by organizing a regular global seminar on subjects ranging from open questions to concrete solutions in the research fields, workshops gathering subsets of the Chronos researchers to address specific issues more deeply, a final public symposium presenting the main contributions and results, and an associated compendium.

9.1.2. Multicore Inria Project Lab

The Multicore IPL is an Inria initiative, led by Gilles Muller, whose goal is to develop techniques for deploying parallel programs on heterogeneous multicore machines while preserving scalability and performance. The IPL brings together researchers from the ALF, Algorille, CAMUS, Compsys, DALI, REGAL, Runtime and Whisper Inria Teams. These connections provide access to a diversity of expertise on open source development and parallel computing, respectively. In this context, Gilles Muller and Julia Lawall are working with Jens Gustedt and Mariem Saeid of Inria Lorraine and on developing a domain-specific language that eases programming with the ordered read-write lock (ORWL) execution model. The goal of this work is to provide a single execution model for parallel programs and to allow them to be deployed on multicore machines with varying architectures.

9.2. International Initiatives

9.2.1. Inria International Partners

9.2.1.1. Informal International Partners

David Lo, of Singapore Management University, is an expert in the use of statistical methods in understanding software and associated artifacts, with over 140 publications in this area. Julia Lawall has worked with Lo over the past 5 years, exploiting the complementarity of her expertise in Linux code and in program analysis with Lo's expertise in statistical methods, resulting in 10 joint publications [47], [44], [66], [70], [71], [72], [73], [69], [76]. This collaboration has been reinforced in the form of a Merlion collaboration grant from the Institut Français for the years 2013 and 2014, resulting in the exchange of researchers and PhD students between Whisper and Singapore Management University.

Wouter Swierstra is lecturer in the Software Technology Group of Utrecht University. His work lies at the crossroad between dependent type theory, generic programming, and domain-specific languages embedded in type theory. As part of his PEPS JCJC, Pierre-Évariste Dagand visited him to apply for a joint Van Gogh grant on the topic of extending type theory with language interoperability, allowing unsafe operations to be performed in a type-safe framework.

Timothy Roscoe is a Professor in the Institute for Pervasive Computing at ETH Zurich. His research areas are operating systems, distributed systems, and networking. As part of his PEPS JCJC, Pierre-Évariste Dagand visited the Systems group at ETH to explore avenues for collaboration on applying synchronous programming concepts to the design and implementation of network stacks.

9.3. International Research Visitors

9.3.1. Visits of International Scientists

Greg Kroah-Hartman visited the Whisper team in March and April 2015, as an Inria invited researcher. Kroah-Hartman is one of the leading developers of the Linux kernel, and at the time only one of two developers employed by the Linux Foundation, with the other being Linus Torvalds. During his visit, he gave a number of courses and seminars at UPMC, Paris Diderot University, and Ecole Normale Supérieure, and a keynote in a conference on the Internet of Things organized by the GTLL. He also participated throughout his visit in the activities of the Whisper team around the use of Coccinelle and research projects related to the Linux kernel.

9.3.1.1. Internships

Iago Abal, a PhD student at the IT University in Copenhagen, Denmark, visited the Whisper team from January 14, 2015 to March 1, 2015.

9.3.1.2. Research stays abroad

As part of Academics Without Borders, Pierre-Évariste Dagand was a visiting researcher at the University of Cape Coast (Ghana) during 2 months. Aside from his teaching duties, his role was to foster the research activity of the university's Computer Science department. He was thus in charge of the organisation of a weekly research seminar, whose purpose was to perform scientific dissemination and to transmit academic best practices.

ALPAGE Project-Team

9. Partnerships and Cooperations

9.1. National Initiatives

9.1.1. LabEx EFL (*Empirical Foundations of Linguistics*) (2011 – 2021)

Participants: Laurence Danlos, Benoît Sagot, Chloé Braud, Marie Candito, Benoit Crabbé, Pierre Magistry, Djamé Seddah, Sarah Beniamine, Maximin Coavoux, Éric Villemonte de La Clergerie.

Linguistics and related disciplines addressing language have achieved much progress in the last two decades but improved interdisciplinary communication and interaction can significantly boost this positive trend. The LabEx (excellency cluster) EFL (Empirical Foundations of Linguistics), launched in 2011 and headed by Jacqueline Vaissière, opens new perspectives by adopting an integrative approach. It groups together some of the French leading research teams in theoretical and applied linguistics, in computational linguistics, and in psycholinguistics. Through collaborations with prestigious multidisciplinary institutions (CSLI, MIT, Max Planck Institute, SOAS...) the project aims at contributing to the creation of a Paris School of Linguistics, a novel and innovative interdisciplinary site where dialog among the language sciences can be fostered, with a special focus on empirical foundations and experimental methods and a valuable expertise on technology transfer and applications.

Alpage is a very active member of the LabEx EFL together with other linguistic teams we have been increasingly collaborating with: LLF (University Paris 7 & CNRS) for formal linguistics, LIPN (University Paris 13 & CNRS) for NLP, LPNCog (University Paris 5 & CNRS) LSCP (ENS, EHESS & CNRS) for psycholinguistics, MII (University Paris 4 & CNRS) for Iranian and Indian studies. Alpage resources and tools have already proven relevant for research at the junction of all these areas of linguistics, both before the start of the LabEx EFL and within several EFL “scientific operations” (see Section 4.6). Moreover, the LabEx provides Alpage with opportunities for collaborating with new teams, e.g., on language resource development and empirical studies in collaboration with descriptive linguists.

The LabEx EFL’s scientific activities are spread across 7 autonomous scientific “strands”. In 2015, Benoît Sagot, Marie Candito and Benoit Crabbé were respectively deputy-head of strand 6 on “Language Resources”, strands 5 on “Computational semantic analysis” and strand 2 on “Experimental grammar from a cross-linguistic perspective”. Several project members are in charge of research operations within these 3 strands.

9.1.2. ANR

9.1.2.1. ANR project PARSEME-FR (2016 - 2019)

Participants: Marie Candito, Mathieu Constant [principal investigator], Benoit Crabbé, Laurence Danlos, Éric Villemonte de La Clergerie, Djamé Seddah.

PARSEME-FR is a 4-year ANR research project headed by Mathieu Constant (LIGM, Université Paris-Est Marne-la-Vallée, currently in “délégation” at Alpage). PARSEME-FR partners are LIGM, Alpage, LI (Université de Tours), LIF (Aix-Marseille Université) and LIFO (Université d’Orléans). This project aims at improving linguistic representativeness, precision and computational efficiency of Natural Language Processing (NLP) applications, notably parsing. The project focuses on the major bottleneck of these applications: Multi-Word Expressions (MWEs), i.e. groups of words with a certain degree of idiomaticity such as “hot dog”, “to kick the bucket”, “San Francisco 49ers” or “to take a haircut”. In particular, it aims at investigating the syntactic and semantic representation of MWEs in language resources, the integration of MWE analysis in (deep) syntactic parsing and its links to semantic processing. Expected deliverables include enhanced language resources (lexicons, grammars and annotated corpora) for French, MWE-aware (deep) parsers and tools linking predicted MWEs to knowledge bases. This proposal is a spin-off of the European IC1207 COST action PARSEME on the same topic.

Alpage will participate mainly to two tasks: (i) the production of an evaluation corpus annotated with MWE and (ii) the production of MWE-aware statistical parsers, both for surface syntax and deep syntax. MWE recognition can be viewed as part of a more ambitious task of recovering the semantic units of a sentence. Combining it to deep syntactic parsing will provide a further step towards semantic parsing.

9.1.2.2. ANR project ASFALDA (2012 – 2016)

Participants: Marie Candito [principal investigator], Marianne Djemaa, Benoît Sagot, Éric Villemonte de La Clergerie, Laurence Danlos, Virginie Moulleron, Vanessa Combet Meunier.

Alpage is principal investigator team for the ANR project ASFALDA, lead by Marie Candito. The other partners are the Laboratoire d'Informatique Fondamentale de Marseille (LIF), the CEA-List, the MELODI team (IRIT, Toulouse), the Laboratoire de Linguistique Formelle (LLF, Paris Diderot) and the Ant'Inno society.

The project aims to provide both a French corpus with semantic annotations and automatic tools for shallow semantic analysis, using machine learning techniques to train analyzers on this corpus. The target semantic annotations are structured following the FrameNet framework [45] and can be characterized roughly as an explicitation of “who does what when and where”, that abstracts away from word order / syntactic variation, and to some of the lexical variation found in natural language.

The project relies on an existing standard for semantic annotation of predicates and roles (FrameNet), and on existing previous effort of linguistic annotation for French (the French Treebank). The original FrameNet project provides a structured set of prototypical situations, called frames, along with a semantic characterization of the participants of these situations (called *roles*). We propose to take advantage of this semantic database, which has proved largely portable across languages, to build a French FrameNet, meaning both a lexicon listing which French lexemes can express which frames, and an annotated corpus in which occurrences of frames and roles played by participants are made explicit. The addition of semantic annotations to the French Treebank, which already contains morphological and syntactic annotations, will boost its usefulness both for linguistic studies and for machine-learning-based Natural Language Processing applications for French, such as content semantic annotation, text mining or information extraction.

To cope with the intrinsic coverage difficulty of such a project, we adopt a hybrid strategy to obtain both exhaustive annotation for some specific selected concepts (commercial transaction, communication, causality, sentiment and emotion, time), and exhaustive annotation for some highly frequent verbs. Pre-annotation of roles will be tested, using linking information between deep grammatical functions and semantic roles.

The project is structured as follows:

- Task 1 concerns the delimitation of the focused FrameNet substructure, and its coherence verification, in order to make the resulting structure more easily usable for inference and for automatic enrichment (with compatibility with the original model);
- Task 2 concerns all the lexical aspects: which lexemes can express the selected frames, how they map to external resources, and how their semantic argument can be syntactically expressed, an information usable for automatic pre-annotation on the corpus;
- Task 3 is devoted to the manual annotation of corpus occurrences (we target 20000 annotated occurrences);
- In Task 4 we will design a semantic analyzer, able to automatically make explicit the semantic annotation (frames and roles) on new sentences, using machine learning on the annotated corpus;
- Task 5 consists in testing the integration of the semantic analysis in an industrial search engine, and to measure its usefulness in terms of user satisfaction.

The scientific key aspects of the project are:

- an emphasis on the diversity of ways to express the same frame, including expression (such as discourse connectors) that cross sentence boundaries;
- an emphasis on semi-supervised techniques for semantic analysis, to generalize over the available annotated data.

9.1.2.3. ANR project Polymnie (2012-2016)

Participants: Laurence Danlos, Éric Villemonte de La Clergerie, Timothée Bernard.

Polymnie is an ANR research project headed by Sylvain Podogolla (Sémagramme, Inria Lorraine) with Melodi (INRIT, CNRS), Signes (LABRI, CNRS) and Alpage as partners. This project relies on the grammatical framework of Abstract Categorical 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. ACG allows for the encoding of a large variety of grammatical formalisms, in particular Tree Adjoining grammars (TAG).

The role of Alpage in this project is to develop sentential or discursive grammars written in TAG and to participate in their conversion in ACG. Results were first achieved in 2014 concerning text generation: GTAG formalism created by Laurence Danlos in the 90's has been rewritten in ACG [65], [66], [67]. As regards discursive analysis, D-STAG formalism created by Laurence Danlos in the 00's has also been rewritten in ACG in 2015 [24] and enhanced with some preliminary linguistic work on attributions [39].

9.1.3. Other national initiatives

9.1.3.1. “Investissements d’Avenir” project PACTE (2012 – 2015)

Participants: Benoît Sagot, Kata Gábor, Pierre Magistry.

PACTE (*Projet d’Amélioration de la Capture TExtuelle*) is an “Investissements d’Avenir” project submitted within the call “Technologies de numérisation et de valorisation des contenus culturels, scientifiques et éducatifs”. It started in November 2012, although the associated fundings only arrived at Alpage in July 2013.

PACTE’s aims was the improvement of performance of textual capture processes (OCR, manual script recognition, manual capture, direct typing), using NLP tools relying on both statistical (n -gram-based, with scalability issues) and hybrid techniques (involving lexical knowledge and POS-tagging models). It was more specifically targeted to the application domain of written heritage. The project takes place in a multilingual context, and therefore aims at developing as language-independent techniques as possible.

PACTE involved 3 companies (Numen, formerly Diadeis, main partner, as well as A2IA and Isako) as well as Alpage and the LIUM (University of Le Mans). It brings together business specialists, large-scale corpora, lexical resources, as well as the scientific and technical expertise required.

9.1.3.2. FUI project COMBI (2014-2016)

Participants: Laurence Danlos, Vanessa Combet Meunier, Jacques Steinlin.

COMBI is an “FUI 16” project. It started in February 2014 for a two year duration. It groups 5 industrial partners (Temis, Isthma, Kwaga, Yseop and Qunb) and Alpage. Temis and Istma work on data mining from texts and big data. Kwaga works on the interpretation and inferences that can be drawn from the data retrieved in the analysis module. Alpage and Qunb work, under the supervision of Yseop, on the production of respectively texts and graphics describing the results of the interpretation module. Currently, COMBI aims at creating the full chain for a user case concerning the weekly activity of an on-line service.

Alpage works on text generation, with the adaptation of TextElaborator, a generation system developed in the 10's by WatchAssistance and based on G-TAG. Alpage also works on the opportunity to describe pieces of information by texts, graphics or both.

9.1.3.3. Institut de Linguistique Française and Consortium Corpus Écrits within the TGIR Huma-Num

Participants: Benoît Sagot, Stéphane Riou, Djamé Seddah.

Huma-Num is a TGIR (Very Large Research Infrastructure) dedicated to digital humanities. Among Huma-Num initiatives are a dozen of consortia, which bring together most members of various research communities. Among them is the *Corpus Écrits* consortium, which is dedicated to all aspects related to written corpora, from NLP to corpus development, corpus specification, standardization, and others. All types of written corpora are covered (French, other languages, contemporary language, medieval language, specialized text, non-standard text, etc.). The consortium Corpus Écrits is managed by the Institut de Linguistique Française, a CNRS federation of which Alpage is a member since June 2013, under the supervision of Franck Neveu.

Alpage is involved in various projects within this consortium, and especially in the development of corpora for CMC texts (blogs, forum posts, SMSs, textchat...) and shallow corpus annotation, especially with MELt, and in the development of a preliminary version of the future Corpus de Référence du Français (French Reference Corpus).

9.2. European Initiatives

9.2.1. H2020 PARTHENOS

Participants: Laurent Romary, Charles Riondet.

This EU project Parthenos of the H2020 INFRADEV program aims at strengthening the cohesion of research in the broad sector of Linguistic Studies, Humanities, Cultural Heritage, History, Archaeology and related fields through a thematic cluster of European Research Infrastructures, integrating initiatives, e-infrastructures and other world-class infrastructures, and building bridges between different, although tightly interrelated, fields. Within this project started in May 2015, Alpage has the leadership over the work package dedicated to the promotion and development of standards in the humanities.

In 2015, Laurent Romary and Charles Riondet have identified digital humanities use cases where standards play a central role and specified an architecture for organising standards related information (specification, software, bibliography, reference material, experts) at the service of scholars in the humanities.

9.2.2. H2020 EHRI

Participants: Laurent Romary, Charles Riondet.

The EHRI 2 (European Holocaust Research Infrastructure), also in the INFRADEV program of H2020, seeks to transform archival research on the Holocaust, by providing methods and tools to integrate and provide access to a wide variety of archival content. The project has started in June 2015 and will lead us to work on both standards for the representation of archival content and develop data mining components for archival textual data.

In 2015, we have focused on the identification of available data sources resulting from the first phase of the project in the previous years and compile specifications for the description of authorities according to the EAC (Encoded Archival Context) standard.

9.2.3. H2020 Iperion

Participant: Laurent Romary.

The H2020 Iperion project aims at coordinating infrastructural activities in the cultural heritage domain. Our team has a small participation in relation to the definition of data management and representation issues. This will directly contribute to increase our experience in curating the kind of heterogeneous linguistic data that we gathered over the years.

In 2015, we have designed a questionnaire for all data producers in the project in order to gather feedback on their existing practices (data flows, licences, formats) concerning the creation, management and dissemination of cultural heritage data. On this basis, we have produced a first version of the data management plan for the project.

9.2.4. Collaborations in European Programs, except FP7 & H2020

Program: IC1207 COST

Project acronym: PARSEME

Project title: PARSing and Multi-word Expressions

Duration: March 2013 - March 2017

Coordinator: Agata Savary

Other partners: interdisciplinary experts (linguists, computational linguists, computer scientists, psycholinguists, and industrialists) from 30 countries

Abstract: The aim of this project is to improve linguistic representativeness, precision and computational efficiency of Natural Language Processing (NLP) applications, focusing on the major bottleneck of these applications: Multi-Word Expressions (MWEs), i.e., sequences of words with unpredictable properties such as "to count somebody in" or "to take a haircut". A breakthrough in their modelling and processing is targeted, as the result of a coordinated effort of multidisciplinary experts working on fourteen different languages.

Program: ISCH COST Action IS1312

Project acronym: TextLink

Project title: Structuring Discourse in Multilingual Europe

Duration: April 2014 - April 2018

Coordinator: Liesbeth Degand

Other partners: experts in computational linguistics and discourse from 24 countries

France MC members: Laurence Danlos and Philippe Muller (IRIT)

Abstract: This action will facilitate European multilingualism by (1) identifying and creating a portal into discourse-level resources within Europe - including annotation tools, search tools, and discourse-annotated corpora; (2) delineating the dimensions and properties of discourse annotation across corpora; (3) organising these properties into a sharable taxonomy; (4) encouraging the use of this taxonomy in subsequent discourse annotation and in cross-lingual search and studies of devices that relate and structure discourse; and (5) promoting use of the portal, its resources and sharable taxonomy.

RITS Project-Team

9. Partnerships and Cooperations

9.1. National Initiatives

9.1.1. ANR

9.1.1.1. COCOVEA

Title: Coopération Conducteur-Véhicule Automatisé

Instrument: ANR

Duration: November 2013 - April 2017

Coordinator: Jean-Christophe Popieul (LAMIH - University of Valenciennes)

Partners: LAMIH, IFSTTAR, Inria, University of Caen, COMETE, PSA, CONTINENTAL, Valeo, AKKA Technologies, SPIROPS

Inria contact: Fawzi Nashashibi

Abstract: CoCoVeA project aims at demonstrating the need to integrate from the design of the system, the problem of interaction with the driver in resolving the problems of sharing the driving process and the degree of freedom, authority, level of automation, prioritizing information and managing the operation of the various systems. This approach requires the ability to know at any moment the state of the driver, the driving situation in which he finds himself, the operating limits of the various assistance systems and from these data, a decision regarding activation or not the arbitration system and the level of response.

9.1.1.2. VALET

Title: Redistribution automatique d'une flotte de véhicules en partage et valet de parking

Instrument: ANR

Duration: January 2016 - December 2018

Coordinator: Fawzi Nashashibi

Partners: Inria, Ecole Centrale de Nantes (IRCCyN), AKKA Technologies

Inria contact: Fawzi Nashashibi

Abstract: The VALET project proposes a novel approach for solving car-sharing vehicles redistribution problem using vehicle platoons guided by professional drivers. An optimal routing algorithm is in charge of defining platoons drivers' routes to the parking areas where the followers are parked in a complete automated mode. The main idea of VALET is to retrieve vehicles parked randomly on the urban parking network by users. These parking spaces may be in electric charging stations, parking for car sharing vehicles or in regular parking places. Once the vehicles are collected and guided in a platooning mode, the objective is then to guide them to their allocated parking area or to their respective parking lots. Then each vehicle is assigned a parking place into which it has to park in an automated mode.

9.1.2. FUI

9.1.2.1. Sinetic

Title: Système Intégré Numérique pour les Transports Intelligents Coopératifs

Instrument: FUI

Duration: December 2014 - May 2017

Coordinator: Thomas Nguyen (Oktal)

Partners: Oktal, ALL4TEC, CIVITEC, Dynalogic, Inria, EURECOM, Renault, Armines, IFSTTAR, VEDECOM

Inria contact: Jean-Marc Lasgouttes

Abstract: The purpose of the project SINETIC is to create a complete simulation environment for designing cooperative intelligent transport systems with two levels of granularity: the system level, integrating all the components of the system (vehicles, infrastructure management centers, etc.) and its realities (terrain, traffic, etc.) and the component-level, modeling the characteristics and behavior of the individual components (vehicles, sensors, communications and positioning systems, etc.) on limited geographical areas, but described in detail.

9.1.3. Competitiveness Clusters

RITS team is a very active partner in the competitiveness clusters, especially MOV'EO and System@tic. We are involved in several technical committees like the DAS SUR of MOV'EO for example. RITS is also the main Inria contributor in the VEDECOM institute (IEED). VEDECOM is financing the PhD theses of Pierre Merdrignac, Younes Bouchaala, Fernando Garrido Carpio and Zayed Alsayed.

9.2. European Initiatives

9.2.1. FP7 & H2020 Projects

9.2.1.1. CityMobil2

Type: COOPERATION (TRANSPORTS)

Instrument: Large-scale integrating project

Duration: September 2012 - August 2016

Coordinator: University of Rome La Sapienza, CTL (Italy)

Partners: Inria (France), DLR (Germany), GEA Chanard (Switzerland), POLIS (Belgium), ERT (Belgium), EPFL (Switzerland),... (45 partners!)

Inria contact: Fawzi Nashashibi

Abstract: The CityMobil2 goal is to address and to remove three barriers to the deployment of automated road vehicles: the implementation framework, the legal framework and the unknown wider economic effect. CityMobil2 features 12 cities which will revise their mobility plans and adopt wherever they will prove effective automated transport systems. Then CityMobil2 will select the best 5 cases (among the 12 cities) to organize demonstrators. The project will procure two sets of automated vehicles and deliver them to the five most motivated cities for a 6 to 8 months demonstration in each city. CityMobil2 will establish a workgroup that will deliver a proposal for a European Directive to set a common legal framework to certify automated transport systems.

See also: <http://www.citymobil2.eu/en/>

9.2.1.2. Mobility2.0

Title: Co-operative ITS systems for enhanced electric vehicle mobility

Type: COOPERATION (TRANSPORTS)

Duration: September 2012 - February 2015

Coordinator: Broadbit (Slovakia)

Partners: ETRA (Spain), Barcelona Digital (Spain), ICCS (Greece), MRE (Italy), Armines (France), University of Twente (Netherlands), Privé (Italy), NEC (United Kingdom)

Inria contact: Jean-Marc Lasgouttes

Abstract: Mobility2.0 will develop and test an in-vehicle commuting assistant for FEV mobility, resulting in more reliable and energy-efficient electro-mobility. In order to achieve a maximum impact, Mobility2.0 takes an integrated approach of addressing the main bottlenecks of urban FEV mobility: “range anxiety” related to the limited FEV range, scarcity of parking spaces with public recharging spots, and the congestion of urban roads. Our integrated approach means the application developed by Mobility2.0 will utilize co-operative systems to simultaneously consider these bottlenecks, so that such an optimization can be achieved which still guarantees reliable transportation for each FEV owner. Mobility2.0 will focus on assisting the daily urban commute, which represents the bulk of urban mobility.

See also: <http://mobility2.eu/>

9.2.1.3. DESERVE

Title: DEvelopment platform for Safe and Efficient dRiVE

Duration: September 2012 - August 2015

Coordinator: VTT (Finland)

Partners: CRF (Italy), Armines (France), CONTINENTAL AUTOMOTIVE FRANCE SAS (France), FICOSA (Italy), Inria (France), TRW (Great Britain), AVL (Austria), BOSCH (Germany), DAIMLER (Germany), VOLVO (Sweden),...(26 partners)

Inria contact: Fawzi Nashashibi

Abstract: To manage the expected increase of function complexity together with the required reduction of costs (fixed and variable) DESERVE will design and build an ARTEMIS Tool Platform based on the standardization of the interfaces, software (SW) reuse, development of common non-competitive SW modules, and easy and safety-compliant integration of standardized hardware (HW) or SW from different suppliers. With innovative design space exploration (DSE) methods system design costs can be reduced by more than 15%. Hence, DESERVE will build an innovation ecosystem for European leadership in ADAS embedded systems, based on the automotive R&D actors, with possible applications in other industrial domains.

See also: <https://artemis-ia.eu/project/38-deserve.html>

9.2.1.4. AutoNet2030

Title: Co-operative Systems in Support of Networked Automated Driving by 2030

Duration: November 2013 - October 2016

Coordinator: Andras KOVACS – BROADBIT (Hungary)

Partners: BROADBIT (Hungary), BASELABS (Germany), CRF (Italy), Armines (France), VOLVO (Sweden), HITACHI EUROPE (France), EPFL (Switzerland), ICCS (Greece), TECHNISCHE UNIVERSITAET DRESDEN (Germany) (9 partners)

Inria contact: Fawzi Nashashibi

AutoNet2030 shall develop and test a co-operative automated driving technology, based on a decentralized decision-making strategy which is enabled by mutual information sharing among nearby vehicles. The project is aiming for a 2020-2030 deployment time horizon, taking into account the expected preceding introduction of co-operative communication systems and sensor based lane-keeping/cruise-control technologies. By taking this approach, a strategy can be worked out for the gradual introduction of fully automated driving systems, which makes the best use of the widespread existence of co-operative systems in the near-term and makes the deployment of fully automated driving systems beneficial for all drivers already from its initial stages.

See also: <http://www.autonet2030.eu>

9.2.1.5. FURBOT

Title: Freight Urban RoBOTic vehicle

Type: FP7

Instrument: Specific Targeted Research Project

Duration: November 2011 - December 2015

Coordinator: Genova University (Italy)

Partner: Bremach (Italy), ZTS (Slovakia), Universite di Pisa (Italy), Persico (Italy), Mazel (Spain), TCB (Portugal), Inria (France).

Inria contact: Fawzi Nashashibi

Abstract: The project proposes novel concept architectures of light-duty, full-electrical vehicles for efficient sustainable urban freight transport and will develop FURBOT, a vehicle prototype, to factually demonstrate the performance expected.

9.2.2. Collaborations with Major European Organizations

RITS is member of the **euRobotics AISBL** and the Leader of “People transport” Topic. This makes from Inria one of the rare French robotics representatives at the European level. See also: <http://www.eu-robotics.net/>

RITS is a full partner of **VRA – Vehicle and Road Automation**, a support action funded by the European Union to create a collaboration network of experts and stakeholders working on deployment of automated vehicles and its related infrastructure. VRA project is considered as the cooperation interface between EC funded projects, international relations and national activities on the topic of vehicle and road automation. It is financed by the European Commission DG CONNECT and coordinated by ERTICO – ITS Europe. See also: <http://vra-net.eu/>

RITS is member of the Working Group on Automation: **iMobility**. This group has been created and is animated by ERTICO ITS Europe. The Automation Working Group was formed under the iMobility Forum, with the initial high level aims of exploring and promoting the potential of highly automated vehicles and applications and working towards the development of a roadmap for the deployment of automated systems. See also: <http://www.imobilitysupport.eu/imobility-forum/working-groups/automation>

9.3. International Initiatives

9.3.1. Inria International Partners

9.3.1.1. International Academics Partners

- **NAIST – Japan:** RITS has a close cooperation with NAIST (Nara institute of Science and Technology), Japan since 2009. Based on this collaboration NAIST and Inria established the MoU agreement to accelerate and strengthen future research collaborations and the exchange of researchers and students. This year RITS hosted Sakriani Watiasri Sakti, assistant professor at NAIST.
- **International Chaire “Drive4U”:** Inria-RITS, Mines ParisTech, EPFL, Univ. of Berkeley (PATH Program) and Shanghai Jiao Tong Univ. (SJTU) are the academic partners of the international Chaire GAT, funded and supported by: Valeo Group, SAFRAN Group and MPSA Group (Peugeot-Citroën). A recent NDA has been signed recently. This Chaire will promote and fund academic activities related to Ground Automated Transportation and autonomous driving.
- **Technical University of Sophia – Bulgaria:** RITS is conducting a close partnership with the Technical University of Sophia (Department of Mechanical Engineering). Since 2009, Professor Plamen Petrov has been a visiting professor at Inria. He contributed in conducting common advanced researches with RITS researchers in the field of dynamic modeling and adaptive motion control for vehicles and robots. Joint works have been also driven to develop and validate platooning concepts for normal speed driving of automated vehicles.

9.3.2. Participation In other International Programs

- ASIA-ITC (STIC-ASIE) programme: project SIM-CITIES (2015-2016), "Sustainable and Intelligent Mobility for Smart Cities", coordinated by F. Nashashibi.
Partners: RITS, IRCCyN/CNRS, NTU (Singapore), Dept. of Computer Science and Electrical Engineering Graduate School of Science and Technology Kumamoto University (Japan), Department of Automation of the Shanghai Jiao Tong University (SJTU University, China) and the Information and Communication Engineering and the MICA Lab (Vietnam). RITS and MICA lab have obtained from the Vietnamese Program 911 the financing of the joint PhD thesis of Dinh-Van Nguyen (co-directed by Eric Castelli from MICA lab and Fawzi Nashashibi).
- ECOS Nord international program: cooperation between Simon Bolivar University – Venezuela and RITS. This program started effectively in 2014 with the visit of two researchers and a PhD student from each institute to the other institute. This year, Adriana Zurita Villamizar engineer (trainee) from SBU made several months stay at RITS. She worked in the field of intelligent control.

9.4. International Research Visitors

9.4.1. Visits of International Scientists

- **Plamen Petrov**, professor at Sofia University, Bulgaria, from July 2015 until September 2015.
- **Sakriani Watiasri Sakti**, assistant professor at NAIST, from February 2015. A part of the work done during her stay has been published in [38].

9.4.1.1. Internships

- **Aidos Ibrayev**, from Al-Farabi Kazakh National University, Kazakhstan.
- **Jose Emilio Traver Becerra and Myriam Vaca Recalde** from Universidad de Extremadura, Spain.
- **Jaycee Holmes** from Spelman College, U.S.A.
- **Adriana Zurita Villamiza** from Simon Bolivar University, Venezuela.

SMIS Project-Team

8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. ANR KISS (Dec. 2011 - Dec. 2015)

Partners: Inria-SMIS (coordinator), Inria-SECRET, LIRIS, Univ. of Versailles, CryptoExperts, Gemalto, Yvelines district.

SMIS funding: 230k€.

The idea promoted in KISS is to embed, in trusted devices, software components capable of acquiring, storing and managing securely various forms of personal data (e.g., salary forms, invoices, banking statements, geolocation data, depending on the applications). These software components form a Personal Data Server which can remain under the holder's control. The scientific challenges include: embedded data management issues tackling regular, streaming and spatio-temporal data (e.g., geolocation data), data provenance-based privacy models, crypto-protected distributed protocols to implement private communications and secure global computations.

8.1.2. CAPPRIS Project-Lab (Dec. 2011 - Dec. 2015)

Inria Partners: PRIVATICS (coordinator), SMIS, PLANETE, CIDRE, COMETE.

External partners: Univ. of Namur, Eurecom, LAAS.

Funding: not associated to individual project-teams.

An Inria Project Lab (IPL) is a long-term multi-disciplinary project launched by Inria to sustain large scale risky research actions in line with its own strategic plan. CAPPRIS stands for "Collaborative Action on the Protection of Privacy Rights in the Information Society". The key issues that are addressed are: (1) the identification of existing and future threats to privacy, (2) the definition of formally grounded measures to assess and quantify privacy, (3) the definition of the fundamental principles underlying privacy by design and methods to apply them in concrete situations and (4) The integration of the social and legal dimensions. To assess the relevance and significance of the research results, they are confronted to three classes of case studies CAPPRIS partners are involved in: namely Online Social Networks, Location Based Services and Electronic Health Record Systems.

8.1.3. CityLab@Inria, Inria Project Lab (May 2014 -).

Inria Partners: ARLES-MIMOVE, CLIME, DICE, FUN, MYRIADS, OAK, SMIS, URBANET, WILLOW.

External partners: UC Berkeley.

Funding: not associated to individual project teams.

CityLab@Inria studies ICT solutions toward smart cities that promote both social and environmental sustainability. A strong emphasis of the Lab is on the undertaking of a multi-disciplinary research program through the integration of relevant scientific and technology studies, from sensing up to analytics and advanced applications, so as to actually enact the foreseen smart city Systems of Systems. SMIS contributes to Privacy-by-Design architectures for trusted smart objects so as to ensure privacy to citizens, which is critical for ensuring that urbanscale sensing contributes to social sustainability and does not become a threat. <https://citylab.inria.fr/>

8.1.4. VALDO (Valorisation et monétisation des données personnelles à l'ère du Big Data), Digital Society Institute (DSI) (May 2015 - Sept. 2016).

Partners: DANTE and SMIS (co-organizers), CERDI, RITM.

SMIS funding: 50K€.

The objective of this project is to study with a multidisciplinary approach (i.e., computer science, law and economics) the impact of putting a certain (e.g., monetary) value on personal data, over the behavior of individuals (that are the rightful owners of the data) and market companies (that make usage of the personal data) in terms of data protection practices and data usage.

WILLOW Project-Team

9. Partnerships and Cooperations

9.1. National Initiatives

9.1.1. Agence Nationale de la Recherche (ANR): SEMAPOLIS

Participants: Mathieu Aubry, Josef Sivic.

The goal of the SEMAPOLIS project is to develop advanced large-scale image analysis and learning techniques to semantize city images and produce semantized 3D reconstructions of urban environments, including proper rendering. Geometric 3D models of existing cities have a wide range of applications, such as navigation in virtual environments and realistic sceneries for video games and movies. A number of players (Google, Microsoft, Apple) have started to produce such data. However, the models feature only plain surfaces, textured from available pictures. This limits their use in urban studies and in the construction industry, excluding in practice applications to diagnosis and simulation. Besides, geometry and texturing are often wrong when there are invisible or discontinuous parts, e.g., with occluding foreground objects such as trees, cars or lampposts, which are pervasive in urban scenes. This project will go beyond the plain geometric models by producing semantized 3D models, i.e., models which are not bare surfaces but which identify architectural elements such as windows, walls, roofs, doors, etc. Semantic information is useful in a larger number of scenarios, including diagnosis and simulation for building renovation projects, accurate shadow impact taking into account actual window location, and more general urban planning and studies such as solar cell deployment. Another line of applications concerns improved virtual cities for navigation, with object-specific rendering, e.g., specular surfaces for windows. Models can also be made more compact, encoding object repetition (e.g., windows) rather than instances and replacing actual textures with more generic ones according to semantics; it allows cheap and fast transmission over low-bandwidth mobile phone networks, and efficient storage in GPS navigation devices.

This is a collaborative effort with LIGM / ENPC (R. Marlet), University of Caen (F. Jurie), Inria Sophia Antipolis (G. Drettakis) and Acute3D (R. Keriven).

9.2. European Initiatives

9.2.1. European Research Council (ERC) Advanced Grant: "VideoWorld" - Jean Ponce

Participants: Jean Ponce, Ivan Laptev, Josef Sivic.

WILLOW will be funded in part from 2011 to 2016 by the ERC Advanced Grant "VideoWorld" awarded to Jean Ponce by the European Research Council.

'Digital video is everywhere, at home, at work, and on the Internet. Yet, effective technology for organizing, retrieving, improving, and editing its content is nowhere to be found. Models for video content, interpretation and manipulation inherited from still imagery are obsolete, and new ones must be invented. With a new convergence between computer vision, machine learning, and signal processing, the time is right for such an endeavor. Concretely, we will develop novel spatio-temporal models of video content learned from training data and capturing both the local appearance and nonrigid motion of the elements—persons and their surroundings—that make up a dynamic scene. We will also develop formal models of the video interpretation process that leave behind the architectures inherited from the world of still images to capture the complex interactions between these elements, yet can be learned effectively despite the sparse annotations typical of video understanding scenarios. Finally, we will propose a unified model for video restoration and editing that builds on recent advances in sparse coding and dictionary learning, and will allow for unprecedented control of the video stream. This project addresses fundamental research issues, but its results are expected to serve as a basis for groundbreaking technological advances for applications as varied as film post-production, video archival, and smart camera phones.'

9.2.2. European Research Council (ERC) Starting Grant: “Activia” - Ivan Laptev

Participant: Ivan Laptev.

WILLOW will be funded in part from 2013 to 2017 by the ERC Starting Grant "Activia" awarded to Ivan Laptev by the European Research Council.

‘Computer vision is concerned with the automated interpretation of images and video streams. Today’s research is (mostly) aimed at answering queries such as ‘Is this a picture of a dog?’, (classification) or sometimes ‘Find the dog in this photo’ (detection). While categorisation and detection are useful for many tasks, inferring correct class labels is not the final answer to visual recognition. The categories and locations of objects do not provide direct understanding of their function i.e., how things work, what they can be used for, or how they can act and react. Such an understanding, however, would be highly desirable to answer currently unsolvable queries such as ‘Am I in danger?’ or ‘What can happen in this scene?’. Solving such queries is the aim of this proposal. My goal is to uncover the functional properties of objects and the purpose of actions by addressing visual recognition from a different and yet unexplored perspective. The main novelty of this proposal is to leverage observations of people, i.e., their actions and interactions to automatically learn the use, the purpose and the function of objects and scenes from visual data. The project is timely as it builds upon the two key recent technological advances: (a) the immense progress in visual recognition of objects, scenes and human actions achieved in the last ten years, as well as (b) the emergence of a massive amount of public image and video data now available to train visual models. ACTIVIA addresses fundamental research issues in automated interpretation of dynamic visual scenes, but its results are expected to serve as a basis for ground-breaking technological advances in practical applications. The recognition of functional properties and intentions as explored in this project will directly support high-impact applications such as detection of abnormal events, which are likely to revolutionise today’s approaches to crime protection, hazard prevention, elderly care, and many others.’

9.2.3. European Research Council (ERC) Starting Grant: “Leap” - Josef Sivic

Participant: Josef Sivic.

The contract has begun on Nov 1st 2014. WILLOW will be funded in part from 2014 to 2018 by the ERC Starting Grant "Leap" awarded to Josef Sivic by the European Research Council.

‘People constantly draw on past visual experiences to anticipate future events and better understand, navigate, and interact with their environment, for example, when seeing an angry dog or a quickly approaching car. Currently there is no artificial system with a similar level of visual analysis and prediction capabilities. LEAP is a first step in that direction, leveraging the emerging collective visual memory formed by the unprecedented amount of visual data available in public archives, on the Internet and from surveillance or personal cameras - a complex evolving net of dynamic scenes, distributed across many different data sources, and equipped with plentiful but noisy and incomplete metadata. The goal of this project is to analyze dynamic patterns in this shared visual experience in order (i) to find and quantify their trends; and (ii) learn to predict future events in dynamic scenes. With ever expanding computational resources and this extraordinary data, the main scientific challenge is now to invent new and powerful models adapted to its scale and its spatio-temporal, distributed and dynamic nature. To address this challenge, we will first design new models that generalize across different data sources, where scenes are captured under vastly different imaging conditions such as camera viewpoint, temporal sampling, illumination or resolution. Next, we will develop a framework for finding, describing and quantifying trends that involve measuring long-term changes in many related scenes. Finally, we will develop a methodology and tools for synthesizing complex future predictions from aligned past visual experiences. Our models will be automatically learnt from large-scale, distributed, and asynchronous visual data, coming from different sources and with different forms of readily-available but noisy and incomplete metadata such as text, speech, geotags, scene depth (stereo sensors), or gaze and body motion (wearable sensors). Breakthrough progress on these problems would have profound implications on our everyday lives as well as science and commerce, with safer cars that anticipate the behavior of pedestrians on streets; tools that help doctors monitor, diagnose and predict patients’ health; and smart glasses that help people react in unfamiliar situations enabled by the advances from this project.’

9.2.4. EIT-ICT labs: Mobile visual content analysis (Inria)

Participants: Ivan Laptev, Josef Sivic.

The goal of this project within the European EIT-ICT activity is to mature developed technology towards real-world applications as well as transfer technology to industrial partners. Particular focus of this project is on computer vision technology for novel applications with wearable devices. The next generation mobile phones may not be in the pocket but worn by users as glasses continuously capturing audio-video data, providing visual feedback to the user and storing data for future access. Automatic answers to “Where did I leave my keys yesterday?” or “How did this place look like 100 years ago?” enabled by such devices could change our daily life while creating numerous new business opportunities. The output of this activity is new computer vision technology to enable a range of innovative mobile wearable applications.

This is a collaborative effort with S. Carlsson (KTH Stockholm) and J. Laaksonen (Aalto University).

9.3. International Initiatives

9.3.1. IARPA FINDER Visual geo-localization (Inria)

Participants: Josef Sivic, Petr Gronat, Relja Arandjelovic.

Finder is an IARPA funded project aiming to develop technology to geo-localize images and videos that do not have geolocation tag. It is common today for even consumer-grade cameras to tag the images that they capture with the location of the image on the earth’s surface (“geolocation”). However, some imagery does not have a geolocation tag and it can be important to know the location of the camera, image, or objects in the scene. Finder aims to develop technology to automatically or semi-automatically geo-localize images and video that do not have the geolocation tag using reference data from many sources, including overhead and ground-based images, digital elevation data, existing well-understood image collections, surface geology, geography, and cultural information.

Partners: ObjectVideo, DigitalGlobe, UC Berkeley, CMU, Brown Univ., Cornell Univ., Univ. of Kentucky, GMU, Indiana Univ., and Washington Univ.

9.3.2. Inria CityLab initiative

Participants: Josef Sivic, Jean Ponce, Ivan Laptev, Alexei Efros [UC Berkeley].

Willow participates in the ongoing CityLab@Inria initiative (co-ordinated by V. Issarny), which aims to leverage Inria research results towards developing “smart cities” by enabling radically new ways of living in, regulating, operating and managing cities. The activity of Willow focuses on urban-scale quantitative visual analysis and is pursued in collaboration with A. Efros (UC Berkeley).

Currently, map-based street-level imagery, such as Google Street-view provides a comprehensive visual record of many cities worldwide. Additional visual sensors are likely to be wide-spread in near future: cameras will be built in most manufactured cars and (some) people will continuously capture their daily visual experience using wearable mobile devices such as Google Glass. All this data will provide large-scale, comprehensive and dynamically updated visual record of urban environments.

The goal of this project is to develop automatic data analytic tools for large-scale quantitative analysis of such dynamic visual data. The aim is to provide quantitative answers to questions like: What are the typical architectural elements (e.g., different types of windows or balconies) characterizing a visual style of a city district? What is their geo-spatial distribution (see figure 1)? How does the visual style of a geo-spatial area evolve over time? What are the boundaries between visually coherent areas in a city? Other types of interesting questions concern distribution of people and their activities: How do the number of people and their activities at particular places evolve during a day, over different seasons or years? Are there tourists sightseeing, urban dwellers shopping, elderly walking dogs, or children playing on the street? What are the major causes for bicycle accidents?

Break-through progress on these goals would open-up completely new ways smart cities are visualized, modeled, planned and simulated, taking into account large-scale dynamic visual input from a range of visual sensors (e.g., cameras on cars, visual data from citizens, or static surveillance cameras).

9.4. International Research Visitors

9.4.1. Visits of International Scientists

Prof. Alexei Efros (UC Berkeley) has visited Willow for one month in 2015. Prof. John Canny (UC Berkeley) has visited Willow during three months in 2015 within the framework of Inria's International Chair program.

9.4.1.1. Internships

Filip Srajer (Czech Technical University) has been a visiting MSc student at Willow in Feb 2015. Nishant Agrawal (IIT, India) has been a visiting intern at Willow for three months in 2015. Yumin Suh (Seoul National Univ., South Korea) has been a visiting intern at Willow for five months in 2015. Michail Nikita (Moscow State Univ., Russia) has been a visiting intern at Willow for three weeks in 2015.