Activity Report 2016

Section Partnerships and Cooperations

ASAP Project-Team

8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. ANR project SocioPlug

Participants: Davide Frey, Anne-Marie Kermarrec, Pierre-Louis Roman, Francois Taiani.

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

8.1.2. DeSceNt CominLabs

Participants: Resmi Ariyattu Chandrasekharannair, Davide Frey, Michel Raynal, Francois Taiani.

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

8.1.3. ANR Blanc project Displexity

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

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

8.1.4. ANR project PAMELA

Participants: Davide Frey, George Giakkoupis, Francois Taiani.

PAMELA is a collaborative ANR project involving ASAP, Inria Lille, UMPC, Mediego and Snips. The project aims at developing machine learning theories and algorithms in order to learn local and personalized models from data distributed over networked infrastructures. This project seeks to provide first answers to modern information systems built by interconnecting many personal devices holding private user data in the search of personalized suggestions and recommendations. More precisely, we will focus on learning in a collaborative way with the help of neighbors in a network. We aim to lay the first blocks of a scientific foundation for these new types of systems, in effect moving from graphs of data to graphs of data and learned models. We argue that this shift is necessary in order to address the new constraints arising from the decentralization of information that is inherent to the emergence of big data. We will in particular focus on the question of learning under communication and privacy constraints. A significant asset of the project is the quality of its industrial partners, SNIPS and MEDIEGO, who bring in their expertise in privacy protection and distributed computing as well as use cases and datasets. They will contribute to translate this fundamental research effort into concrete outcomes by developing personalized and privacy-aware assistants able to provide contextualized recommendations on small devices and smartphones.

8.1.5. ANR project OBrowser

Participants: David Bromberg, Davide Frey, Francois Taiani.

OBrowser is a collaborative ANR project involving Inria (ASAP team), the Univ. Nantes, the Bretagne Sud. University, and Orange. The project emerges from the vision of designing and deploying distributed application on millions of machines using web-enabled technologies without relying on a cloud or a central authority. OBrowser proposes to build collaborative applications through a decentralized execution environment composed of users' browsers that autonomously manages issues such as communication, naming, heterogeneity, and scalability. The introduction of browser-to-browser communication with WebRTC's Datachannel has made these scenarios closer, but today only experts can afford to tackle the technical challenges associated with large-scale browser-based deployments such as decentralized instant-messaging (Firechat) and Infrastructure-less Mission Critical Push To Talk. O'Browser aims to solve these challenges by means of a novel programming framework.

8.1.6. ANR project DESCARTES

Participants: George Giakkoupis, Michel Raynal, Francois Taiani.

DESCARTES is a collaborative ANR project involving ASAP, Labri (U. Bordeaux), Lafia (U. Paris Diderot), Vérimag (Grenoble), LIF (Marseilles), and LINA (Nantes). Despite the practical interests of reusable frameworks for implementing specific distributed services, many of these frameworks still lack solid theoretical bases, and only provide partial solutions for a narrow range of services. In this project, we argue that this is mainly due to the lack of a generic framework that is able to unify the large body of fundamental knowledge on distributed computation that has been acquired over the last 40 years. The DESCARTES project aims at bridging this gap, by developing a systematic model of distributed computation that organizes the functionalities of a distributed computing system into reusable modular constructs assembled via well-defined mechanisms that maintain sound theoretical guarantees on the resulting system. DESCARTES arises from the strong belief that distributed computing is now mature enough to resolve the tension between the social needs for distributed computing systems, and the lack of a fundamentally sound and systematic way to realize these systems.

8.1.7. ANR-ERC Tremplin project NDFUSION

Participant: George Giakkoupis.

NDFUSION is an 18-month ANR project awarded to the PI to support his preparation for his upcoming ERC grant application. The idea of intervening in a network diffusion process to enhance or retard its spread has been studied in various contexts, e.g., to increase the spread or speed of diffusion by choosing an appropriate set of seed nodes (a standard goal in viral marketing by word-of-mouth), or achieve the opposite effect either by choosing a small set of nodes to remove (a goal in immunization against diseases), or by seeding a competing diffusion (e.g., to limit the spread of misinformation in a social network). The aim of this project is to consolidate existing work under a single, comprehensive framework, and using this framework to develop

new, efficient algorithms for optimizing (maximizing or minimizing) the spread of diffusion processes. Novel aspects of the project involve issues of scalability, multiple concurrent diffusions, and the use of multistage online strategies to optimize diffusions. Results from this project are likely to be relevant to many different disciplines, from network optimization in computing to disease containment in medicine.

8.2. International Initiatives

8.2.1. Inria International Labs

Anne-Marie Kermarrec has been scientific collaborator at EPFL, Lausanne, since Feb 2014.

Anne-Marie Kermarrec has been the scientific coordinator of the EPFL/Inria International Lab since Feb 2015.

8.3. International Research Visitors

8.3.1. Visits of International Scientists

Antonio Carzaniga, Università della Svizzera italiana (USI), Apr 29.

Evangelos Bampas, Aix-Marseille Université, Mar 23.

Fábio Moreira Costa, Institute of Informatics, Federal University of Goiás, Goiânia-GO, Brazil, Sep 12–16.

Ricardo Couto Antunes da Rocha, Department of Computer Science, Federal University of Goiás, Catalão-GO, Brazil, Sep 12–16.

Rachid Guerraoui, EPFL, Switzerland, invited Professor at Univ. Rennes I / ISTIC, since September 2016.

Arvid Bosk, KTH Royal Institute of Technology, guest PhD Student, from Dec 2016.

8.3.1.1. Internships

Florestan De Moor, Collaborative Filtering Under a Sybil Attack, Univ. Rennes I, May to Jul 2016, supervised by Davide Frey.

Julien Lepiller, Private Decentralized Aggregation, Inria, Feb to Jun 2016, supervised by Davide Frey and Francois Taiani.

8.3.2. Visits to International Teams

8.3.2.1. Research Stays Abroad

David Bromberg visited UFG, Goiania, Brazil, from Jun to Jul 2016 (CONFAP CNRS project)

8.3.2.2. Internships

Pierre-Louis Roman did an internship at Vrije Universiteit Amsterdam, The Netherlands, from Jun to Aug 2016 under the supervision of Spyros Voulgaris, with a grant from Université Bretagne Loire.

Simon Bouget did an internship at Centre for Complex Systems and Big Data at University of Neuchatel, Switzerland, from May to Aug 2016, under the supervision of Etienne Rivière, with a grant from the "Outgoing Mobility for Doctoral Students" program of Rennes Métropole.

Stéphane Delbruel did an internship at Universita della Svizzera Italiana, Switzerland, from Jun to Jul 2016, under the supervision of Antonio Carzaniga.

CIDRE Project-Team

9. Partnerships and Cooperations

9.1. Regional Initiatives

- **Region Bretagne ARED Grant :** the PhD of Mourad Leslous on malicious codes in Android applications is supported by a grant from the Région Bretagne.

- **Labex COMINLAB contract (2012-2016): "SecCloud" -** http://www.seccloud.cominlabs.ueb. eu/ Attacks targeting web browsers constitute a major threat. We tackled in the context of the SecCloud project attacks induced by client-side code execution (javascript, flash or html5). Existing security mechanisms such as os-level access control often are not sufficient to pre- vent client-side browser attacks as the web browser is granted the same privileges as the user. The idea is to monitor information flows within the web browser in order to enforce a security information flow policy. Such a policy should allow to define fine-grained in- formation flow rules between user data and distant web sites. We proposed a new secure information flow control model specifically designed for JavaScript. This study was conducted in cooperation with other Inria Teams (Ascola and Celtique). Deepak Subramanian is doing his PhD in the context of this project.

- **Labex COMINLAB contract (2013-2018): "DeSceNt" -** http://www.descent.cominlabs.ueb.eu In DeSceNt, we propose to investigate how decentralized home-based networks of plug computers can support personal clouds according to sound architectural principles, mechanisms, and program- ming abstractions. To fulfill this vision we see three core scientific challenges, which we think must be overcome. The first challenge, decentralized churn-poor design, arises from the nature of plug federations, which show much lower levels of churn than traditional peer-to-peer environments. The second challenge, quasi-causal consistency, is caused by the simultaneous needs to produce a highly scalable environment (potentially numbering millions of users), that also offers collaborative editing capabilities of mutable data-structures (to offer rich social interactions). The third and final chal- lenge, intuitive data structures for plug programming, arises from the need by programmers for intu- itive and readily reusable data-structures to rapidly construct rich and robust decentralized personal cloud applications. This study is conducted in cooperation with other teams (GDD Team (University of Nantes), Inria team ASAP)

- **Labex COMINLAB contract (2014-2017): "Kharon-Security" -** http://kharon.gforge.inria.fr

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

  In the project we have already developed GroddDroid a tool dedicated to automatic identification and execution of suspicious code. We have also built a dataset of Android malware, it this dataset, all malware are entirely manually reverse and documented. We have also developed an analysis platform. This platform is currently under private deployment.

- **Labex COMINLAB contract (2015-2018): "HardBlare-Security" -   http://www.hardblare. cominlabs.ueb.eu/**

The general context of the HardBlare project is to address Dynamic Information Flow Control that generally consists in attaching marks to denote the type of information that is saved or generated within the system. These marks are then propagated when the system evolves and information flow control is performed in order to guarantee a safe execution and storage within the system. Existing solutions imply a large overhead induced by the monitoring process. Some attempts rely on a hardware-software approach where DIFC operations are delegated to a coprocessor. Nevertheless, such approaches are based on modified processors. Beyond the fact hardware-assisted DIFC is hardly adopted, existing works do not take care of coprocessor security and multicore/multiprocessor embedded systems.

We plan to implement DIFC mechanisms on boards including a non-modified ARM processor and a FPGA such as those based on the Xilinx Zynq family. The HardBlare project is a multidisciplinary project between CentraleSupélec IETR SCEE research team, CentraleSupélec Inria CIDRE research team and UBS Lab-STICC laboratory. Mounir Nasr Allah is doing his PhD in the context of this project. The main objective of this PhD is to study how hybrid analysis could improve hardware assisted DIFC using static analysis performed at compile-time. Another objective is to manage labels for persistent memory (i.e., files) using a modified OS kernel.

9.2. National Initiatives

9.2.1. ANR

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

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

9.2.2. Inria Project Labs

- **CAPPRIS (2012-2016)**

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

– The design of appropriate metrics to assess and quantify privacy, primarily by extending and integrating the various possible definitions existing for the generic privacy properties such as anonymity, pseudonymity, unlinkability and unobservability, as well as notions coming from information theory or databases such as the recent but promising concept of differential privacy;

– The definition and the understanding of the fundamental principles underlying "privacy by design", with the hope of deriving practical guidelines to implement notions such as data minimization, proportionality, purpose specification, usage limitation, data sovereignty and accountability directly in the formal specifications of our information systems;

– The integration between the legal and social dimensions, intensely necessary since the developed privacy concepts, although they may rely on computational techniques, must be in adequacy with the applicable law (even in its heterogeneous and dynamic nature). In particular, privacy-preserving technologies cannot be considered efficient as long as they are not properly understood, accepted and trusted by the general public, an outcome which cannot be achieved by the means of a mathematical proof.

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

In addition of the scientific advances in the field of privacy, members of CAPPRIS are actively involved in the animation and federation of the French community on privacy, through the APVP workshop but also interdisciplinary colloquiums.

9.3. European Initiatives

9.3.1. FP7 & H2020 Projects

The **PANOPTESEC** project (http://www.panoptesec.eu) started on the 1st of November 2013 and ended in 2016. It deals with the automated and assisted security management of IT and SCADA system. The main objective of PANOPTESEC is to provide an integrated solution that will allow to efficiently monitor SCADA systems, detect intrusions and react to them. To that end, it encompasses many of the research topics that are addressed by the CIDRE team: alerts aggregation and correlation, policy-aware intrusion detection, architecture-aware intrusion detection, automated trust management, trust-based automated reaction and visualization.

The CIDRE team is involved in the project on all of these aspects. The partners are:
- REHA (BE),
- Nokia-Lucent Bell Labs France (FR),
- Epistematica (IT),
- the University of Rome (IT),
- the University of Hamburg (GE),
- the Institut Mines-Telecom (FR),
- ACEA (IT),
- CentraleSupélec (FR).

This year, our work focused on design and implementation but also on the integration phase. Most of our work focused on WP5 and WP6, that deal with the IDS event correlation system and the visualization system.

9.4. International Initiatives

9.4.1. Inria International Partners

9.4.1.1. Informal International Partners

Emmanuelle Anceaume is actively working with Leonardo Querzoni from the University La Sapienza, Italy, on data streams algorithms and engines. Their cooperation gave rise to two conference publications in 2016, one in Middelware [25] and the other one in Algotel [26].

Since several years, Michel Hurfin works with Professor Yun Wang (Southeast University, Nanjing, China). Their joint work focuses on convergence and synchronization problems in unreliable distributed systems prone to byzantine failures. In 2016, we investigate the iterative approximate byzantine consensus problem during a joint work with Chuanyou Li [22]. A visit of Professor Yun Wang in Rennes is planned next year.

9.5. International Research Visitors

9.5.1. *Visits of International Scientists*

Prof. Jean-Marc Robert from ETS (Ecole Supérieure de Technologie) of Montréal has made several short visits in the CIDRE research group in 2016.

<h1 style="text-align:center; color:red">COAST Project-Team</h1>

7. Partnerships and Cooperations

7.1. Regional Initiatives

7.1.1. Region Lorraine TV Paint (2016–2017)
Participants: Claudia-Lavinia Ignat [contact], Gérald Oster, Quang Vinh Dang, Matthieu Nicolas.

   Partners: TVPaint Development, Inria COAST project-team

   Website: https://www.tvpaint.com/

This is a project in collaboration with TVPaint Development financed by Region Lorraine. The goal is to contribute to the creation of a collaborative system dedicated to animation movies, that allows to manipulate high quantities of digital artifacts in a collaborative way.

7.2. National Initiatives

7.2.1. OpenPaas NG (2015–2018)
Participants: Claudia-Lavinia Ignat, François Charoy [contact], Gérald Oster, Olivier Perrin, Jean-Philippe Eisenbarth, Phillippe Kalitine, Matthieu Nicolas, Mohammed Riyadh Abdmeziem, Kahina Bessai, Victorien Elvinger, Quentin Laporte Chabasse, Hoai Le Nguyen, Hoang Long Nguyen.

   Partners: Linagora, XWiki SAS, Nexedi, COAST project-team (Université de Lorraine, LORIA), DaScim team (LIX).

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

This project is financed by BpiFrance and involves French industrial leaders in open-source software development (Linagora, Nexedi, XWiki) and academic partners in collaborative work (COAST team) and recommender systems (DaScim team, LIX). The goal of the project is to develop next generation cloud enabled virtual desktop based on an Enterprise Social Network to provide advanced collaborative and recommendation services. COAST team is responsible of the work package dedicated to the design of the peer-to-peer collaborative middleware. In this context, we bring our expertise on data replication for collaborative data in peer-to-peer environments and on trust and access control and identity management in distributed collaborative information systems.

7.2.2. Inria ADT PLM (2014-2016)
Participants: Gérald Oster [contact], Matthieu Nicolas.

   Partners: COAST project-team, MYRIADS project-team.

   Website: https://github.com/BuggleInc/plm/

This work is performed jointly with Martin Quison (previously member of project-team VERIDIS, now Professor at ENS Rennes).

The Programmer's Learning Machine (PLM) is a software platform dedicated to computer programming education. This generic platform offers support to teachers for creating programming microworlds suitable to teaching courses. It features an integrated and graphical environment, providing a short feedback loop to students in order to improve the effectiveness of the autonomous learning process.

This project aims at establishing an experimental platform for studying the teaching of basic programming and a research instrument to design new collaborative learning environments.

7.3. European Initiatives

7.3.1. FP7 & H2020 Projects

7.3.1.1. SyncFree (2013-2016)

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

Program: FP7-ICT-2013-10

Project acronym: SyncFree

Project title: Large-scale computation without synchronisation

Duration : October 2013 - September 2016

Coordinator: Marc Shapiro, Inria

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

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

7.4. International Initiatives

7.4.1. *Inria Associate Teams Not Involved in an Inria International Labs*

7.4.1.1. USCOAST2

Title: User Studies on Trustworthy Collaborative Systems

International Partner (Institution - Laboratory - Researcher):

> Wright State University (United States) - Department of Psychology, Knoesis - Valerie Shalin

Start year: 2016

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

The proposed project addresses the perception of trust by users, the appropriateness of a trust-based security approach and the role of trust metrics in the management of distributed work. The main challenge of this project is how to measure trust based on user behaviour and to verify by means of experimental studies with users that the trust-based mechanism is acceptable by users. We plan to apply this trust-based mechanism for two types of applications. The first one is collaborative editing where user trust will be computed based on the quality of user contributions for a document or project. The second type of application is in the management of work over a large group of people in order to conduct efficient, high-yield, high-density real time crowdsourcing activities.

Partners of USCOAST2 project have complementary expertise. Coast provides expertise in collaborative methods, systems and related technologies. Coast will propose algorithms that track and manipulate trust metrics. Kno.e.sis provides expertise on the analysis of human work-related behavior, including methods of data collection and data analysis, as well as a theoretical foundation for the evaluation of human performance. Knoesis will analyse trust from a psychological phenomenon point of view.

7.5. International Research Visitors

7.5.1. Visits to International Teams

7.5.1.1. Research Stays Abroad

- Claudia-Lavinia Ignat visited the Department of Computer Science & Knoesis, Wright State University for 1 month in the period June–July 2016 in the context of the associated team USCOAST2
- Gérald Oster visited the Department of Computer Science & Knoesis, Wright State University for 1 month in the period June–July 2016 in the context of the associated team USCOAST2

<p align="center" style="color:red;">CTRL-A Team</p>

9. Partnerships and Cooperations

9.1. Regional Initiatives

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

9.1.1. Equipe-action HPES

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

9.1.2. Projet Exploratoire CASE

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

9.2. National Initiatives

9.2.1. ANR

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

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

9.2.2. Informal National Partners

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

9.2.3. Informal National Industrial Partners

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

9.3. International Initiatives

9.3.1. Inria International Labs

We participated to the 6th Workshop of the JLESC, with partners Inria, the University of Illinois, Argonne National Laboratory, Barcelona Supercomputing Center, Jülich Supercomputing Centre and RIKEN AICS. We presented the potential of Autonomic Computing, examplified by our results from Section 7.2.3 , and had contacts with collaboration potentials.

9.3.2. Inria International Partners

9.3.2.1. Informal International Partners

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

9.3.3. Participation in Other International Programs

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

<p style="text-align:center">**MIMOVE Team**</p>

8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. Inria Support

8.1.1.1. Inria IPL CityLab@Inria

Participants: Valérie Issarny [correspondent], Fadwa Rebhi.

- **Name:** CityLab@Inria – *Overcoming the Smart City Challenge – Toward Environmental and Social Sustainability*
- **Related activities:** § 7.3 and § 6.3
- **Period:** [January 2014 – December 2018]
- **Inria teams:** CLIME, DICE, FUN, MIMOVE, MYRIADS, SMIS, URBANET, WILLOW
- **URL:** http://citylab.inria.fr

The Inria Project Lab (IPL) 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. Obviously, running experiments is a central concern of the Lab, so that we are able to confront proposed approaches to actual settings.

8.1.1.2. Inria ADT CityLab Platform

Participants: Valérie Issarny [correspondent], Fadwa Rebhi.

- **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. The ADT is more specifically focused on the development of a middleware platform supporting mobile crowd-Xing for environmental pollution monitoring through user-led observations.

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-IoT

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

> **Name:** FIESTA-IoT – *Federated Interoperable Semantic IoT/cloud Testbeds and Applications*
>
> **URL:** http://fiesta-iot.eu
>
> **Type:** Research & Innovation Action (ICT)
>
> **Topic:** FIRE+ (Future Internet Research & Experimentation)
>
> **Related activities:** § 7.5
>
> **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 Digital Env&You*
Participant: Valérie Issarny [correspondent].

> **Name:** Env&You – *Personalizing environmental science for your home, your neighborhood and your life*
>
> **URL:** http://ambiciti.io
>
> **Related activities:** § 7.3 and § 6.3
>
> **Period:** [January 2016 - December 2016]
>
> **Partners:** Ambientic (F), CapDigital (F), Forum Virium Helsinki (FI), Inria CLIME, Inria MIMOVE [**coordinator**], NumTech (F), TheCivicEngine (USA).

There is a clear, and probably increasing, desire from the citizens to better know their individual exposure to pollution. Partial solutions exist to the exposure data problem but each focuses on one or another domain of information – crowdsourcing exposure, translating government open data to usable consumer information, harnessing social media information, harnessing biometrics – what is unique about Env&You is that we assimilate a multi-dimensional picture of exposure and provide the integrated information to citizen, government, and business use (spanning: B2G, B2B and B2C business cases).

8.2.2.2. *EIT Digital CivicBudget*
Participants: Valérie Issarny [correspondent], Nikolaos Georgantas [correspondent].

> **Name:** CivicBudget – *Software platform supporting Internet-based participatory budgeting campaigns*
>
> **Related activities:** § 7.4 and § 6.4
>
> **Period:** [January 2016 - December 2016]
>
> **Partners:** CITRIS (USA), Inria MIMOVE, MissionsPubliques (F) [**coordinator**], Nexus (DE), and TU Berlin (DE).

Many cities in Europe and the U.S.A, and around the world, commit a percentage of their annual budget (often 5%) to implement citizen-proposed projects through a process called Participatory Budgeting (PB). However, supporting urban-scale participatory budgeting campaigns is greatly challenged as it still principally relies on physical meetings. CivicBudget addresses this challenge by leveraging latest ICT so as to promote urban-scale inclusion. CivicBudget fosters a new and inclusive urban public sphere of citizenship. It is especially designed for community groups and activists who want to participate in the PB process. City governments will also be able to promote its use. CivicBudget will facilitate the mobilization of residents both to promote their proposals and to monitor their progress through the PB process to implementation.

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 the EECS Department of University of California, Berkeley, and hosted by CITRIS.

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

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

Participant: Rachit Agarwal [correspondent].

> **Name:** SARATHI – *Personalized Mobility Services for Urban Travelers*
> **Instrument:** Inria DRI/DST-CEFIPRA Associate Team
> **Related activities:** § 7.6
> **Period:** [January 2014 - December 2016]
> **Partners:** Indraprastha Institute of Information Technology (IIIT) Delhi (India), Inria MiMove.
> **Website:** http://sarathi.gitlab.io/web/

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.

8.3.2.2. *Inria/Brazil Associate Team: ACHOR*

Participant: Nikolaos Georgantas [correspondent].

> **Name:** ACHOR – *Adaptive enactment of service choreographies*
> **Instrument:** Inria/Brazil Associate Team
> **Related activities:** § 7.2 and § 6.2
> **Period:** [January 2016 - December 2018]
> **Partners:** Universidade Federal de Goiás (UFG), Brazil, Inria MiMove.
> **Website:** http://www.inf.ufg.br/projects/achor

Service choreographies are distributed compositions of services (e.g., Web services) that coordinate their execution and interactions without centralized control. Due to this decentralized coordination and the ability to compose third-party services, choreographies have shown great potential as an approach to automate the construction of large-scale, on-demand, distributed applications. Technologies to enable this approach are reaching maturity level, such as modeling languages for choreography specification and engines that operate the deployment of services and enactment of choreographies at Future Internet scales. Nevertheless, a number of problems remain open on the way to fully realize the approach, among them: (i) Deployment of multiple choreographies on top of a collection of shared services (considering service sharing as an effective way to increase the utilization of resources); (ii) Dynamic adaptation of functional and non-functional properties due to runtime changes in the environment and user requirements (adapting the set of services and/or the resources used to run the services in order to add/remove/change functions and maintain QoS properties, respectively); and (iii) Seamless and dynamic integration of mobile services (e.g., smartphone apps, sensors and actuators on handhelds and wearables) and cloud- based services (including the need to consider: mobility of both devices and services, resource constraints of mobile devices, temporary disconnection, interoperability between different interaction paradigms (message-passing, event-based, data-sharing) at the middleware layer, and effect of these paradigms on end-to-end QoS).

The overall goal of the project is to design an architecture for adaptive middleware to support service choreographies in large-scale scenarios that involve dynamicity and diversity in terms of application requirements, service interaction protocols, and the use of shared local, mobile and cloud resources.

8.4. International Research Visitors

8.4.1. Visits of International Scientists

8.4.1.1. Internships

Garvita Bajaj (from May 2016 until Sept 2016)

> PhD internship funded by Associate Team Sarathi and H2020 FIESTA-IoT project.
>
> Subject: *Extending current FIESTA-IoT Ontology*
>
> Institution: Indraprastha Institute of Information Technology (IIIT) Delhi (India)

8.4.2. Visits to International Teams

8.4.2.1. Research Stays Abroad

Valérie Issarny is visiting scholar at the EECS Department at UC Berkeley; she is hosted by CITRIS 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.

<h1 style="color:red; text-align:center">MYRIADS Project-Team</h1>

9. Partnerships and Cooperations

9.1. Regional Initiatives

9.1.1. IRT B-Com

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

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

In the last period, they were involved in the elaboration of new projects in the Cloud Computing lab of B-Com.

9.1.2. CominLabs EPOC project (2013-2017)

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

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

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

9.1.3. INDIC - Cybersecurity Pole of Excellence (2014-2018)

Participants: Anna Giannakou, Christine Morin, Jean-Louis Pazat, Louis Rilling, Amir Teshome Wonjiga.

Our study carried out in the framework of a collaboration with DGA-MI aims at defining and enforcing SLA for security monitoring of virtualized information systems. To this aim we study three topics:

- defining relevant SLA terms for security monitoring,
- enforcing and evaluating SLA terms,
- making the SLA terms enforcement mechanisms self-adaptable to cope with the dynamic nature of clouds.

The considered enforcement and evaluation mechanisms should have a minimal impact on performance. The funding from DGA funds two PhD students: Anna Giannakou and Amir Teshome Wonjiga.

9.2. National Initiatives

9.2.1. Inria ADT GinFlow (2014-2016)

Participants: Christine Morin, Matthieu Simonin, Cédric Tedeschi.

---

[0]http://b-com.org/wp/

The GinFlow technological development action funded by INRIA targets the development of a fully-operational workflow management system based on the HOCL-TS software prototype developed during the PhD thesis of Hector Fernandez between 2009 and 2012. Also, it allows the integration of this software with the TIGRES workflow engine developed at the Lawrence Berkeley National Lab so as to make the workflows submitted using the TIGRES programming model run in a decentralized fashion. These developments led to the release of the GinFlow software and its deposit at the APP (Agence de Protection des Programmes).

9.2.2. *Inria ADT SaaP (2016-2018)*

Participant: Martin Quinson.

The SaaP technological development action (SimGrid As A Platform) funded by INRIA targets the refactoring of SimGrid to make it ready to use in production and teaching contexts. Our ultimate goal is to sustain the development of the framework by involving 5 to 10 companies that are using it internally. Our target of the teaching context is thus an intermediate goal, as we think that the best solution to ensure the adoption of our tool by the industrial engineers is that they discovered the tool during their studies.

The technical actions envisioned for this ADT are the complete rearchitecturation of the software (to make it easier to script a new model within the tool kernel) and a reorganization of the interfaces (for a better integration in the Java and python language). This work is lead in collaboration with the whole SimGrid community, which provide valuable feedback.

9.2.3. *Inria IPL Discovery (2015-2019)*

Participants: Anne-Cécile Orgerie, Matthieu Simonin, Cédric Tedeschi.

The Inria IPL Discovery officially started in September 2015. It targets the design, development and deployment of a distributed Cloud infrastructure within the network's backbone. It will be based upon a set of building blocks whose design will take locality as a primary constraint, so as to minimize distant communications and consequently achieve better network traffic, partition management and improved availability.

Its developments are planned to get integrated within the OpenStack framework. An energy/cost benefit analysis of the fully distributed Discovery architecture will also be performed to show the energy efficiency of the chosen approach.

9.2.4. *Inria IPL CityLab (2015-2018)*

Participant: Christine Morin.

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

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

In 2016, Christine Morin was involved in the MOOC entitled *Villes Intelligentes : défis technologiques et sociétaux* (Smart cities : technological and social challenges) run on the FUN platform from January to March 2016. She prepared eight sequences on urban data management in clouds. In 2016, we also conducted a comparative experimental evaluation of data stream processing environments executed on clusters and in a cloud. We compared the performance and energy consumption of Heron, Storm and SparkStreaming frameworks.

9.2.5. *Inria IPL Hac Specis (2016-2020)*

Participants: Anne-Cécile Orgerie, Martin Quinson.

The goal of the HAC SPECIS (High-performance Application and Computers: Studying PErformance and Correctness In Simulation) project (http://hacspecis.gforge.inria.fr/) is to answer methodological needs of HPC application and runtime developers and to allow to study real HPC systems both from the correctness and performance point of view. To this end, we gather experts from the HPC, formal verification and performance evaluation community.

The Anh Pham started a PhD thesis in November 2016, co-advised by Thierry Jéron (team SUMO, formal methods) and Martin Quinson. The envisionned work will pursue the previous efforts to formally assess distributed applications within the SimGrid framework.

9.2.6. COSMIC PRE (2016 - 2018)

Participants: Benjamin Camus, Anne-Cécile Orgerie.

The distributed nature of Cloud infrastructures involves that their components are spread across wide areas, interconnected through different networks, and powered by diverse energy sources and providers, making overall energy monitoring and optimization challenging. The COSMIC project aims at taking advantage of the opportunity brought by the Smart Grids to exploit renewable energy availability and to optimize energy management in distributed Clouds. This PRE, led by Anne-Cécile Orgerie also involves Fanny Dufossé from Dolphin team (Inria Lille) and Benjamin Camus, who has started a 18 months post-doc in October 2016 in the context of this project.

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

Participants: Yvon Jégou, Christine Morin, Manh Linh Pham, Nikos Parlavantzas.

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

In 2016, we further developed a distributed framework which allows to exploit multiple compute servers in parallel. Parallelism is exploited both at server level using OpenMP and at data-center level using this framework. To facilitate the deployment of the workloads on heterogeneous environments, this framework limits the requirements concerning the server configurations. They need not share any file system, the workloads can be programmed in differing programming language. These servers need only the capability to communicate through the network. The system allows to dynamically add and stop servers. To some extend, it is tolerant to server failures. The framework had being repackaged to facilitate its reuse for new workloads. We also worked on the automated deployment of the framework on top of one or multiple IaaS clouds.

9.2.8. PIA ELCI (2015-2018)

Participant: Anne-Cécile Orgerie.

The PIA ELCI project deals with software environment for computation-intensive applications. It is leaded by BULL. In the context of this project, we collaborate with ROMA and Avalon teams from Lyon: we co-supervise a PhD student (Issam Rais) funded by this project with these teams on multicriteria scheduling for large-scale HPC environments.

9.2.9. CNRS PEPS EcoSmart (2016)

Participant: Anne-Cécile Orgerie.

Smart Grids are connected to telecommunication networks and can thus optimize the production, distribution and consumption of electricity. Virtualized distributed systems (Clouds) are the major players in providing services over the Internet. The success of these on-demand services makes the energy consumption of these systems worrying. This project aims to optimize the energy consumption of these large consumers, namely virtualized distributed Clouds consisting of computing, storage and communication resources. The objective is to exploit the capabilities offered by smart grids to control the consumption of these systems and be able to influence it according to the availability or the nature of the electricity used.

9.2.10. CNRS GDS EcoInfo

Participant: Anne-Cécile Orgerie.

The EcoInfo group deals with reducing environmental and societal

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

9.3. European Initiatives

9.3.1. FP7 & H2020 Projects

9.3.1.1. PaaSage

Title: PaaSage: Model Based Cloud Platform Upperware

Programm: FP7

Duration: October 2012 - September 2016

Coordinator: ERCIM

Partners:

Akademia Gorniczo-Hutnicza Im. Stanislawa Staszica W Krakowie (Poland)

Automotive Simulation Center Stuttgart Ev (Germany)

Be.Wan Sprl (Belgium)

Centred'Excellence en Technologies de l'Information et de la Communication (Belgium)

Geie Ercim (France)

Evry As (Norway)

Flexiant (United Kingdom)

Foundation for Research and Technology Hellas (Greece)

Gesellschaft Fur Wissenschaftliche Datenverarbeitung Mbh Gottingen (Germany)

Ibsac - Intelligent Business Solutions Ltd (Cyprus)

Inria (France)

Lufthansa Systems (Germany)

Stiftelsen Sintef (Norway)

Science and Technology Facilities Council (United Kingdom)

University of Cyprus (Cyprus)

Universitaet Stuttgart (Germany)

Universitaet Ulm (Germany)

Universitetet I Oslo (Norway)

Inria contact: Christine Morin

PaaSage (2012-2016) (http://www.paasage.eu) is an FP7 collaborative project that develops an open-source cloud platform, with an accompanying methodology and language, which enables developers to access cloud services in a technology-neutral approach while guiding them to configure their applications for best performance. PaaSage facilitates application deployment on multiple clouds while enhancing the flexibility, adaptivity and scalability of applications. Myriads develops the Adapter subsystem that supports dynamic, cross-cloud application adaptation. In 2016, we improved the Adapter implementation and evaluated its use within the business scenarios of PaaSage partners.

9.3.1.2. Fed4Fire

Title: Federation for FIRE

Programm: FP7

Duration: October 2012 - September 2016

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

Partners:

> University of Southampton (It Innovation, United Kingdom)
>
> Universite Pierre et Marie Curie - paris6 (UPMC, France)
>
> Fraunhofer-Gesellschaft zur Foerderung der Angewandten Forschung e.v (Fraunhofer, Germany)
>
> Technische Universitat Berlin (TUB, Germany)
>
> The University of Edinburgh (UEDIN, United Kingdom)
>
> National Ict Australia Limited (NICTA, Australia)
>
> Atos Spain SA (Atos, Spain)
>
> Panepistimio Thessalias (University of Thessaly) (UTH, Greece)
>
> National Technical University of Athens (NTUA, Greece)
>
> University of Bristol (UNIVBRIS, United Kingdom)
>
> Fundacio Privada i2cat, Internet I Innovacio Digital a Catalunya (i2cat, Spain)
>
> Eurescom-European Institute for Research and Strategic Studies in Telecommunications (EUR, Gmbh Germany)
>
> Delivery of Advanced Network Technology to Europe limited (DANTE limited, United Kingdom)
>
> Universidad de Cantabria (UC, Spain)
>
> National Information Society agency (NIA, Korea (republic of))

Inria contact: Walid Dabbous

Fed4FIRE is an FP7 Integrated Project project running between October 2012 and September 2016 (http://www.fed4fire.eu), extended to December 2016. In Fed4FIRE, we investigate the means by which our experimental platforms (BonFIRE, and in a secondary way Grid'5000) could be made interoperable with a wider eco-system of experimental platforms in Europe and beyond. 2016 is the sustainability year of Fed4FIRE, and as usage from experimenters is not bringing any revenue, we closed the BonFIRE platform as it was become unmaintainable without significant effort.

9.3.2. Collaborations in European Programs, Except FP7 & H2020

9.3.2.1. NESUS

Participant: Anne-Cécile Orgerie.

> Program: ICT COST
>
> Project acronym: NESUS
>
> Project title: Network for Sustainable Ultrascale Computing (ICT COST Action IC1305)
>
> Duration: 2014 - 2018
>
> Coordinator: Prof. Jesus Carretero, University Carlos III of Madrid, Spain, http://www.nesus.eu
>
> Other partners: 33 COST countries and 11 non-COST countries

Abstract: Ultrascale systems are envisioned as large-scale complex systems joining parallel and distributed computing systems that will be two to three orders of magnitude larger that today's systems. The EU is already funding large scale computing systems research, but it is not coordinated across researchers, leading to duplications and inefficiencies. The goal of the NESUS Action is to establish an open European research network targeting sustainable solutions for ultrascale computing aiming at cross fertilization among HPC, large scale distributed systems, and big data management. The network will contribute to gluing disparate researchers working across different areas and provide a meeting ground for researchers in these separate areas to exchange ideas, to identify synergies, and to pursue common activities in research topics such as sustainable software solutions (applications and system software stack), data management, energy efficiency, and resilience. Some of the most active research groups of the world in this area are members of this proposal. This Action will increase the value of these groups at the European-level by reducing duplication of efforts and providing a more holistic view to all researchers, it will promote the leadership of Europe, and it will increase their impact on science, economy, and society. Anne-Cécile Orgerie is co-responsible of the focus group on metrics, monitoring, instrumentation and profiling in the Working Group 5 on Energy Efficiency.

9.3.3. Collaborations with Major European Organizations

Partner 1: EPFL, Network architecture lab (Switzerland)

We collaborate with Katerina Argyraki's research group on the integration of networking and cloud computing technologies in order to support placement constraints between cloud resources.

Partner 2: VU University Amsterdam, dept. of Computer Science (the Netherlands)

We collaborate with Thilo Kielmann's research group at VU University Amsterdam on research and development around the ConPaaS system.

Partner 3: University of Neuchâtel, dept. of Computer Science (Switzerland)

We collaborate with Pascal Felber's research group on energy efficiency in Clouds and in particular on the design of energy cost models for virtual machines.

9.4. International Initiatives

9.4.1. Inria International Labs

9.4.1.1. DALHIS

Title: Data Analysis on Large Heterogeneous Infrastructures for Science

International Partner (Institution - Laboratory - Researcher):

> Lawrence Berkeley National Laboratory (United States) - Data Science and Technology department - Deb Agarwal

Start year: 2016

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

Data produced by scientific instruments (large facilities like telescopes or field data), large-scale experiments, and high-fidelity simulations are increasing in magnitude and complexity. Existing data analysis methods, tools and infrastructure are often difficult to use and unable to provide the complete data management, collaboration, and curation environment needed to manage these complex, dynamic, and large-scale data analysis environments. The goal of the Inria-LBL DALHIS associate team involving the Myriads (PI) and Avalon Inria project-teams and the Data Science and Technology (DST) department at Lawrence Berkeley National Laboratory (LBL) is to create a collaborative distributed software ecosystem to manage data lifecycle and enable data analytics on distributed data sets and resources. Specifically, our goal is to build a dynamic software stack that is user-friendly, scalable, energy-efficient and fault tolerant. Our research will determine appropriate execution environments that allow users to seamlessly execute their end-to-end dynamic data analysis workflows

in various resource environments and scales while meeting energy-efficiency, performance and fault tolerance goals. We will engage in deep partnerships with scientific teams (Fluxnet in environmental science and SNFactory and LSST experiences in cosmology) and use a mix of user research with system software R&D to address specific challenges that these communities face. Our experience will in turn inform future research directions.

9.4.2. Inria International Partners

9.4.2.1. Informal International Partners

Partner: Rutgers University, dept. of Computer Science (New Jersey, United States)

We collaborate with Manish Parashar's research group on energy efficiency in edge Clouds and in particular on the design of energy cost models for such environments.

Partner: Northeastern University, dept. of Computer Science (Massachusetts, United States)

We collaborate with Gene Cooperman 's research group on virtualization technologies for the study of large-scale distributed systems.

Partner: University of Guadalajara (Mexico)

We collaborate with the team of Prof. H$\sqrt{}$©ctor Duran-Limon on application and resource management in the cloud. In 2016, we produced a joint journal publication [14]. Nikos Parlavantzas is co-advising a PhD student enrolled in the University of Guadalajara (Carlos Ruiz Diaz).

Partner: Tlemcen University (Algeria)

We collaborate with Djawida Dib on energy-efficient fault-tolerant resource and application management in containerized clouds. Christine Morin will co-advise a PhD student enrolled in the University of Tlemcen (Yasmina Bouizem) from December 2016.

9.5. International Research Visitors

9.5.1. Visits of International Scientists

Deb Agarwal, senior scientist at Lawrence Berkeley National Laboratory, who has been awarded an Inria International Chair for the 2015-2019 period, visited Myriads team during two months from May 1st to June 30th, 2016.

Christian Heinrich, PhD student in the Polaris team at Inria Grenoble, spent one month in October in the Myriads team to improve how large-scala distributed systems are declared in the SimGrid framework.

Professor Gene Cooperman, Northeastern University, Boston, USA, visited the Myriads team for one week in June to revive our collaboration on the virtualization of large-scale distributed systems.

Professor Peter Hubwieser, Technic University of Munchen, Germany, visited the Myriads team for two weeks in November to start a collaboration on the didactics of computer science with Martin Quinson.

Carlos Ruiz Diaz, PhD student in the University of Guadalajara, Mexico, spent 6 months in the Myriads team (from September 2015 to February 2016) to advance his work on adapting cloud configurations.

9.5.1.1. Internships

Benjamin Trubert

Date: May-August 2016

Institution: University of Rennes 1

Supervisor: Guillaume Pierre

Kartik Sathyanarayanan

Date: May-July 2016

Institution: Birla Institute of Technology & Science, Pilani (India)

Supervisor: Christine Morin

9.5.2. Visits to International Teams

9.5.2.1. Research Stays Abroad

- Anna Giannakou did a 3-month research internship in the Data Science and Technology department of the Lawrence Berkeley National Laboratory from August to October 2016. She worked with Sean Peisert, staff scientist, on building a workflow for anomaly Detection in HPC environments using statistical data.

- Yunbo Li did a 2 month research internship in the Computer Science department of Rutgers University from August to September 2016. He worked with Prof. Manish Parashar on building an energy cost model for edge cloud applications.

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 3 years.

8.1.2. ESTATE - (2016–2020)

Members: LIP6 (Regal, project leader), LaBRI (Univ. de Bordeaux); Verimag (Univ. de Grenoble).

Funding: ESTATE is funded by ANR (PRC) for a total of about 544 000 euros, of which 233 376 euros for Regal.

Objectives: The core of ESTATE consists in laying the foundations of a new algorithmic framework for enabling Autonomic Computing in distributed and highly dynamic systems and networks. We plan to design a model that includes the minimal algorithmic basis allowing the emergence of dynamic distributed systems with self-* capabilities, *e.g.*, self-organization, self-healing, self-configuration, self-management, self-optimization, self-adaptiveness, or self-repair. In order to do this, we consider three main research streams:

(i) building the theoretical foundations of autonomic computing in dynamic systems, (ii) enhancing the safety in some cases by establishing the minimum requirements in terms of amount or type of dynamics to allow some strong safety guarantees, (iii) providing additional formal guarantees by proposing a general framework based on the Coq proof assistant to (semi-)automatically construct certified proofs.

The coordinator of ESTATE is Franck Petit.

8.1.3. RainbowFS - (2016–2020)

Members: LIP6 (Regal, project leader), Scality SA, CNRS-LIG, Télécom Sud-Paris.

Funding: is funded by ANR (PRC) for a total of 919 534 euros, of which 359 554 euros for Regal.

Objectives: RainbowFS proposes a "just-right" approach to storage and consistency, for developing distributed, cloud-scale applications. Existing approaches shoehorn the application design to some predefined consistency model, but no single model is appropriate for all uses. Instead, we propose tools to co-design the application and its consistency protocol. Our approach reconciles the conflicting requirements of availability and performance vs. safety: common-case operations are designed to be asynchronous; synchronisation is used only when strictly necessary to satisfy the application's integrity invariants. Furthermore, we deconstruct classical consistency models into orthogonal primitives that the developer can compose efficiently, and provide a number of tools for quick, efficient

and correct cloud-scale deployment and execution. Using this methodology, we will develop an entreprise-grade, highly-scalable file system, exploring the rainbow of possible semantics, and we demonstrate it in a massive experiment.

The coordinator of RainbowFS is Marc Shapiro.

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 – December 2016

Coordinator: Inria

Partners:

Basho Technologies (United Kingdom)

Faculdade de Ciencias E Tecnologiada Universidade Nova de Lisboa (Portugal)

Koc University (Turkey)

Rovio Entertainment OY (Finland)

Trifork AS (Denmark)

Université Catholique de Louvain (Belgium)

Technische Universitaet Kaiserslautern (Germany)

Erlang Solutions Ltd (United Kingdom).

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.

8.2.1.2. LightKone

Title: Lightweight Computation for Networks at the Edge

Programm: H2020-ICT-2016-2017

Duration: January 2017 - December 2019

Coordinator: Université Catholique de Louvain

Partners:

Université Catholique de Louvain (Belgium)

Technische Universitaet Kaiserslautern (Germany)

INESC TEC - Instituto de Engenharia de Sistemas e Computadores, Tecnologia e Ciencia (Portugal)

Faculdade de Ciencias E Tecnologiada Universidade Nova de Lisboa (Portugal)

Universitat Politecnica De Catalunya (Spain)

Scality (France)

Gluk Advice B.V. (Netherlands)

Inria contact: Marc Shapiro

The goal of LightKone is to develop a scientifically sound and industrially validated model for doing general-purpose computation on edge networks. An edge network consists of a large set of heterogeneous, loosely coupled computing nodes situated at the logical extreme of a network. Common examples are networks of Internet of Things, mobile devices, personal computers, and points of presence including Mobile Edge Computing. Internet applications are increasingly running on edge networks, to reduce latency, increase scalability, resilience, and security, and permit local decision making. However, today's state of the art, the gossip and peer-to-peer models, give no solution for defining general-purpose computations on edge networks, i.e., computation with shared mutable state. LightKone will solve this problem by combining two recent advances in distributed computing, namely synchronisation-free programming and hybrid gossip algorithms, both of which are successfully used separately in industry. Together, they are a natural combination for edge computing. We will cover edge networks both with and without data center nodes, and applications focused on collaboration, computation, and both. Project results will be new programming models and algorithms that advance scientific understanding, implemented in new industrial applications and a startup company, and evaluated in large-scale realistic settings.

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. 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.

8.3.2.2. Capes-Cofecub

Title: CHOOSING - Cooperation on Hybrid cOmputing clOuds for energy SavING

French Partners: Paris XI (LRI), Regal, LIG, SUPELEC

International Partners (Institution - Laboratory - Researcher):

Universidade de São Paulo - Instituto de Matemática e Estatística - Brazil, Unicamp - Instituto de Computação - Brazil

Duration: 2014–2018

The cloud computing is an important factor for environmentally sustainable development. If, in the one hand, the increasing demand of users drive the creation of large datacenters, in the other hand, cloud computing's "multitenancy" trait allows the reduction of physical hardware and, therefore, the saving of energy. Thus, it is imperative to optimize the energy consumption corresponding to the datacenter's activities. Three elements are crucial on energy consumption of a cloud platform: computation (processing), storage and network infrastructure. Therefore, the aim of this project is to provide different techniques to reduce energy consumption regarding these three elements. Our work mainly focuses on energy saving aspects based on virtualization, i.e., pursuing the idea of the intensive migration of classical storage/processing systems to virtual ones. We will study how different organizations (whose resources are combined as hybrid clouds) can cooperate with each other in order to minimize the energy consumption without the detriment of client requirements or quality of service. Then, we intend to propose efficient algorithmic solutions and design new coordination mechanisms that incentive cloud providers to collaborate.

8.3.2.3. Spanish research ministry project

Title: BFT-DYNASTIE - Byzantine Fault Tolerance: Dynamic Adaptive Services for Partitionable Systems

French Partners: Labri, Irisa, LIP6

International Partners (Institution - Laboratory - Researcher):

University of the Basque Country UPV - Spain, EPFL - LSD - Switzerland, Friedrich-Alexander-Universitat Erlangen-Nurenberg - Deutschland, University of Sydney - Australia

Duration: 2017–2019

The project BFT-DYNASTIE is aimed at extending the model based on the alternation of periods of stable and unstable behavior to all aspects of fault-tolerant distributed systems, including synchrony models, process and communication channel failure models, system membership, node mobility, and network partitioning. The two main and new challenges of this project are: the consideration of the most general and complex to address failure model, known as Byzantine, arbitrary or malicious, which requires qualified majorities and the use of techniques form the security area; and the operation of the system in partitioned mode, which requires adequate reconciliation mechanisms when two partitions merge.

8.4. International Research Visitors

8.4.1. Visits of International Scientists

Ajoy Kumar Datta

Date: May 2016 - June 2016

Institution: University of Nevada, Las Vegas (USA)

João Barreto

Date: April 2016 - September 2016

Institution: Instituto Superior Técnico, Lisbon, INESC-ID (Portugal)

8.4.1.1. Internships

Alvarez Colombo Santiago Javier

Date: Jul 2015 - Jan 2016

Institution: Universidad de Buenos Aires (Argentina)

<div align="center">

SPIRALS Project-Team

</div>

9. Partnerships and Cooperations

9.1. Regional Initiatives

9.1.1. *Région Nord-Pas De Calais*

9.1.1.1. Citizen Awareness and Contribution to Air Quality Monitoring
Participants: Daniel Romero Acero, Romain Rouvoy [correspondant], Lionel Seinturier.

This is a 3-year project in the context of the so-called "Chercheur citoyen" program that started in 2015. The partners are LISIC/Université Côte d'Opale (leader), ATMO Nord-Pas De Calais, Association Bâtisseurs d'Economie Solidaire. This project targets the distributed monitoring of air quality with crowd-sensing solutions obtained via sensors connected to smart devices. We aim at inciting citizens to perform their own measures, and to obtain thanks to GPS geo-localisation a large-scale database and a dynamic fine-grained cartography of air quality. This project takes advantage of the APISENSE® crowdsensing platform (see Section 6.1).

9.1.2. *Inria Lille - Nord Europe*

9.1.2.1. ADT Spoon3R
Participants: Gérard Paligot, Martin Monperrus [correspondant].

ADT Spoon3R (2014–16) is a technology development initiative supported by the Inria Lille - Nord Europe Center that aims at supporting the development of the SPOON software library. (see Section 6.4) Spoon3R aims at extending SPOON with the features defined in the context of our research activities on automated software repair.

9.1.2.2. ADT LibRepair
Participants: Benjamin Danglot, Martin Monperrus [correspondant], Simon Urli.

ADT LibRepair (2016–18) is a technology development initiative supported by the Inria Lille - Nord Europe Center that aims at supporting the development of an integrated library of automated software repair algorithms and techniques. This ADT builds on our results about with the Astor, Nopol and NpeFix that have been obtained in the context of the defended PhD theses of Matias Martinez [66] and Benoit Cornu [57].

9.1.2.3. North European Lab LLEX
Participants: Martin Monperrus [correspondant], Lionel Seinturier.

North European Lab LLEX (2015–17) is an international initiative supported by the Inria Lille - Nord Europe Center that takes place in the context of a collaboration between Inria and University College London. LLEX deals with research on automatic diagnosis and repair of software bugs. Automatic software repair is the process of fixing software bugs automatically An automatic software repair system fixes software bugs with no human intervention. The goal of automatic software repair is to save maintenance costs and to enable systems to be more resilient to bugs and unexpected situations. This research may dramatically improve the quality of software systems. The objective of the partnership is to work on the automated diagnosis of exceptions with a focus on null pointer exceptions.

9.1.2.4. LEDA
Participant: Philippe Merle [correspondant].

LEDA (2013–16) Laboratoire d'Expérimentation et de Démonstrations Ambiantes is a demonstration space allocated by the Inria Lille - Nord Europe Center whose goal is to show the scientific results of the Spirals team in the domains of distributed systems, adaptable middleware, software product lines, green computing, and ambiant computing. These results are illustrated around the scenario of a mock digital home.

9.2. National Initiatives

9.2.1. ANR

9.2.1.1. ANR BottleNet
Participants: Romain Rouvoy [correspondant], Walter Rudametkin Ivey, Lionel Seinturier.

BottleNet is a 48-month project funded by ANR that started on October 2015. The objective of BottleNet is to deliver methods, algorithms, and software systems to measure Internet Quality of Experience (QoE) and diagnose the root cause of poor Internet QoE. Our goal calls for tools that run directly at users' devices. We plan to collect network and application performance metrics directly at users' devices and correlate it with user perception to model Internet QoE, and to correlate measurements across users and devices to diagnose poor Internet QoE. This data-driven approach is essential to address the challenging problem of modeling user perception and of diagnosing sources of bottlenecks in complex Internet services. BottleNet will lead to new solutions to assist users, network and service operators as well as regulators in understanding Internet QoE and the sources of performance bottleneck.

9.2.1.2. ANR SATAS
Participants: Philippe Merle [correspondant], Romain Rouvoy, Lionel Seinturier.

SATAS is a 48-month project funded by ANR that started on October 2015. SATAS aims to advance the state of the art in massively parallel SAT solving with a particular eye to the applications driving progress in the field. The final goal of the project is to be able to provide a "pay as you go" interface to SAT solving services, with a particular focus on its power consumption. This project will extend the reach of SAT solving technologies, daily used in many critical and industrial applications, to new application areas, which were previously considered too hard, and lower the cost of deploying massively parallel SAT solvers on the cloud.

9.2.2. Competitivity Clusters

9.2.2.1. FUI StoreConnect
Participants: Julien Duribreux, Romain Rouvoy, Lionel Seinturier [correspondant], Antoine Veuiller.

StoreConnect is a 24-month project funded by FUI and labelized by the PICOM (Pôle des Industries du COMmerce) competitivity cluster which has started in September 2016. The partners are Neosensys (leader), Tevolys, Ubudu, Smile, STIME, Leroy Merlin, Insiteo, Inria Spirals, Inria Fun, Inria Stars. The goal of the project is to define a modular multi-sensors middleware platform for indoor geolocation.

9.2.3. Programme Investissement d'Avenir (PIA)

9.2.3.1. PIA Datalyse
Participants: Romain Rouvoy, Lionel Seinturier [correspondant], Bo Zhang.

Datalyse is a 42-month project of the Programme Investissement d'Avenir Cloud Computing 3rd call for projects. The project started in May 2013. The partners are Eolas (leader), Business & Decision, Groupement des Mousquetaires, Université Grenoble 1, Université Lille 1, Inria, Université Montpellier 2. The project aims at defining an elastic cloud computing infrastructure for processing big volumes of data. The originality of the project is to consider jointly data generated by users and by the infrastructure, and to correlate data at these two levels.

9.2.3.2. PIA OCCIware
Participants: Romain Rouvoy, Philippe Merle [correspondant], Lionel Seinturier.

OCCIware is a 36-month project of the Programme Investissement d'Avenir Cloud Computing and Big Data 4th call for projects. The project started in December 2014. The partners are Open Wide (leader), ActiveEon SA, CSRT, Institut Mines-Télécom/Télécom SudParis, Inria, Linagora GSO, Obeo, OW2 Consortium, Pôle Numérique, and Université Joseph Fourier - Grenoble. The project aims at defining a formal framework for managing every digital resources in the clouds, based on *Open Cloud Computing Interface* (OCCI) recommendations from *Open Grid Forum* (OGF).

9.2.4. Inria National Initiatives

9.2.4.1. Inria ADT Focus CrowdLab
Participants: Julien Duribreux, María Gómez Lacruz, Romain Rouvoy [correspondant], Antoine Veuiller.

The purpose of the ADT Focus CrowdLab (2014–2016) is to strengthen the technological part of the Metroscope consortium and to promote the APISENSE$^®$ crowd-sensing platform (see Section 6.1) as a reference platform fo gathering mobile data within the scientific community. The CrowdLab project focuses on three stringent goals: (1) consolidating the current technological solutions, (2) technical and logistical support of the research activities initiated in different scientific domains, and (3) the improvement of security and anonymity of collected data. In addition to the Metroscope consortium, the Inria research teams participating of the ADT Focus CrowdLab project are: Spirals (coordinator), Madynes, Diana, Muse.

9.2.4.2. Inria IPL BetterNet
Participants: Lakhdar Meftah, Romain Rouvoy [correspondant].

BetterNet (2016–19) aims at building and delivering a scientific and technical collaborative observatory to measure and improve the Internet service access as perceived by users. In this Inria Project Lab, we will propose new original user-centered measurement methods, which will associate social sciences to better understand Internet usage and the quality of services and networks. Our observatory can be defined as a vantage point, where: (1) tools, models and algorithms/heuristics will be provided to collect data, (2) acquired data will be analyzed, and shared appropriately with scientists, stakeholders and civil society, (3) and new value-added services will be proposed to end-users. IPL BetterNet is lead by Isabelle Chrisment (Inria Madynes), with the participation of the Diana, Dionysos, Inria Chile, Muse, and Spirals Inria project-teams.

9.2.5. Others

9.2.5.1. CNRS INS2I JCJC FPDefendor
Participant: Walter Rudametkin Ivey [correspondant].

FPDefendor is a 12-month project funded by the CNRS INS2I institute. The JCJC program targets young researchers. Walter Rudametkin is the recipient of such a grant. The project aims at better understanding browser fingerprinting, its risks to privacy, and to provide measures to detect it and effective countermeasures to mitigate it. The proposal brings together software engineering, security and privacy, and formal verification to propose a platform that uses dynamic reconfiguration as a means to evade fingerprint tracking.

9.3. European Initiatives

9.3.1. FP7 & H2020 Projects

Program: FP7 ICT.

Project acronym: PaaSage.

Project title: Model Based Cloud Platform Upperware.

Duration: October 2012–September 2016.

Coordinator: ERCIM.

Other partners: ERCIM (Fr), SINTEF (No), STFC (UK), U. of Stuttgart (De), Inria (Fr), CETIC (Be), FORTH (El), Be.Wan (Be), EVRY Solutions (No), SysFera (Fr), Flexiant (UK), Lufthansa Systems AG (De), Gesellschaft fur wissenschaftliche Datenverarbeitung mbh Gottingen (De), Automotive Simulation Center Stuttgart (De).

Abstract: Cloud computing is a popular and over-hyped concept in ICT. The concept of infinitely scalable elastic resources changing without complex systems administration and paying only for resources used is attractive. These benefits are not immediately realizable. Within organisation benefits are realizable at considerable cost. IaaS (*Infrastructure-as-a-Service*) public Clouds have different interfaces and conditions of use thus for an organisation to "scale out" requires considerable investment using skilled technical staff. The business need is to allow organisations to "scale out" from their private Cloud to public Clouds without a technical chasm between. This cannot easily be achieved. Aligned with the EU strategic direction of an open market for services, SOA (*Service-Oriented architecture*) offers a way to virtualize across heterogeneous public Clouds and organizational private Clouds. It opens a market for European SMEs to provide services to be utilized (and paid for) by business applications and for all organisations to benefit from a catalogue of services that can be used across the environment. PaaSage will deliver an open and integrated platform, to support both deployment and design of Cloud applications, together with an accompanying methodology that allows model-based development, configuration, optimisation, and deployment of existing and new applications independently of the existing underlying Cloud infrastructures. Specifically it will deliver an IDE (*Integrated Development Environment*) incorporating modules for design time and execution time optimisation of applications specified in the Cloud Modeling Language (Cloud ML), execution-level mappers and interfaces and a metadata database.
Participants: Laurence Duchien, Daniel Romero Acero, Romain Rouvoy, Lionel Seinturier [correspondant].

Program: FP7 FET.
Project acronym: DIVERSIFY.
Project title: More software diversity. More adaptivity in CAS.
Duration: 36 months (2013–16).
Coordinator: Inria.
Other partners: SINTEF (Norway), Trinity College Dublin (Ireland), University of Rennes 1 (France).
Abstract: DIVERSIFY explores diversity as the foundation for a novel software design principle and increased adaptive capacities in CASs (*Collective Adaptive Systems*). Higher levels of diversity in the system provide a pool of software solutions that can eventually be used to adapt to unforeseen situations at design time. The scientific development of DIVERSIFY is based on a strong analogy with ecological systems, biodiversity, and evolutionary ecology. DIVERSIFY brings together researchers from the domains of software-intensive distributed systems and ecology in order to translate ecological concepts and processes into software design principles.
Participants: Martin Monperrus [correspondant].

Program: H2020 ICT-10-2016.
Project acronym: STAMP.
Project title: Software Testing Amplification.
Duration: 36 months (2016–19).
Coordinator: Inria.
Other partners: ActiveEon (France), Atos (Spain), Engineering (Italy), OW2 (France), SINTEF (Norway), TellU (Norway), TU Delft (The Netherlands), XWiki (France).
Abstract: By leveraging advanced research in automatic test generation, STAMP aims at pushing automation in DevOps one step further through innovative methods of test amplification. It will reuse existing assets (test cases, API descriptions, dependency models), in order to generate more test cases and test configurations each time the application is updated. Acting at all steps of development cycle, STAMP techniques aim at reducing the number and cost of regression bugs at unit level, configuration level and production stage.
Participants: Benjamin Danglot, Martin Monperrus [correspondant].

Program: H2020 JU Shift2Rail.

Project acronym: X2Rail-1.

Project title: Start-up activities for Advanced Signalling and Automation System.

Duration: 36 months (2016–19).

Coordinator: Siemens.

Other partners: 19 partners, among others Bombardier, Siemens, Thales, IRT Railenium.

Abstract: Our contribution to the project is focused on adaptive communication middleware for cyber-physical railway systems.

Participants: Lionel Seinturier [correspondant].

9.3.2. Collaborations in European Programs, Except FP7 & H2020

Program: EUREKA Celtic-Plus.

Project acronym: SENDATE.

Project title: SEcure Networking for a DATa Center Cloud in Europe.

Duration: 36 months (2016–19).

Coordinator: Nokia.

Other partners: 50+ partners in Finland, France, Germany, Norway, and Sweden. Selected partners involved: Nokia, Orange.

Abstract: The project addresses the convergence of telecommunication networks and IT in the context of distributed data centers. We are involved in the TANDEM subproject that targets the infrastructure of such a distributed system. More specifically, we are studying new approaches in terms of software engineering and component-based solutions for enabling this convergence of network and IT.

Participants: Lionel Seinturier [correspondant].

9.4. International Initiatives

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

9.4.1.1. SOMCA

Title: Self-Optimization of Service Oriented Architectures for Mobile and Cloud Applications

International Partner (Institution - Laboratory - Researcher):

Université du Québec À Montréal (Canada) - LATECE - Naouel MOHA

Start year: 2014

See also: http://sofa.uqam.ca/somca.php

The long-term goal of this research program is to propose a novel and innovative methodology embodied in an software platform, to support the runtime detection and correction of anti-patterns in large-scale service-oriented distributed systems in order to continuously optimize their quality of service. One originality of this program lies in the dynamic nature of the service-oriented environments and the application on emerging frameworks for embedded and distributed systems (e.g., Android/iOS for mobile devices, PaaS/SaaS for Cloud environments), and in particular mobile systems interacting with remote services hosted on the Cloud.

9.4.2. Participation in Other International Programs

9.4.2.1. STIC AmSud - Project MineAPI

Participants: María Gómez Lacruz, Martin Monperrus [correspondant], Vincenzo Musco, Gérard Paligot, Romain Rouvoy.

MineAPI is a STIC AmSud project (2015–16) between with University Diego Portales, Santiago, Chile, and Federal University of Uberlândia, Brazil. The coordinator on the French side is Damien Cassou from Inria Rmod. The project aims at facilitating the usage of frameworks and application programming interfaces (APIs) by mining software repositories. Our intuition is that mining reveals how existing projects instantiate these frameworks. By locating concrete framework instantiations in existing projects, we can recommend to developers the concrete procedures for how to use a particular framework for a particular task in a new system. Our project also tackles the challenge of adapting existing systems to new versions of a framework or API by seeking repositories for how other systems adapted to such changes.

9.5. International Research Visitors

9.5.1. *Visits of International Scientists*

Prof. Marcelo Maia, from the Federal University of Uberlândia, Brazil, visited us for 1 week in November 2016 in the context of the MineAPI project.

Fernanda Madeiral Delfim, PhD Student from the Federal University of Uberlândia, Brazil, started a 6-month visit in December 2016 in the context of the MineAPI project.

Mohamed Berkane, associate professor at the University Constantine 2, Algeria, visited us for 1 month in October 2016.

9.5.1.1. *Research Stays Abroad*

María Gómez spent 4 months from January to April 2016 at Universität Hamburg in the research group of Prof. Walid Maalej.

<p align="center" style="color:red">WHISPER Project-Team</p>

9. Partnerships and Cooperations

9.1. Regional Initiatives

- City of Paris, 2016-2019, 100 000 euros. As part of the "Émergence - young team" program the city of Paris is supporting part of our work on domain-specific languages.

9.2. National Initiatives

9.2.1. ANR

ITrans - awarded in 2016, duration 2017 - 2020

Members: LIP6 (Whisper), David Lo (Singapore Management University)

Coordinator: Julia Lawall

Whisper members: Julia Lawall, Gilles Muller

Funding: ANR PRCI, 287,820 euros.

Objectives:

Large, real-world software must continually change, to keep up with evolving requirements, fix bugs, and improve performance, maintainability, and security. This rate of change can pose difficulties for clients, whose code cannot always evolve at the same rate. This project will target the problems of *forward porting*, where one software component has to catch up to a code base with which it needs to interact, and *back porting*, in which it is desired to use a more modern component in a context where it is necessary to continue to use a legacy code base, focusing on the context of Linux device drivers. In this project, we will take a *history-guided source-code transformation-based* approach, which automatically traverses the history of the changes made to a software system, to find where changes in the code to be ported are required, gathers examples of the required changes, and generates change rules to incrementally back port or forward port the code. Our approach will be a success if it is able to automatically back and forward port a large number of drivers for the Linux operating system to various earlier and later versions of the Linux kernel with high accuracy while requiring minimal developer effort. This objective is not achievable by existing techniques.

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.

9.2.2. *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 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.

9.3. International Initiatives

9.3.1. *Inria International Partners*

9.3.1.1. Informal International Partners

We collaborate with David Lo and Lingxiao Jiang of Singapore Management University, who are experts in software mining, clone detection, and information retrieval techniques. Our work with Lo and/or Jiang has led to 7 joint publications since 2013 [66], [77], [81], [82], [83], [86], [84], at conferences including ASE and ICSME.

9.4. International Research Visitors

9.4.1. *Visits of International Scientists*

9.4.1.1. Internships

Natacha Crooks, PhD student at the University of Austin, Texas, spent three months in Whisper from May to August working on Ipanema.

Derek Palinski, undergraduate at Oberlin College, USA, spent January and June to August working on understanding of device driver evolution, including the evaluation of Prequel.

Vatika Harlalka, undergraduate at the International Institute of Information Technology - Hyderabad, India, spent May to July working on strategies for improving the performance of multicore real-time systems.

Denis Merigoux, final-year student from Ecole Polytechnique, spent March to August working on inference of Coccinelle semantic patches from examples.

Roman Delgado, undergraduate at UPMC, spent June to August working with Pierre-Évariste Dagand on implementing dependent induction in type theory.

Swaraj Dash, undergraduate at Cambridge University, spent August to September working with Pierre-Évariste Dagand on the derivative of indexed datatypes.

Redha Gouicem, Master 2 at UPMC, spent March to August working on memory access control for multicore real-time systems.

Axelle Piot, Master 2 at ENS, spent March to July working on Ipanema.

<h1 style="color:red; text-align:center">ALPINES Project-Team</h1>

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. ANR Cine-Para

October 2015 - September 2019, Laura Grigori is Principal Coordinator for Inria Paris. Funding for Inria Paris is 145 Keuros. The funding for Inria is to combine Krylov subspace methods with parallel in time methods. Partners: University Pierre and Marie Curie, J. L. Lions Laboratory (PI Y. Maday), CEA, Paris Dauphine University, Paris 13 University.

9.1.1.3. 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.

9.1.1.4. Soilμ-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 CO_2 and N_2O 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. NLAFET

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 NLAFET 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 Partners

9.3.1.1. Informal International Partners

- J. Demmel, UC Berkeley, USA
- R. Hipmair, ETH Zurich
- M. Grote (Université de Bâle, Suisse)
- F. Assous (Israel)

9.4. International Research Visitors

9.4.1. Visits to International Teams

9.4.1.1. Research Stays Abroad

- Laura Grigori has spent 5 months at UC Berkeley, from January 2016 to May 2016, as a visiting Professor/Researcher.

8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. PIA

8.1.1.1. PIA ELCI, Environnement Logiciel pour le Calcul Intensif, 2014-2017
Participants: Hélène Coullon, Thierry Gautier, Laurent Lefevre, Christian Perez, Issam Rais, Jérôme Richard.

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

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

8.1.2. French National Research Agency Projects (ANR)

8.1.2.1. ANR INFRA MOEBUS, Multi-objective scheduling for large computing platforms, 4 years, ANR-13-INFR-000, 2013-2016
Participants: Laurent Lefevre, Salem Harrache, Olivier Mornard, Christian Perez, Frédéric Suter.

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

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

8.1.2.2. ANR INFRA SONGS, Simulation Of Next Generation Systems, 4 years, ANR-12-INFRA-11, 2012-2016
Participant: Frédéric Suter.

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

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

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

8.1.3. Inria Large Scale Initiative

8.1.3.1. C2S@Exa, Computer and Computational Sciences at Exascale, 4 years, 2013-2017
Participants: Hélène Coullon, Laurent Lefevre, Christian Perez, Jérôme Richard, Thierry Gautier.

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

8.1.3.2. DISCOVERY, DIstributed and COoperative management of Virtual Environments autonomousLY, 4 years, 2015-2019
Participants: Jad Darrous, Gilles Fedak, Christian Perez.

To accommodate the ever-increasing demand for Utility Computing (UC) resources, while taking into account both energy and economical issues, the current trend consists in building larger and larger Data Centers in a few strategic locations. Although such an approach enables UC providers to cope with the actual demand while continuing to operate UC resources through centralized software system, it is far from delivering sustainable and efficient UC infrastructures for future needs.

The DISCOVERY initiative aims at exploring a new way of operating Utility Computing (UC) resources by leveraging any facilities available through the Internet in order to deliver widely distributed platforms that can better match the geographical dispersal of users as well as the ever increasing demand. Critical to the emergence of such locality-based UC (LUC) platforms is the availability of appropriate operating mechanisms. The main objective of DISCOVERY is to design, implement, demonstrate and promote the LUC Operating System (OS), a unified system in charge of turning a complex, extremely large-scale and widely distributed infrastructure into a collection of abstracted computing resources which is efficient, reliable, secure and at the same time friendly to operate and use.

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

By deploying and using such a LUC Operating System on backbones, our ultimate vision is to make possible to host/operate a large part of the Internet by its internal structure itself: A scalable set of resources delivered by any computing facilities forming the Internet, starting from the larger hubs operated by ISPs, government and academic institutions, to any idle resources that may be provided by end-users.

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

Participants: Laurent Lefevre, Frédéric Suter.

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

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

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

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

8.2. European Initiatives

8.2.1. FP7 & H2020 Projects

8.2.1.1. PaaSage

Participants: Pedro de Souza Bento Da Silva, Matthieu Imbert, Christian Perez.

Title: PaaSage: Model-based Cloud Platform Upperware

Type: Seventh Framework Programme

Instrument: Collaborative project

Duration: October 2012 - September 2016 (48 months)

Coordinator: Pierre Guisset (GEIE ERCIM)

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

See also: http://paasage.eu

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

8.2.2. Collaborations in European Programs, Except FP7 & H2020

8.2.2.1. CHIST-ERA STAR

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

Title: SwiTching And tRansmission project

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

Duration: 2013-2016

Coordinator: Jaafar Elmirghani (University of Leeds - UK)

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

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

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

8.2.2.2. COST IC1305 : Nesus

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

Program: COST

Project acronym: IC1305

Project title: Network for Sustainable Ultrascale Computing (NESUS)

Duration: 2014-2019

Coordinator: Jesus Carretero (Univ. Madrid)

Abstract: Ultrascale systems are envisioned as large-scale complex systems joining parallel and distributed computing systems that will be two to three orders of magnitude larger that today's systems. The EU is already funding large scale computing systems research, but it is not coordinated across researchers, leading to duplications and inefficiencies. The goal of the NESUS Action is to establish an open European research network targeting sustainable solutions for ultrascale computing aiming at cross fertilization among HPC, large scale distributed systems, and big data management. The network will contribute to glue disparate researchers working across different areas and provide a meeting ground for researchers in these separate areas to exchange ideas, to identify synergies, and to pursue common activities in research topics such as sustainable software solutions (applications and system software stack), data management, energy efficiency, and resilience. In Nesus, Laurent Lefevre is co-chairing the Working on Energy Efficiency (WG5).

8.3. International Initiatives

8.3.1. Inria International Labs

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

Participants: Hélène Coullon, Gilles Fedak, Thierry Gautier, Vincent Lanore, Christian Perez, Jérôme Richard.

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

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

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

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

Participant: Frédéric Suter.

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

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

8.3.1.3. Informal International Partners

- Université Gaston Berger, Saint Louis, Sénégal. Contact: Pr. Ousmane Thiaré.
- École Centrale Mahindra, Hyderabad, India. Contact: Dr. Arya Kumar Bhattacharya.
- Center for Computing and Networking, Chinese Academy of Sciences, Beijing, China. Pr. Haiwu He.

8.4. International Research Visitors

8.4.1. Visits of International Scientists

Alberto Cabrera, University of La Laguna, Spain, Jan 2016

Damian Fernandez Cerero, University of Sevilla, Spain, Sep 2016-Dec 2016

Pr. Haiwu He, Computer Network Information Center, Chinese Academy of Sciences, Beijing, China, Nov 2016-Jan 2017

Tchimou N'Takpé, Université Nangui Abrogoua, Côte d'Ivoire, Nov 2016-Dec 2016.

8.4.1.1. Internships

Daniel Ciugurean, University of Cluj, Romania, Jun-Sep 2016

Joel Faubert, University of Ottawa, Canada, May-Jul 2016

<p align="center" style="color:red">DATAMOVE Team</p>

8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. ANR

- **ANR grant MOEBIUS (2013-2017).** Multi-objective scheduling for large computing platforms. Coordinator: Grenoble-INP (DataMove). Partners: Grenoble-INP, Inria, BULL-ATOS .

8.1.2. Competitivity Clusters

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

8.2. European Initiatives

8.2.1. FP7 & H2020 Projects

8.2.1.1. VELaSSCo

Title: Visualization For Extremely Large-Scale Scientific Computing

Program: STREP (Specific Targeted Research Project)

Duration: January 2014 - December 2016

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

Partners: JOTNE (No.), SINTEF (No.), Fraunhofer IGD (D), ATOS (SP), Univ. Edinburgh (UK)

Inria contact: Toan Nguyen, Bruno Raffin

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

8.3. International Initiatives

8.3.1. Inria International Labs

8.3.1.1. JLESC

Title: Joint Laboratory for Extreme-Scale-Computing.

International Partners:

University of Illinois at Urbana Champaign (USA)

Argonne National Laboratory (USA),

Barcelona Supercomputing Center (Spain),

Jülich Supercomputing Centre (Germany)

Riken Advanced Institute for Computational Science (Japan)

Start year: 2009

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

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

8.3.1.2. ANOMALIES@EXASCALE

Title: Anomalies Detection and Handling towards Exascale Platforms

International Partner:

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

Start year: 2014. End year: 2016.

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

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

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

8.3.2.1. ExaSE

Title: Exascale Computing Scheduling and Energy

International Partners:

UFRGS, PUC Minas and UPS (Brazil)

Duration: 2014 - 2016

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

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

8.3.3. Participation in Other International Programs

8.3.3.1. LICIA

Title: International Laboratory in High Performance and Ubiquitous Computing

International Partner (Institution - Laboratory - Researcher):

UFRGS (Brazil)

Duration: 2011 - 2018

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

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

8.3.3.2. CAPES/COFECUB StarShip

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

International Partner (Institution - Laboratory - Researcher):

UFRGS (Brazil)

Duration: 2013 - 2016

PI: Bruno Raffin (DataMove) and Alexandre Carissimi (UFRGS)

8.4. International Research Visitors

8.4.1. Internships

PhD in progress: Marcos Amaris Gonzalez, Performance Evaluation for GPU, USP (Sao Paulo, Brasil). 1 year "sandwich" visit. Local adviser: Denis Trystram

8.4.2. Visits to International Teams

- Pierre François Dutot. Six month stay at University of Hawaii at Manoa (Sept. 2016 - Jan. 2017)

HIEPACS Project-Team

9. Partnerships and Cooperations

9.1. National Initiatives

9.1.1. Inria Project Lab

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

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

9.1.2. ANR

9.1.2.1. SOLHAR: SOLvers for Heterogeneous Architectures over Runtime systems

Participants: Emmanuel Agullo, Mathieu Faverge, Abdou Guermouche, Pierre Ramet, Jean Roman, Guillaume Sylvand.

Grant: ANR-MONU
Dates: 2013 – 2017
Partners: Inria (REALOPT, STORM Bordeaux Sud-Ouest et ROMA Rhone-Alpes), IRIT/INPT, CEA-CESTA et Airbus Group Innovations.
Overview:

During the last five years, the interest of the scientific computing community towards accelerating devices has been rapidly growing. The reason for this interest lies in the massive computational power delivered by these devices. Several software libraries for dense linear algebra have been produced; the related algorithms are extremely rich in computation and exhibit a very regular pattern of access to data which makes them extremely good candidates for GPU execution. On the contrary, methods for the direct solution of sparse linear systems have irregular, indirect memory access patterns that adversely interact with typical GPU throughput optimizations.

This project aims at studying and designing algorithms and parallel programming models for implementing direct methods for the solution of sparse linear systems on emerging computer equipped with accelerators. The ultimate aim of this project is to achieve the implementation of a software package providing a solver based on direct methods for sparse linear systems of equations. To date, the approaches proposed to achieve this objective are mostly based on a simple offloading of some computational tasks to the accelerators and rely on fine hand-tuning of the code and accurate performance modeling to achieve efficiency. This project proposes an innovative approach which relies on the efficiency and portability of runtime systems. The development of a production-quality, sparse direct solver requires a considerable research effort along three distinct axes:

- linear algebra: algorithms have to be adapted or redesigned in order to exhibit properties that make their implementation and execution on heterogeneous computing platforms efficient and reliable. This may require the development of novel methods for defining data access patterns that are more suitable for the dynamic scheduling of computational tasks on processing units with considerably different capabilities as well as techniques for guaranteeing a reliable and robust behavior and accurate solutions. In addition, it will be necessary to develop novel and efficient accelerator implementations of the specific dense linear algebra kernels that are used within sparse, direct solvers;

- runtime systems: tools such as the `StarPU` runtime system proved to be extremely efficient and robust for the implementation of dense linear algebra algorithms. Sparse linear algebra algorithms, however, are commonly characterized by complicated data access patterns, computational tasks with extremely variable granularity and complex dependencies. Therefore, a substantial research effort is necessary to design and implement features as well as interfaces to comply with the needs formalized by the research activity on direct methods;

- scheduling: executing a heterogeneous workload with complex dependencies on a heterogeneous architecture is a very challenging problem that demands the development of effective scheduling algorithms. These will be confronted with possibly limited views of dependencies among tasks and multiple, and potentially conflicting objectives, such as minimizing the makespan, maximizing the locality of data or, where it applies, minimizing the memory consumption.

Given the wide availability of computing platforms equipped with accelerators and the numerical robustness of direct solution methods for sparse linear systems, it is reasonable to expect that the outcome of this project will have a considerable impact on both academic and industrial scientific computing. This project will moreover provide a substantial contribution to the computational science and high-performance computing communities, as it will deliver an unprecedented example of a complex numerical code whose parallelization completely relies on runtime scheduling systems and which is, therefore, extremely portable, maintainable and evolvable towards future computing architectures.

9.1.2.2. ANEMOS: Advanced Numeric for ELMs : Modeling and Optimized Schemes

Participants: Guillaume Latu, Pierre Ramet.

Grant: ANR-MN
Dates: 2012 – 2016
Partners: Univ. Nice, CEA/IRFM, CNRS/MDS.
Overview: The main goal of the project is to make a significant progress in understanding of active control methods of plasma edge MHD instabilities Edge Localized Modes (ELMs) wich represent particular danger with respect to heat and particle loads for Plasma Facing Components (PFC) in ITER. The project is focused in particular on the numerical modelling study of such ELM control methods as Resonant Magnetic Perturbations (RMPs) and pellet ELM pacing both foreseen in ITER. The goals of the project are to improve understanding of the related physics and propose possible new strategies to improve effectiveness of ELM control techniques. The tool for the non-linear MHD modeling is the JOREK code which was essentially developed within previous ANR ASTER. JOREK will be largerly developed within the present project to include corresponding new physical models in conjunction with new developments in mathematics and computer science strategy. The present project will put the non-linear MHD modeling of ELMs and ELM control on the solid ground theoretically, computationally, and applications-wise in order to progress in urgently needed solutions for ITER.

Regarding our contributions, the `JOREK` code is mainly composed of numerical computations on 3D data. The toroidal dimension of the tokamak is treated in Fourier space, while the poloidal plane is decomposed in Bezier patches. The numerical scheme used involves a direct solver on a large sparse matrix as a main computation of one time step. Two main costs are clearly identified: the assembly of the sparse matrix, and the direct factorization and solve of the system that includes communications between all processors. The efficient parallelization of `JOREK` is one of our main goals, to do so we will reconsider: data distribution, computation distribution or GMRES implementation. The quality of the sparse solver is also crucial, both in term of performance and accuracy. In the current release of `JOREK`, the memory scaling is not satisfactory to solve problems listed above , since at present as one increases the number of processes for a given problem size, the memory footprint on each process does not reduce as much as one can expect. In order to access finer meshes on available supercomputers, memory savings have to be done in the whole code. Another key point for improving parallelization is to carefully profile the application to understand the regions of the code that do not scale well. Depending on the timings obtained, strategies to diminish communication overheads will be evaluated and schemes that improve load balancing will be initiated. `JOREK` uses `PaStiX` sparse matrix library for matrix inversion. However, large number of toroidal harmonics and particular thin structures to resolve for realistic plasma parameters and ITER machine size still require more aggressive optimisation in numeric dealing with numerical stability, adaptive meshes etc. However many possible applications of `JOREK` code we proposed here which represent urgent ITER relevant issues related to ELM control by RMPs and pellets remain to be solved.

9.1.2.3. DEDALES: Algebraic and geometric domain decomposition for subsurface/groundwater flows

Participants: Emmanuel Agullo, Mathieu Faverge, Luc Giraud, Louis Poirel.

Grant: ANR-14-CE23-0005
Dates: 2014 – 2018
Partners: Inria EPI POMDAPI (leader); Université Paris 13 - Laboratoire Analyse, Géométrie et Applications; Maison de la Simulation; Andra.
Overview: Project DEDALES 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 project will be driven by an application to radioactive waste deep geological disposal. Its main feature is phenomenological complexity: water-gas flow in highly heterogeneous medium, with widely varying space and time scales. The assessment of large scale model is of major importance and issue for this application, and realistic geological models have several million grid cells. Few, if at all, software codes provide the necessary physical features with massively parallel simulation capabilities. The aim of the DEDALES project is to study, and experiment with, new approaches to develop effective simulation tools with the capability to take advantage of modern computer architectures and their hierarchical structure. To achieve this goal, we will explore two complementary software approaches that both match the hierarchical hardware architecture: on the one hand, we will integrate a hybrid parallel linear solver into an existing flow and transport code, and on the other hand, we will explore a two level approach with the outer level using (space time) domain decomposition, parallelized with a distributed memory approach, and the inner level as a subdomain solver that will exploit thread level parallelism. Linear solvers have always been, and will continue to be, at the center of simulation codes. However, parallelizing implicit methods on unstructured meshes, such as are required to accurately represent the fine geological details of the heterogeneous media considered, is notoriously difficult. It has also been suggested that time level parallelism could be a useful avenue to provide an extra degree of parallelism, so as to exploit the very large number of computing elements that will be part of these next generation computers. Project DEDALES will show that space-time DD methods can provide this extra level, and can usefully be combined with parallel linear solvers at the subdomain level. For all tasks, realistic test cases will be used to show the validity and the parallel scalability of the chosen approach. The most demanding models will be at the frontier of what is currently feasible for the size of models.

9.1.2.4. TECSER: Novel high performance numerical solution techniques for RCS computations

Participants: Emmanuel Agullo, Luc Giraud, Matthieu Kuhn.

Grant: ANR-14-ASTRID
Dates: 2014 – 2017
Partners: Inria EPI NACHOS (leader), Corida, HiePACS; Airbus Group Innovations, Nucletudes.
Overview: the objective of the TECSER projet is to develop an innovative high performance numerical methodology for frequency-domain electromagnetics with applications to RCS (Radar Cross Section) calculation of complicated structures. This numerical methodology combines a high order hybridized DG method for the discretization of the frequency-domain Maxwell in heterogeneous media with a BEM (Boundary Element Method) discretization of an integral representation of Maxwell's equations in order to obtain the most accurate treatment of boundary truncation in the case of theoretically unbounded propagation domain. Beside, scalable hybrid iterative/direct domain decomposition based algorithms are used for the solution of the resulting algebraic system of equations.

9.2. European Initiatives

9.2.1. FP7 & H2020 Projects

9.2.1.1. EoCoE

Title: Energy oriented Centre of Excellence for computer applications

Programm: H2020

Duration: October 2015 - October 2018

Coordinator: CEA

Partners:

Barcelona Supercomputing Center - Centro Nacional de Supercomputacion (Spain)

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

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

Consiglio Nazionale Delle Ricerche (Italy)

The Cyprus Institute (Cyprus)

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

Fraunhofer Gesellschaft Zur Forderung Der Angewandten Forschung Ev (Germany)

Instytut Chemii Bioorganicznej Polskiej Akademii Nauk (Poland)

Forschungszentrum Julich (Germany)

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

University of Bath (United Kingdom)

Universite Libre de Bruxelles (Belgium)

Universita Degli Studi di Trento (Italy)

Inria contact: Michel Kern

The aim of the present proposal is to establish an Energy Oriented Centre of Excellence for computing applications, (EoCoE). EoCoE (pronounce "Echo") will use the prodigious potential offered by the ever-growing computing infrastructure to foster and accelerate the European transition to a reliable and low carbon energy supply. To achieve this goal, we believe that the present revolution in hardware technology calls for a similar paradigm change in the way application codes are designed. EoCoE will assist the energy transition via targeted support to four renewable energy pillars: Meteo, Materials, Water and Fusion, each with a heavy reliance on numerical modelling. These four pillars will be anchored within a strong transversal multidisciplinary basis providing high-end expertise in applied mathematics and HPC. EoCoE is structured around a central Franco-German hub coordinating a pan-European network, gathering a total of 8 countries and 23 teams. Its partners are strongly engaged in both the HPC and energy fields; a prerequisite for the long-term

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

9.2.1.2. HPC4E

Title: HPC for Energy

Programm: H2020

Duration: December 2015 - November 2017

Coordinator: Barcelona Supercomputing Center

Partners:

Centro de Investigaciones Energeticas, Medioambientales Y Tecnologicas-Ciemat (Spain)

Iberdrola Renovables Energia (Spain)

Repsol (Spain)

Total S.A. (France)

Lancaster University (United Kingdom)

Inria contact: Stéphane Lanteri

This project aims to apply the new exascale HPC techniques to energy industry simulations, customizing them, and going beyond the state-of-the-art in the required HPC exascale simulations for different energy sources: wind energy production and design, efficient combustion systems for biomass-derived fuels (biogas), and exploration geophysics for hydrocarbon reservoirs. For wind energy industry HPC is a must. The competitiveness of wind farms can be guaranteed only with accurate wind resource assessment, farm design and short-term micro-scale wind simulations to forecast the daily power production. The use of CFD LES models to analyse atmospheric flow in a wind farm capturing turbine wakes and array effects requires exascale HPC systems. Biogas, i.e. biomass-derived fuels by anaerobic digestion of organic wastes, is attractive because of its wide availability, renewability and reduction of CO_2 emissions, contribution to diversification of energy supply, rural development, and it does not compete with feed and food feedstock. However, its use in practical systems is still limited since the complex fuel composition might lead to unpredictable combustion performance and instabilities in industrial combustors. The next generation of exascale HPC systems will be able to run combustion simulations in parameter regimes relevant to industrial applications using alternative fuels, which is required to design efficient furnaces, engines, clean burning vehicles and power plants. One of the main HPC consumers is the oil & gas (O&G) industry. The computational requirements arising from full wave-form modelling and inversion of seismic and electromagnetic data is ensuring that the O&G industry will be an early adopter of exascale computing technologies. By taking into account the complete physics of waves in the subsurface, imaging tools are able to reveal information about the Earth's interior with unprecedented quality.

9.2.1.3. 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)

Universite de Versaillesint-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 Associate Teams Not Involved in an Inria International Labs

9.3.1.1. MORSE

Title: Matrices Over Runtime Systems @ Exascale

International Partner (Institution - Laboratory - Researcher):

KAUST Supercomputing Laboratory (United States) - KSL - Hatem Ltaief

Start year: 2011

See also: http://icl.cs.utk.edu/morse/index.html

The goal of Matrices Over Runtime Systems at Exascale (MORSE) project is to design dense and sparse linear algebra methods that achieve the fastest possible time to an accurate solution on large-scale multicore systems with GPU accelerators, using all the processing power that future high end systems can make available. To develop software that will perform well on petascale and exascale systems with thousands of nodes and millions of cores, several daunting challenges have to be overcome, both by the numerical linear algebra and the runtime system communities. By designing

a research framework for describing linear algebra algorithms at a high level of abstraction,the MORSE team will enable the strong collaboration between research groups in linear algebra, runtime systems and scheduling needed to develop methods and libraries that fully benefit from the potential of future large-scale machines. Our project will take a pioneering step in the effort to bridge the immense software gap that has opened up in front of the High-Performance Computing (HPC) community.

9.3.1.2. FASTLA

Title: Fast and Scalable Hierarchical Algorithms for Computational Linear Algebra

International Partner (Institution - Laboratory - Researcher):

> Stanford University (USA) - Institute for Computational and Mathematical Engineering - Eric Darve

Start year: 2015

See also: http://people.bordeaux.inria.fr/coulaud/projets/FastLA_Website/

In this project, we propose to study fast and scalable hierarchical numerical kernels and their implementations on heterogeneous manycore platforms for two major computational kernels in intensive challenging applications. Namely, fast multipole methods (FMM) and sparse linear solvers that appear in many intensive numerical simulations in computational sciences. For the solution of large linear systems, the ultimate goal is to design parallel scalable methods that rely on efficient sparse and dense direct methods using H-matrix arithmetic. Finally, the innovative algorithmic design will be essentially focused on heterogeneous manycore platforms by using task based runtime systems. The partners, Inria HiePACS, Lawrence Berkeley Nat. Lab and Stanford University, have strong, complementary and recognized experiences and backgrounds in these fields

KERDATA Project-Team

9. Partnerships and Cooperations

9.1. National Initiatives

9.1.1. ANR

9.1.1.1. OverFlow (2015–2019)

- Project Acronym: OverFlow.
- Project Title: Workflow Data Management as a Service for Multisite Applications.
- Coordinator: Alexandru Costan.
- Duration: Octobre 2015–October 2019.
- Other Partners: None (Young Researcher Project).
- External collaborators: Kate Keahey (University of Chicago and Argonne National Laboratory), Bogdan Nicolae (Huawei Research) and Christophe Blanchet (Institut Français de Bioinformatique).
- Abstract: This JCJC project led by Alexandru Costan investigates approaches to data management enabling an efficient execution of geographically distributed workflows running on multi-site clouds. Ultimately, OverFlow will propose a new, pioneering paradigm: Workflow Data Management as a Service — a general and easy-to-use, cloud-provided service that bridges for the first time the gap between single- and multi-site workflow data management. It aims to reap economic benefits from the geo-diversity while accelerating the scientific discovery through a democratization of access to globally distributed data.

9.1.2. Other National Projects

9.1.2.1. DISCOVERY (2015–2019)

- Project Acronym: DISCOVERY.
- Project Title: DIStributed and COoperative framework to manage Virtual EnviRonments autonomicallY.
- Coordinator: Adrien Lèbre.
- Duration: 2015–2019.
- Partners: Inria Project-Teams including ASAP, ASCOLA, Avalon, Myriads, and KerData.
- Abstract: An Inria Project Lab, led by Adrien Lèbre (ASCOLA), that aims at exploring a new way of operating Utility Computing (UC) resources by leveraging any facilities available through the Internet. The goal is to deliver widely distributed platforms that can better match the geographical dispersal of users, as well as the unending demand.

  Within DISCOVERY, S. Ibrahim (KerData Inria Team) is working with Gilles Fedak (Avalon Inria Project-Team) to address the VM images management challenge.

9.1.2.2. ADT Damaris

- Project Acronym: ADT Damaris
- Project Title: Technology development action for te Damaris environment.
- Coordinator: Alexandru Costan.
- Duration: 2016–2018.
- Abstract: This action aims to support the development of the Damaris software. Inria's *Technological Development Office* (D2T, *Direction du Développement Technologique*) provided 2 years of funding support for a senior engineer.

  Hadi Salimi is funded through this project to document, test and extend the Damaris software and make it a safely distributable product.

9.1.2.3. Grid'5000.

We are members of Grid'5000 community and run experiments on the Grid'5000 platform on a daily basis.

9.2. European Initiatives

9.2.1. FP7 and H2020 Projects

9.2.1.1. BigStorage

- Title: BigStorage: Storage-based Convergence between HPC and Cloud to handle Big Data.
- Programme: H2020.
- Duration: January 2015–December 2018.
- Coordinator: Universidad Politécnica de Madrid (UPM).
- Partners:
    - Barcelona Supercomputing Center — Centro Nacional de Supercomputacion (Spain)
    - CA Technologies Development Spain (Spain)
    - CEA — Commissariat à l'énergie atomique et aux énergies alternatives (France)
    - Deutsches Klimarechenzentrum (Germany)
    - Foundation for Research and Technology Hellas (Greece)
    - Fujitsu Technology Solutions (Germany)
    - Johannes Gutenberg Universitaet Mainz (Germany)
    - Universidad Politecnica de Madrid (Spain)
    - Seagate Systems UK (United Kingdom)
- Inria contact: G. Antoniu and Adrien Lèbre.
- URL: http://www.bigstorage-project.eu/.
- Description: BigStorage is a European Training Network (ETN) whose main goal is to train future *data scientists*. It aims at enabling them and us to apply holistic and interdisciplinary approaches to take advantage of a data-overwhelmed world. This world requires *HPC* and *Cloud* infrastructures with a redefinition of *storage* architectures underpinning them — focusing on meeting highly ambitious performance and *energy* usage objectives. The KerData team will be hosting 2 *Early Stage Researchers* in this framework.

9.3. International Initiatives

9.3.1. Inria International Labs

9.3.1.1. JLESC: Joint Laboratory on Extreme-Scale Computing

The Joint Laboratory on Extreme-Scale Computing is jointly run by Inria, UIUC, ANL, BSC, JSC and RIKEN/AICS. It has ben created in 2014 as a follow-up of the Inria-UIUC JLPC, the *Joint Laboratory for Petascale Computing*.

The KerData team is collaborating with teams from ANL and UIUC within this lab since 2009 on several topics in the areas of I/O, storage and in situ processing and cloud computing. This collaboration has been initially formalized as the *Data@Exascale* Associate Team with ANL and UIUC (2013–2015) followed by *Data@Exascale 2* Associate Team with ANL (2016–2018).

Since 2015, Gabriel Antoniu serves as a topic leader for Inria for the *I/O, Storage and In Situ Processing* topic.

9.3.1.1.1. Associate Team involved in the International Lab: Data@Exascale 2

Project Acronym: Data@Exascale 2.

Project Title: Convergent Data Storage and Processing Approaches for Exascale Computing and Big Data Analytics.

International Partner:

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

Start year: 2013.

URL: http://www.irisa.fr/kerdata/data-at-exascale/.

Description: In the past few years, countries including United States, the European Union, Japan and China have set up aggressive plans to get closer to what appears to be the next goal in terms of high-performance computing (HPC): Exaflop computing, a target which is now considered reachable by the next-generation supercomputers in 2020-2023. While these government-led initiatives have naturally focused on the big challenges of Exascale for the development of new hardware and software architectures, the quite recent emergence of the Big Data phenomenon introduces what could be called a tectonic shift that is impacting the entire research landscape for Exascale computing. As data generation capabilities in most science domains are now growing substantially faster than computational capabilities, causing these domains to become data-intensive, new challenges appeared in terms of volumes and velocity for data to be stored, processed and analyzed on the future Exascale machines.

To face the challenges generated by the exponential data growth (a general phenomenon in many fields), a certain progress has already been made in the recent years in the rapidly-developing, industry-led field of cloud-based Big Data analytics, where advanced tools emerged, relying on machine-learning techniques and predictive analytics.

Unfortunately, these advances cannot be immediately applied to Exascale computing: the tools and cultures of the two worlds, HPC (High-Performance Computing) and BDA (Big Data Analytics) have developed in a divergent fashion (in terms of major focus and technical approaches), to the detriment of both. The two worlds share however multiple similar challenges and unification now appears as essential in order to address the future challenges of major application domains that can benefit from both.

The scientific program we propose for the Data@Exascale 2 Associate Team is defined from this new, highly-strategic perspective and builds on the idea that the design of innovative approaches to data I/O, storage and processing allowing Big Data analytics techniques and the newest HPC architectures to leverage each other clearly appears as a key catalyst factor for the convergence process.

9.3.2. Inria International Partners

9.3.2.1. DataCloud@Work

Title: DataCloud@Work.

International Partner:

- Polytechnic University of Bucharest (Romania), Computer Science Department, Nicolae Tapus and Valentin Cristea.

Duration: 4 years.

Start year: 2013. The status of IIP was established right after the end of our former *DataCloud@work* Associate Team (2010–2012).

URL: https://www.irisa.fr/kerdata/doku.php?id=cloud_at_work:start.

Description: Our research topics address the area of distributed data management for cloud services, focusing on autonomic storage. The goal is explore how to build an efficient, secure and reliable storage IaaS for data-intensive distributed applications running in cloud environments by enabling an autonomic behavior.

9.3.3. Informal International Partners

National University of Singapore (NUS): We collaborate on resource management for workflows in the cloud and optimizing graph processing in geo-distributed data-centers.

9.4. International Research Visitors

9.4.1. Visits of International Scientists

Guillaume Aupy (Vanderbilt University) visited the KerData team for one week (February 2016).

9.4.2. Visits to International Teams

9.4.2.1. Research Stays Abroad

CIC-IPN, Mexico:
Participants: Gabriel Antoniu, Alexandru Costan, Luis Eduardo Pineda Morales, Pierre Matri.

From October 31 to November 4, four members of our team visited the Informatics Research Centre of the National Polytechnic Institute (CIC-IPN for its acronym in Spanish) in Mexico City, Mexico.

The visit was a follow up to previous discussions held with the Network and Data Science Laboratory. The goal is to create a scientific collaboration on the grounds of cloud-based big data for smart cities, for which a proposal has been submitted in August to the program ECOS-NORD (Mexico-France). The visit included scientific presentations from both teams, a plenary talk from KerData to the IPN community, as well as discussions on future common research lines. Additionally, we held meetings with the partnering coordinator to talk about possible funding sources for students exchanges.

ANL, USA:
Participant: Nathanaël Cheriere.

Nathanaël Cheriere visited Matthieu Dorier and Rob Ross at ANL for 5.5 months, co-funded by the PUF NextGen project in the context of the Joint Laboratory for Extreme-Scale Computing (JLESC).

Vanderbilt University, USA:
Participant: Tien-Dat Phan.

Tien-Dat Phan visited(Guillaume Aupy, Padma Raghavan at Vanderbilt University for 2 months, funded by Vanderbilt University.

Technische Universitat Munchen and Huawei Research Center in Munich:
Participant: Ovidiu-Cristian Marcu.

Ovidiu-Cristian Marcu is doing an internship at Huawei in Munich, Germany for 4 months, starting October 2016. The goal is to create a framework to improve memory management for streaming systems.

National University of Singapore, Singapore:
Participant: Tien-Dat Phan.

Tien-Dat Phan is visiting NUS (Bingsheng He) for 3 months, co-funded by a Mobility grant from University Bretagne Loire (UBL) and NUS.

<p style="text-align:center;color:red;">**POLARIS Team**</p>

8. Partnerships and Cooperations

8.1. European Initiatives

8.1.1. FP7 & H2020 Projects

8.1.1.1. Mont-Blanc 2

Program: FP7 Programme

Project acronym: Mont-Blanc 2

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

Duration: October 2013 - September 2016

Coordinator: BSC (Barcelone)

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

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

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

8.1.1.2. QUANTICOL

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

Project acronym: QUANTICOL

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

Duration: 04 2013 – 03 2017

Coordinator: Jane Hillston (University of Edinburgh, Scotland)

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

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

8.1.1.3. HPC4E

Title: HPC for Energy

Program: H2020

Duration: 01 2016 – 01 2018

Coordinator: Barcelona Supercomputing Center

Inria contact: Stephane Lanteri

Other partners:

- Europe: Lancaster University (ULANC), Centro de Investigaciones Energéticas Medioambientales y Tecnológicas (CIEMAT), Repsol S.A. (REPSOL), Iberdrola Renovables Energía S.A. (IBR), Total S.A. (TOTAL).

- Brazil: Fundação Coordenação de Projetos, Pesquisas e Estudos Tecnoclógicos (COPPE), National Laboratory for Scientific Computation (LNCC), Instituto Tecnológico de Aeronáutica (ITA), Petroleo Brasileiro S. A. (PETROBRAS), Universidade Federal do Rio Grande do Sul (INF-UFRGS), Universidade Federal de Pernambuco (CER-UFPE)

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

8.1.2. Collaborations with Major European Organizations

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

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

BSC (Barcelona): Barcelona Supercomputer Center (Spain). We collaborate with the performance evaluation group through the HPC4E project, the Mont-blanc 2 project, and the JLESC.

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

8.2. International Initiatives

8.2.1. Inria International Labs

8.2.1.1. North America

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

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

8.2.2.1. EXASE

Title: Exascale Computing Scheduling and Energy

International Partner (Institution - Laboratory - Researcher):

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

Start year: 2014

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

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

8.2.3. Inria International Partners

8.2.3.1. Declared Inria International Partners

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

8.2.4. Participation in Other International Programs

8.2.4.1. South America

- *LICIA:* The CNRS, Inria, the Universities of Grenoble, Grenoble INP, and Universidade Federal do Rio Grande do Sul have created the LICIA (*Laboratoire International de Calcul intensif et d'Informatique Ambiante*). LICIA's main research themes are high performance computing, language processing, information representation, interfaces and visualization as well as distributed systems. Jean-Marc Vincent is the director of the laboratory on the French side and visited Porto Alegre for two weeks in November 2016.

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

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

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

8.3. International Research Visitors

8.3.1. Visits of International Scientists

- Matthieu Jonckeere (Buenos Aires University) visited for 3 weeks.
- Mario Bravo (University of Santiago, Chile) visited POLARIS for 1 week in Feb. 2016.
- Mathias Staudigl (Maastricht University) visited POLARIS for 2 weeks in July 2016.

8.3.2. Visits to International Teams

8.3.2.1. Sabbatical programme

- Florence Perronnin spent one year in sabbatical leave (rachat de service) at the Université Versailles-Saint-Quentin (DAVID lab)

8.3.2.2. Research Stays Abroad

- Panayotis Mertikopoulos was an invited professor at the University of Athens, Athens, Greece, for four months (March–June 2016).
- Panayotis Mertikopoulos was an invited professor at LUISS Guido Carli University, Rome, Italy, for one month (Sept. 2016).

<p style="text-align:center;color:red;font-weight:bold;">ROMA Project-Team</p>

9. Partnerships and Cooperations

9.1. Regional Initiatives

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

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

9.2. National Initiatives

9.2.1. ANR

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

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

9.3. European Initiatives

9.3.1. FP7 & H2020 Projects

9.3.1.1. SCORPIO

Title: Significance-Based Computing for Reliability and Power Optimization

Programm: FP7

Duration: June 2013 - May 2016

Coordinator: Kentro Erevnas Technologias Kai Anaptyxix Thessalias

Partners:

> Ethniko Kentro Erevnas Kai Technologikis Anaptyxis (Greece)
>
> Ecole Polytechnique Federale de Lausanne (Switzerland)
>
> The Queen's University of Belfast (United Kingdom)
>
> Rheinisch-Westfaelische Technische Hochschule Aachen (Germany)
>
> Interuniversitair Micro-Electronica Centrum Vzw (Belgium)

Inria contact: Frédéric Vivien

Manufacturing process variability at low geometries and power dissipation are the most challenging problems in the design of future computing systems. Currently manufacturers go to great lengths to guarantee fault-free operation of their products by introducing redundancy in voltage margins, conservative layout rules, and extra protection circuitry. However, such design redundancy may result into energy overheads. Energy overheads cannot be alleviated by lowering supply voltage below a nominal value without hardware components experiencing faulty operation due to timing errors. On the other hand, many modern workloads, such as multimedia, machine learning, visualization, etc. are designed to tolerate a degree of imprecision in computations and data. SCoRPiO seeks to exploit this observation and to relax reliability requirements for the hardware layer by allowing a controlled degree of imprecision to be introduced to computations and data. It proposes to introduce methodologies that allow the system- and application-software layers to synergistically characterize the significance of various parts of the program for the quality of the end result, and their tolerance to faults. Based on this information, extracted automatically or semi-automatically, the system software will steer computations and data to either low-power, yet unreliable or higher-power and reliable functional and storage units. In addition, the system will be able to aggressively reduce its power footprint by opportunistically powering hardware modules below nominal values. Significance-based computing lays the foundations for not only approaching the theoretical limits of energy reduction of CMOS technology, but moving beyond those limits by accepting hardware faults in a controlled manner. Significance-based computing promises to be a preferred alternative to dark silicon, which requires that large portions of a chip be powered-off in every cycle to avoid excessive power dissipation.

9.4. International Initiatives

9.4.1. Inria International Labs

9.4.1.1. JLESC — Joint Laboratory on Extreme Scale Computing

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

Research areas include:

- Scientific applications (big compute and big data) that are the drivers of the research in the other topics of the joint-laboratory.

- Modeling and optimizing numerical libraries, which are at the heart of many scientific applications.

- Novel programming models and runtime systems, which allow scientific applications to be updated or reimagined to take full advantage of extreme-scale supercomputers.

- Resilience and Fault-tolerance research, which reduces the negative impact when processors, disk drives, or memory fail in supercomputers that have tens or hundreds of thousands of those components.

- I/O and visualization, which are important part of parallel execution for numerical silulations and data analytics

- HPC Clouds, that may execute a portion of the HPC workload in the near future.

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

9.4.2. Inria Associate Teams Not Involved in an Inria International Labs

9.4.2.1. Keystone

Title: Scheduling algorithms for sparse linear algebra at extreme scale

International Partner (Institution - Laboratory - Researcher):

Vanderbilt University (United States) - Padma Raghavan

Start year: 2016

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

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

9.4.3. Inria International Partners

9.4.3.1. Declared Inria International Partners

- Christophe Alias has a regular collaboration with Sanjay Rajopadhye from Colorado State University (USA) through the advising of the PhD thesis of Guillaume Iooss.
- Anne Benoit, Frédéric Vivien and Yves Robert have a regular collaboration with Henri Casanova from Hawaii University (USA). This is a follow-on of the Inria Associate team that ended in 2014.

9.4.4. Cooperation with ECNU

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

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

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

In the context of this collaboration two students from ECNU, Li Han and Changjiang Gou, have joined Roma for their PhD.

9.5. International Research Visitors

9.5.1. Visits of International Scientists

- Samuel McCauley visited the team for four months (Oct. 2015 - Feb. 2016) to work with Loris Marchal, Bertrand Simon and Frédéric Vivien on the minimization of I/Os during the out-of-core execution of task trees.

9.5.1.1. Internships

- Laure Gonnord supervised two Master Students in Spring 2016, Vitor Paisante (static analyses for pointers) and Julien Braine (static analyses for data structures).

- Bora Uçar supervised an Raluca Portase, an Erasmus student, for three months (June–September 2016).

9.5.2. Visits to International Teams

9.5.2.1. Research Stays Abroad

- Yves Robert has been appointed as a visiting scientist by the ICL laboratory (headed by Jack Dongarra) at the University of Tennessee Knoxville. He collaborates with several ICL researchers on high-performance linear algebra and resilience methods at scale.

STORM Team

8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. PIA

ELCI   The ELCI project (Software Environment for HPC) aims to develop a new generation of software stack for supercomputers, numerical solvers, runtime and programming development environments for HPC simulation. The ELCI project also aims to validate this software stack by showing its capacity to offer improved scalability, resilience, security, modularity and abstraction on real applications. The coordinator is Bull, and the different partners are CEA, Inria, SAFRAN, CERFACS, CNRS CORIA, CENAERO, ONERA, UVSQ, Kitware and AlgoTech.

8.1.2. ANR

ANR SOLHAR   (http://solhar.gforge.inria.fr/doku.php?id=start).

> ANR MONU 2013 Program, 2013 - 2016 (36 months)
>
> Identification: ANR-13-MONU-0007
>
> Coordinator: Inria Bordeaux/LaBRI
>
> Other partners: CNRS-IRIT, Inria-LIP Lyon, CEA/CESTA, EADS-IW
>
> Abstract: This project aims at studying and designing algorithms and parallel programming models for implementing direct methods for the solution of sparse linear systems on emerging computers equipped with accelerators. The ultimate aim of this project is to achieve the implementation of a software package providing a solver based on direct methods for sparse linear systems of equations. Several attempts have been made to accomplish the porting of these methods on such architectures; the proposed approaches are mostly based on a simple offloading of some computational tasks (the coarsest grained ones) to the accelerators and rely on fine hand-tuning of the code and accurate performance modeling to achieve efficiency. This project proposes an innovative approach which relies on the efficiency and portability of runtime systems, such as the StarPU tool developed in the runtime team (Bordeaux). Although the SOLHAR project will focus on heterogeneous computers equipped with GPUs due to their wide availability and affordable cost, the research accomplished on algorithms, methods and programming models will be readily applicable to other accelerator devices such as ClearSpeed boards or Cell processors.

ANR Songs   Simulation of next generation systems (http://infra-songs.gforge.inria.fr/).

> ANR INFRA 2011, 01/2012 - 12/2015 (48 months)
>
> Identification: ANR-11INFR01306
>
> Coordinator: Martin Quinson (Inria Nancy)
>
> Other partners: Inria Nancy, Inria Rhône-Alpes, IN2P3, LSIIT, Inria Rennes, I3S.
>
> Abstract: The goal of the SONGS project is to extend the applicability of the SimGrid simulation framework from Grids and Peer-to-Peer systems to Clouds and High Performance Computation systems. Each type of large-scale computing system will be addressed through a set of use cases and lead by researchers recognized as experts in this area.

8.1.3. ADT - Inria Technological Development Actions

ADT K'Star   (http://kstar.gforge.inria.fr/#!index.md)
Participants: Olivier Aumage, Nathalie Furmento, Samuel Pitoiset, Samuel Thibault.

Inria ADT Campaign 2013, 10/2013 - 9/2015 (24 months)

Coordinator: Thierry Gautier (team AVALON, Inria Grenoble - Rhône-Alpes) and Olivier Aumage (team RUNTIME, Inria Bordeaux - Sud-Ouest)

Abstract: The Inria action ADT K'Star is a joint effort from Inria teams AVALON and RUNTIME to design the Klang-Omp source-to-source OpenMP compiler to translate OpenMP directives into calls to the API of AVALON and RUNTIME respective runtime systems (XKaapi for AVALON, StarPU for RUNTIME).

8.1.4. IPL - Inria Project Lab

C2S@Exa - Computer and Computational Sciences at Exascale   **Participant:** Olivier Aumage.

Inria IPL 2013 - 2017 (48 months)

Coordinator: Stéphane Lantéri (team Nachos, Inria Sophia)

Since January 2013, the team is participating to the C2S@Exa http://www-sop.inria.fr/c2s_at_exa Inria Project Lab (IPL). This national initiative aims at the development of numerical modeling methodologies that fully exploit the processing capabilities of modern massively parallel architectures in the context of a number of selected applications related to important scientific and technological challenges for the quality and the security of life in our society. This collaborative effort involves computer scientists that are experts of programming models, environments and tools for harnessing massively parallel systems, algorithmists that propose algorithms and contribute to generic libraries and core solvers in order to take benefit from all the parallelism levels with the main goal of optimal scaling on very large numbers of computing entities and, numerical mathematicians that are studying numerical schemes and scalable solvers for systems of partial differential equations in view of the simulation of very large-scale problems.

HAC-SPECIS - High-performance Application and Computers, Studying PErformance and Correctness In Simulation **Participants:** Samuel Thibault, Luka Stanisic.

Inria IPL 2016 - 2020 (48 months)

Coordinator: Arnaud Legrand (team Polaris, Inria Rhône Alpes)

Since June 2016, the team is participating to the HAC-SPECIS http://hacspecis.gforge.inria.fr/ Inria Project Lab (IPL). This national initiative aims at answering methodological needs of HPC application and runtime developers and allowing to study real HPC systems both from the correctness and performance point of view. To this end, it gathers experts from the HPC, formal verification and performance evaluation community.

8.2. European Initiatives

8.2.1. FP7 & H2020 Projects

8.2.1.1. INTERTWinE

Title: Programming Model INTERoperability ToWards Exascale

Programm: H2020

Duration: October 2015 - October 2018

Coordinator: EPCC

Partners:

Barcelona Supercomputing Center - Centro Nacional de Supercomputacion (Spain)

Deutsches Zentrum für Luft - und Raumfahrt Ev (Germany)

Fraunhofer Gesellschaft Zur Forderung Der Angewandten Forschung Ev (Germany)

Institut National de Recherche en Informatique et en Automatique (France)

Kungliga Tekniska Hoegskolan (Sweden)

T-Systems Solutions for Research (Germany)

The University of Edinburgh (United Kingdom)

Universitat Jaume I de Castellon (Spain)

The University of Manchester (United Kingdom)

Inria contact: Olivier Aumage

This project addresses the problem of programming model design and implementation for the Exascale. The first Exascale computers will be very highly parallel systems, consisting of a hierarchy of architectural levels. To program such systems effectively and portably, programming APIs with efficient and robust implementations must be ready in the appropriate timescale. A single, "silver bullet" API which addresses all the architectural levels does not exist and seems very unlikely to emerge soon enough. We must therefore expect that using combinations of different APIs at different system levels will be the only practical solution in the short to medium term. Although there remains room for improvement in individual programming models and their implementations, the main challenges lie in interoperability between APIs. It is this interoperability, both at the specification level and at the implementation level, which this project seeks to address and to further the state of the art. INTERTWinE brings together the principal European organisations driving the evolution of programming models and their implementations. The project will focus on seven key programming APIs: MPI, GASPI, OpenMP, OmpSs, StarPU, QUARK and PaRSEC, each of which has a project partner with extensive experience in API design and implementation. Interoperability requirements, and evaluation of implementations will be driven by a set of kernels and applications, each of which has a project partner with a major role in their development. The project will implement a co- design cycle, by feeding back advances in API design and implementation into the applications and kernels, thereby driving new requirements and hence further advances.

8.2.1.2. Mont-Blanc 2

Title: Programming Model INTERoperability ToWards Exascale

Programm: FP7

Duration: September 2013 - January 2017

Coordinator: BSC

Partners: Atos/Bull, ARM, Jülich, LRZ, Univ. Stuttgart, CINECA, CNRS, CEA, Univ. Bristol, Allinea Software, Univ. Cantabria

Inria contact: Olivier Aumage

The Mont-Blanc project aims to develop a European Exascale approach leveraging on commodity power-efficient embedded technologies. The project has developed a HPC system software stack on ARM, and will deploy the first integrated ARM-based HPC prototype by 2014, and is also working on a set of 11 scientific applications to be ported and tuned to the prototype system. Team STORM has been involved in porting the MAQAO binary code analyzer and instrumenter on ARM platforms and interfacing it with the kernel autotuning framework BOAST.

8.3. International Initiatives

8.3.1. Inria International Partners

8.3.1.1. Declared Inria International Partners

- Team STORM is supervising the membership of Inria as part of the OpenMP Architecture Review Board (ARB), the international body in charge of the standardisation of the OpenMP parallel programming language. The membership has been supported by an InriaHUB/Standardisation grant.

- Team STORM is member of the Khronos Group Advisory Panel about the standardization of the OpenCL and SYCL programming languages.

<p align="center" style="color:red">TADAAM Team</p>

9. Partnerships and Cooperations

9.1. National Initiatives

9.1.1. ANR

ANR MOEBUS Scheduling in HPC (http://moebus.gforge.inria.fr/doku.php).
> ANR INFRA 2013, 10/2013 - 9/2017 (48 months)
> Coordinator: Denis Trystram (Inria Rhône-Alpes)
> Other partners: Inria Bordeaux Sud-Ouest, Bull/ATOS
> Abstract: This project focuses on the efficient execution of parallel applications submitted by various users and sharing resources in large-scale high-performance computing environments

ANR SATAS SAT as a Service.
> AP générique 2015, 01/2016 - 12-2019 (48 months)
> Coordinator: Laurent Simon (LaBRI)
> Other partners: CRIL (Univ. Artois), Inria Lille (Spirals)
> Abstract: The SATAS project aims to advance the state of the art in massively parallel SAT solving. The final goal of the project is to provide a "pay as you go" interface to SAT solving services and will extend the reach of SAT solving technologies, daily used in many critical and industrial applications, to new application areas, which were previously considered too hard, and lower the cost of deploying massively parallel SAT solvers on the cloud.

9.1.2. IPL - Inria Project Lab

MULTICORE - Large scale multicore virtualization for performance scaling and portability
> **Participants:** Emmanuel Jeannot and Farouk Mansouri.
> Multicore processors are becoming the norm in most computing systems. However supporting them in an efficient way is still a scientific challenge. This large-scale initiative introduces a novel approach based on virtualization and dynamicity, in order to mask hardware heterogeneity, and to let performance scale with the number and nature of cores. It aims to build collaborative virtualization mechanisms that achieve essential tasks related to parallel execution and data management. We want to unify the analysis and transformation processes of programs and accompanying data into one unique virtual machine. We hope delivering a solution for compute-intensive applications running on general-purpose standard computers.

9.2. European Initiatives

9.2.1. Collaborations in European Programs, Except FP7 & H2020

COLOC: the Concurrency and Locality Challenge (http://www.coloc-itea.org).
> Program: ITEA2
> Project acronym: COLOC
> Project title: The Concurrency and Locality Challenge
> Duration: November 2014 - November 2017
> Coordinator: BULL/ATOS
> Other partners: BULL/ATOS (France); Dassault Aviation (France) ; Enfeild AB (Sweden); Scilab entreprise (France); Teratec (France); Inria (France); Swedish Defebnse Research Agency - FOI (France); UVSQ (France).
> Abstract: The COLOC project aims at providing new models, mechanisms and tools for improving applications performance and supercomputer resources usage taking into account data locality and concurrency.

NESUS: Network for Ultrascale Computing (http://www.nesus.eu)

> Program: COST
>
> Project acronym: NESUS
>
> Project title: Network for Ultrascale Computing
>
> Duration: April 2014 - April 2018
>
> Coordinator: University Carlos III de Madrid
>
> Other partners: more than 35 countries
>
> Abstract: Ultrascale systems are envisioned as large-scale complex systems joining parallel and distributed computing systems that will be two to three orders of magnitude larger that today's systems. The EU is already funding large scale computing systems research, but it is not coordinated across researchers, leading to duplications and inefficiencies. The goal of the NESUS Action is to establish an open European research network targeting sustainable solutions for ultrascale computing aiming at cross fertilization among HPC, large scale distributed systems, and big data management. The network will contribute to glue disparate researchers working across different areas and provide a meeting ground for researchers in these separate areas to exchange ideas, to identify synergies, and to pursue common activities in research topics such as sustainable software solutions (applications and system software stack), data management, energy efficiency, and resilience. Some of the most active research groups of the world in this area are members of this proposal. This Action will increase the value of these groups at the European-level by reducing duplication of efforts and providing a more holistic view to all researchers, it will promote the leadership of Europe, and it will increase their impact on science, economy, and society.

9.2.2. Collaborations with Major European Organizations

> Partner 1: INESC-ID, Lisbon, (Portugal)
>
> Subject 1: Application modeling for for hierarchical memory system
>
> Partner 2: Argonne National Lab
>
> Subject 2: Topology-aware data aggregation for I/O intensive application
>
> Partner 3: BSC, Barcelona (Spain)
>
> Subject 3: High-performance communication on new architectures; load-balancing and meshing: improve the distribution of data accross the processors for a flow and particle simulation in the human nasal cavity.
>
> Partner 4: University of Liege (Belgium), Université Catholique de Louvain (Belgium), Weierstrass Institute for Applied Analysis and Stochastics (WIAS) (Germany)
>
> Subject 4: Coupling sequential remeshers with PaMPA began in 2016. The work [23] is in progress and it concerns Tetgen developped by Hang Si, and Gmsh by Christophe Geuzaine and Jean-François Remacle.

9.3. International Initiatives

9.3.1. Inria International Labs

Joint-Lab on Extreme Scale Computing (JLESC):

> Coordinators: Franck Cappello and Marc Snir.
>
> Other partners: Argonne National Lab, University of Urbanna Champaign, Tokyo Riken, Jülich Supercomputing Center, Barcelona Supercomputing Center.
>
> Abstract: The Joint Laboratory is based at Illinois and includes researchers from Inria, and the National Center for Supercomputing Applications, ANL, Riken, Jülich, and BSC. It focuses on software challenges found in extreme scale high-performance computers.

9.3.2. Inria International Partners

9.3.2.1. Declared Inria International Partners

Partner 1: AMD Research

Subject 1: Managing locality in the Heterogeneous System Architecture.

AMD provided hardware and details about its future architectures and programming models (HSA) to improve locality support for its products in the HWLOC software.

9.3.2.2. Informal International Partners

Partner 1: ICL at University of Tennessee

Subject 1: on instrumenting MPI applications and modeling platforms (works on HWLOC take place in the context of the OPEN MPI consortium) and MPI and process placement

Partner 2: Cisco Systems

Subject 2: network topologies and platform models

Partner 3: University of Tokyo and RIKEN

Subject 3: Adaptation of MPI and runtime systems to lightweight kernels used on clusters of manycores. This action has been submitted as a JLESC project proposal, currently beeing evaluated.

Partner 4: Lawrence Livermore National Laboratory

Subject 4: Testing of the mapping features of SCOTCH on very large process graphs (more than two billion vertices) and very large target architectures (more than 200,000 parts).

Partner 5: Sandia National Lab

Subject 5: Topology-aware management and allocation of computing resources in runtime systems.

9.4. International Research Visitors

9.4.1. Visits of International Scientists

- Balazs Gerofi from RIKEN visited us to present his work on micro-kernels for HPC. His visit led to a project proposal for JLESC.
- Jose-Luiz Garcìa Zapata, stayed for three months in the team to work on spectral partitioning and mapping. He implemented a spectral bipartitioning method in SCOTCH.

<p align="center" style="color:red">ASCOLA Project-Team</p>

9. Partnerships and Cooperations

9.1. Regional Initiatives

9.1.1. RFI Atlanstic 2020

9.1.1.1. CoMe4ACloud
Participants: Thomas Ledoux [coordinator], Frederico Alvares, Zakarea Al Shara.

The high-level objective of the 1-year CoMe4ACloud (Constraints and Model Engineering for Autonomic Clouds) project is to provide an end-to-end solution for autonomic Cloud services. To that end, we rely on techniques of Constraint Programming so as a decision-making tool and Model-driven Engineering to ease the automatic generation of the so-called autonomic managers as well as their communication with the managed system.

CoMe4ACloud is an Atlanstic2020 funded project and supports a post-doc position. The project is led by Ascola research team and involves also AtlanModels and TASC, all of them from the LINA (Nantes Computer Science Laboratory) and situated at Ecole des Mines de Nantes. See https://come4acloud.github.io for more information.

9.1.2. Pays de la Loire

9.1.2.1. SyMeTRIC
Participant: Jean-Marc Menaud.

SyMeTRIC is a regional federated project in Systems Medicine funded by the Pays de la Loire region. Systems Medicine approaches can be compared to Systems Biology. They aim at integrating several information sources to design and validate bio-models and biomarkers to anticipate and enhance patients following (diagnosis, treatment response prediction, prognosis).

The long term goal of SyMeTRIC is to build a common Systems Medicine computing infrastructure to accelerate the discovery and validation of biomarkers in the fields of oncology, transplantation, and chronic cardiovascular diseases.

9.2. National Initiatives

9.2.1. CominLabs laboratory of excellence

9.2.1.1. EPOC
Participants: Jean-Marc Menaud [coordinator], Thomas Ledoux, Md Sabbir Hasan, Yunbo Li.

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

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

9.2.1.2. PrivGen
Participants: Fatima-Zahra Boujdad, Mario Südholt [coordinator].

PrivGen ("Privacy-preserving sharing and processing of genetic data") is a three-year project that has been started in Oct. 2016 and is conducted by three partners: a team of computer scientists from the LATIM Inserm institute in Brest mainly working on data watermarking techniques, a team of geneticians from an Inserm institute in Rennes working on the gathering and interpretation of genetic data, and the Ascola team. The project provides funding of 330 KEUR altogether with an Ascola share of 120 KEUR.

The project considers challenges related to the outsourcing of genetic data that is in the Cloud by different stakeholders (researchers, organizations, providers, etc.). It tackles several limitations of current security solutions in the cloud, notably the lack of support for different security and privacy properties at once and computations executed at different sites that are executed on behalf of multiple stakeholders.

The partners are working on three main challenges:
- Mechanisms for a continuous digital content protection
- Composition of security and privacy-protection mechanisms
- Distributed processing and sharing of genetic data

The Ascola team is mainly involved in providing solutions for the second and third challenges.

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

The high-level objective of the 3-year SecCloud (Secure Scripting for the Cloud) project is to enhance the security of devices on which web applications can be downloaded, i.e. to enhance client-side security in the context of the Cloud. In order to do so, the project relies on a language-based approach, focusing on three related issues:
- The definition of security policies for web architectures, especially on the client-side.
- Formally-proven analyses of web programming languages.
- Multi-level enforcement mechanisms for the security policies (based on static and dynamic analysis encompassing application-level and system-level software).

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

This year, we have finalized our proposal of extensible JavaScript modules and applied it to extend in a modular way the full-blown JavaScript interpreter Narcissus with several dynamic analyses including information-flow analyses.

9.2.2. ANR

9.2.2.1. SONGS (ANR/INFRA)
Participants: Adrien Lebre [coordinator], Jonathan Pastor, Anthony Simonet.

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

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

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

9.2.3. FSN

9.2.3.1. OpenCloudware (FSN)

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

The OpenCloudware project is coordinated by France Telecom, funded by the French Fonds National pour la Société Numérique (FSN, call Cloud n°1) and endorsed by competitiveness clusters Minalogic, Systematic and SCS. OpenCloudware is developed by a consortium of 18 partners bringing together industry and academic leaders, innovative technology start-ups and open source community expertise. The project started in 2012 for a duration of 42 months.

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

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

9.2.3.2. Hosanna (FSN)

Participants: Jean-Marc Menaud [coordinator], Rémy Pottier.

The Hosanna project (aims to scientifically and technically addresses the problem of deploying applications on a distributed multi-cloud virtual infrastructure (private cloud, Amazon, OVH, CloudWatt, Numergy etc.). This recent need is an important topic issue highlighted by recent major Outages in 2013 by the biggest players in the cloud such as Amazon or Netflix. This project aims to provide services that allow users to deploy their cloud multi-tier applications on hybrid Clouds infrastructures without any separation between IaaS. The Ascola team is extending its optimization solution to address the task placement problem in a multi-cloud environment and will develop a case study on a secure distributed file system. The project started in 2015 for a duration of 2 years.

9.2.4. CPER

9.2.4.1. SeDuCe

Participants: Jean-Marc Menaud [coordinator], Adrien Lebre.

The SeDuCe project (Sustainable Data Centers: Bring Sun, Wind and Cloud Back Together), aims to design an experimental infrastructure dedicated to the study of data centers with low energy footprint. This innovative data center will be the first experimental data center in the world for studying the energy impact of cloud computing and the contribution of renewable energy (solar panels, wind turbines) as well on the scientific, technological, that economical. This project is integrated in the national context of grid computing (Grid'5000), and the Constellation project, which will be an inter-node (Pays de la Loire, Brittany). He also participated in the validation of scientific work in interdisciplinary axis STIC and energy efficiency of the laboratory of excellence COMIN Labs.

9.2.5. Inria Project Labs

9.2.5.1. DISCOVERY

Participants: Ronan Alexandre Rcherreau, Adrien Lebre [coordinator], Anthony Simonet, Mario Südholt.

To accommodate the ever-increasing demand for Utility Computing (UC) resources, while taking into account both energy and economical issues, the current trend consists in building larger and larger Data Centers in a few strategic locations. Although such an approach enables UC providers to cope with the actual demand while continuing to operate UC resources through centralized software system, it is far from delivering sustainable and efficient UC infrastructures for future needs.

The DISCOVERY initiative [36] aims at exploring a new way of operating Utility Computing (UC) resources by leveraging any facilities available through the Internet in order to deliver widely distributed platforms that can better match the geographical dispersal of users as well as the ever increasing demand. Critical to the emergence of such locality-based UC (also referred as Fog/Edge Computing) platforms is the availability of appropriate operating mechanisms. The main objective of DISCOVERY is to design, implement, demonstrate and promote a new kind of Cloud Operting System (OS) that will enable the management of such a large-scale and widely distributed infrastructure in an unified and friendly manner.

The consortium is composed of experts in the following research areas: large-scale infrastructure management systems, networking and P2P algorithms. Moreover, two key network operators, namely Orange and RENATER, are involved in the project.

By deploying and using a Fog/Edge OS on backbones, our ultimate vision is to enable large parts of the Internet to be hosted and operated by its internal structure itself: a scalable set of resources delivered by any computing facilities forming the Internet, starting from the larger hubs operated by ISPs, governments and academic institutions, to any idle resources that may be provided by end users.

ASCOLA leads the DISCOVERY IPL and contributes mainly around two axes: VM life cycle management and security concerns.

9.2.6. InriaHub

9.2.6.1. MERCURY
Participants: Ronan-Alexandre Rcherrueau, Adrien Lebre [coordinator].

ASCOLA, in particular within the framework of the DISCOVERY initiative has been working on the massively distributed use case since 2013. With the development of several proof-of-concepts around OpenStack, the team has had the opportunity to start an InriaHub action. Named MERCURY, the goal of this action is twofold: (i) support the research development made within the context of DISCOVERY and (ii) favor the transfer toward the OpenStack community.
Further information available at: http://beyondtheClouds.github.io.

9.3. European Initiatives

9.3.1. FP7 & H2020 Projects

9.3.1.1. CoqHoTT

> Title: Coq for Homotopy Type Theory
>
> Programm: H2020
>
> Type: ERC
>
> Duration: June 2015 - May 2020
>
> Coordinator: Inria
>
> Inria contact: Nicolas TABAREAU

Every year, software bugs cost hundreds of millions of euros to companies and administrations. Hence, software quality is a prevalent notion and interactive theorem provers based on type theory have shown their efficiency to prove correctness of important pieces of software like the C compiler of the CompCert project. One main interest of such theorem provers is the ability to extract directly the code from the proof. Unfortunately, their democratization suffers from a major drawback, the mismatch between equality in mathematics and in type theory. Thus, significant Coq developments have only been done by virtuosos playing with advanced concepts of computer science and mathematics. Recently, an extension of type theory with homotopical concepts such as univalence is gaining traction because it allows for the first time to marry together expected principles of equality. But the univalence principle has been treated so far as a new axiom which breaks one fundamental property of mechanized proofs: the ability to compute with programs that make use of this axiom. The main goal of the CoqHoTT project is to provide a new generation of proof assistants

with a computational version of univalence and use them as a base to implement effective logical model transformation so that the power of the internal logic of the proof assistant needed to prove the correctness of a program can be decided and changed at compile time—according to a trade-off between efficiency and logical expressivity. Our approach is based on a radically new compilation phase technique into a core type theory to modularize the difficulty of finding a decidable type checking algorithm for homotopy type theory. The impact of the CoqHoTT project will be very strong. Even if Coq is already a success, this project will promote it as a major proof assistant, for both computer scientists and mathematicians. CoqHoTT will become an essential tool for program certification and formalization of mathematics.

9.3.1.2. BigStorage

> Title: BigStorage: Storage-based Convergence between HPC and Cloud to handle Big Data
>
> Programm: H2020
>
> Duration: January 2015 - December 2018
>
> Coordinator: Universidad politecnica de Madrid
>
> Partners:
>
>> Storage Research Group, Barcelona Supercomputing Center - Centro Nacional de Super-computacion (Spain)
>>
>> Ca Technologies Development Spain (Spain)
>>
>> Commissariat A L Energie Atomique et Aux Energies Alternatives (France)
>>
>> Deutsches Klimarechenzentrum (Germany)
>>
>> ICS, Foundation for Research and Technology Hellas (Greece)
>>
>> Fujitsu Technology Solutions (Germany)
>>
>> Johannes Gutenberg Universitaet Mainz (Germany)
>>
>> Universidad Politecnica de Madrid (Spain)
>>
>> Seagate Systems Uk (United Kingdom)
>
> Inria contact: G. Antoniu & A. Lebre

The consortium of this European Training Network (ETN) 'BigStorage: Storage-based Convergence between HPC and Cloud to handle Big Data' will train future data scientists in order to enable them and us to apply holistic and interdisciplinary approaches for taking advantage of a data-overwhelmed world, which requires HPC and Cloud infrastructures with a redefinition of storage architectures underpinning them - focusing on meeting highly ambitious performance and energy usage objectives. There has been an explosion of digital data, which is changing our knowledge about the world. This huge data collection, which cannot be managed by current data management systems, is known as Big Data. Techniques to address it are gradually combining with what has been traditionally known as High Performance Computing. Therefore, this ETN will focus on the convergence of Big Data, HPC, and Cloud data storage, ist management and analysis. To gain value from Big Data it must be addressed from many different angles: (i) applications, which can exploit this data, (ii) middleware, operating in the cloud and HPC environments, and (iii) infrastructure, which provides the Storage, and Computing capable of handling it. Big Data can only be effectively exploited if techniques and algorithms are available, which help to understand its content, so that it can be processed by decision-making models. This is the main goal of Data Science. We claim that this ETN project will be the ideal means to educate new researchers on the different facets of Data Science (across storage hardware and software architectures, large-scale distributed systems, data management services, data analysis, machine learning, decision making). Such a multifaceted expertise is mandatory to enable researchers to propose appropriate answers to applications requirements, while leveraging advanced data storage solutions unifying cloud and HPC storage facilities.

DIVERSE Project-Team

8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. ANR

8.1.1.1. GEMOC

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

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

8.1.1.2. SOPRANO

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

8.1.1.3. Gdiv MRSE

- Coordinator: B. Baudry
- Inria Rennes
- Dates: 2014-2016
- Abstract: The objective of GDiv is to setup a strong network of European partners around the core team composed of Inria and SINTEF. This network will gather another academic partner and between 3 and 5 industry partners in the areas of software development and deployment. The project proposal setup by the GDiv network will address the risks of large scale software reuse through integrated, multi-level software diversification techniques.

8.1.2. BGLE / LEOC

8.1.2.1. CONNEXION

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

8.1.2.2. CLARITY

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

8.1.2.3. Occiware

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

8.1.3. DGA

8.1.3.1. MOTIV

- Coordinator: InPixal
- Other partners: Bertin, DGA, Inria
- Dates: 2012-2014
- Abstract: This project investigates innovative software test generation and management solutions to handle the very high degrees of variability in video processing algorithmic chains. The objective is to provide systematic criteria to qualify the testing activity when developing video processing software and to tailor these criteria to the variability dimensions that emerge in the context of visible images.

8.1.3.2. FPML (CYBERDEFENSE)

- Coordinator: DGA
- Partners: DGA MI, Inria
- Dates: 2014-2016

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

8.1.4. Cominlabs

8.1.4.1. PROFILE

- Coordinator: Université de Rennes 1
- Partners: Inria, Université de Rennes 2
- Dates: 2016-2019
- Abstract: The PROFILE project brings together experts from law, computer science and sociology to address the challenges raised by online profiling, following a multidisciplinary approach. More precisely, the project will pursue two complementary and mutually informed lines of research: (i) Investigate, design, and introduce a new right of opposition into the legal framework of data protection to better regulate profiling and to modify the behavior of commercial companies towards being more respectful of the privacy of their users; (ii)S Provide users with the technical means they need to detect stealthy profiling techniques as well as to control the extent of the digital traces they routinely produce. As a case study, we focus on browser fingerprinting, a new profiling technique for targeted advertisement. The project will develop a generic framework to reason on the data collected by profiling algorithms, to uncover their inner working, and make them more accountable to users. PROFILE will also propose an innovative protection to mitigate browser fingerprinting, based on the collaborative reconfiguration of browsers.

8.2. European Initiatives

8.2.1. FP7 & H2020 Projects

8.2.1.1. FP7 FET STREP DIVERSIFY

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

8.2.1.2. FP7 STREP HEADS

- Coordinator: SINTEF
- Other partners: Inria, Software AG, ATC, Tellu, eZmonitoring
- Dates: 2013-2016
- Abstract: The idea of the HEADS project is to leverage model-driven software engineering and generative programming techniques to provide a new integrated software engineering approach which allow advanced exploitation the full range of diversity and specificity of the future computing continuum. The goal is to empower the software and services industry to better take advantage of the opportunities of the future computing continuum and to effectively provide new innovative services that are seamlessly integrated to the physical world making them more pervasive, more

robust, more reactive and closer (physically, socially, emotionally, etc.) to their users. We denote such services HD-services. HD-services (Heterogeneous and Distributed services) characterize the class of services or applications within the Future Internet whose logic and value emerges from a set of communicating software components distributed on a heterogeneous computing continuum from clouds to mobile devices, sensors and/or smart-objects.

8.2.1.3. H2020 ICT-10-2016 STAMP

- Coordinator: Inria (DIVERSE)
- Other partners: ATOS, ActiveEon, OW2, TellU, Engineering, XWiki, TU Delft, SINTEF
- Dates: 2016-2019
- Abstract: Leveraging advanced research in automatic test generation, STAMP aims at pushing automation in DevOps one step further through innovative methods of test amplification. It will reuse existing assets (test cases, API descriptions, dependency models), in order to generate more test cases and test configurations each time the application is updated. Acting at all steps of development cycle, STAMP techniques aim at reducing the number and cost of regression bugs at unit level, configuration level and production stage.

  STAMP will raise confidence and foster adoption of DevOps by the European IT industry. The project gathers 3 academic partners with strong software testing expertise, 5 software companies (in: e-Health, Content Management, Smart Cities and Public Administration), and an open source consortium. This industry-near research addresses concrete, business-oriented objectives. All solutions are open source and developed as microservices to facilitate exploitation, with a target at TRL 6.

8.2.2. Collaborations in European Programs, Except FP7 & H2020

8.2.2.1. ICT COST Action MPM4CPS (IC1404)

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

8.2.3. Collaborations with Major European Organizations

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

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

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

8.3. International Initiatives

- Université de Montréal (Canada)

- McGill University (Canada)
- University of Alabama (USA)
- TU Wien (Austria)
- Michigan State University (USA)
- Aachen University (Germany)

8.3.1. Participation in Other International Programs

The GEMOC studio has been sustained through the creation of a Research Consortium at the Eclipse Foundation.

8.3.2. International initiative GEMOC

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

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

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

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

8.4. International Research Visitors

8.4.1. Visits of International Scientists

Yves Le Traon, Professor at the University of Luxembourg, visited the team in June and July 2016.

Tanja Mayerhofer, Junior Researcher at the TU Wien, visited the team in September 2016.

Bernhard Rumpe, Professor at Aachen University, visited the team in May 2016.

8.4.1.1. Internships

Vikas Mishra, Master intership at the Birla Institute of Technology & Science, visited the team from June to August 2016.

Alexandre Nuttinck, Axel Halin, Master interships at the University of Namur, visited the team from September 2016 to January 2017.

8.4.2. Visits to International Teams

Manuel Leduc visited CWI for 3 weeks in December 2016

Benoit Baudry visited Professor Stephanie Forrest at the University of New Mexico for one month in April 2016.

Benoit Combemale visited Professor Jorg Kienzle at McGill University for 3 weeks in June 2016; and visited Professor Bernhard Rumpe at Aachen University in April 2016.

8.4.2.1. Research Stays Abroad

Marcelino Rodriguez-Cancio visited Vanderbildt University from November 2016 to May 2017.

<p style="text-align:center; color:red;">**FOCUS Project-Team**</p>

8. Partnerships and Cooperations

8.1. National Initiatives

- REVER (Programming Reversible Recoverable Systems) is an ANR project with a 4-year duration. REVER aims to study the possibility of defining semantically well-founded and composable abstractions for dependable computing on the basis of a reversible programming language substrate, where reversibility means the ability to undo any distributed program execution, possibly step by step. The critical assumption behind REVER is that by adopting a reversible model of computation, and by combining it with appropriate notions of compensation and modularity, one can develop systematic and composable abstractions for recoverable and dependable systems. Main persons involved: Giachino, Lanese, Laneve, Zavattaro.

- PACE (Processus non-standard: Analyse, Coinduction, et Expressivité) is an ANR project with a 4-year duration. The project targets three fundamental ingredients in theories of concurrent processes, namely coinduction, expressiveness, and analysis techniques. The project targets processes that are beyond the realm of "traditional" processes. Specifically, the models studied exhibit one or more of the following features: probabilities, higher-order, quantum, constraints, knowledge, and confidentiality. These models are becoming increasingly important for today's applications. Coinduction is intended to play a pivotal role. Indeed, the approaches to expressiveness and the analysis techniques considered in the project are based on coinductive equalities. Main persons involved: Hirschkoff (project coordinator), Dal Lago, Lanese, Sangiorgi, Zavattaro.

- ELICA (Expanding Logical Ideas for Complexity Analysis) is an ANR project that started on October 2014 and that will finish on September 2018. ELICA focuses on methodologies for the static analysis of programs and their resource consumption. The project's aim is to further improve on logical methodologies for complexity analysis (type systems, rewriting, etc.). More specifically, one would like to have more powerful techniques with less false negatives, being able at the same time to deal with nonstandard programming paradigms (concurrent, probabilistic, etc.). Main persons involved: Avanzini, Cappai, Dal Lago, Hirschkoff, Martini, Sangiorgi.

- REPAS (Reliable and Privacy-Aware Software Systems via Bisimulation Metrics) is an ANR Project that started on October 2016 and that will finish on October 2020. The project aims at investigating quantitative notions and tools for proving program correctness and protecting privacy. In particular, the focus will be put on bisimulation metrics, which are the natural extension of bisimulation to quantitative systems. As a key application, we will develop a mechanism to protect the privacy of users when their location traces are collected. Main persons involved: Dal Lago, Martini, Sangiorgi.

- COCAHOLA (Cost models for Complexity Analyses of Higher-Order Languages) is an ANR Project that started on October 2016 and that will finish on October 2019. The project aims at developing complexity analyses of higher-order computations. The focus is not on analyzing fixed programs, but whole programming languages. The aim is the identification of adequate units of measurement for time and space, i.e. what are called reasonable cost models. Main persons involved: Dal Lago, Martini.

8.2. European Initiatives

8.2.1. FP7 & H2020 Projects

- ENVISAGE (Engineering Virtualized Services) is a EU FP7 project, with starting date October 1st, 2013, and with a 3-year duration. The project is about model-based development of virtualized services, including tool support for resource analysis. Most Focus members are involved.

8.2.2. Collaborations in European Programs, Except FP7 & H2020

- The ICT COST Action BETTY (Behavioural Types for Reliable Large-Scale Software Systems). initiated in October 2012 and with a 4-year duration, uses behavioural type theory as the basis for new foundations, programming languages, and software development methods for communication-intensive distributed systems. Behavioural type theory encompasses concepts such as interfaces, communication protocols, contracts, and choreographies. Main persons involved: Bravetti, Giachino, Hirschkoff, Lanese, Laneve, Mauro, Sangiorgi, Zavattaro.

- ICT COST Action IC1405 (Reversible computation - extending horizons of computing). Initiated at the end of April 2015 and with a 4-year duration, this COST Action studies reversible computation and its potential applications, which include circuits, low-power computing, simulation, biological modeling, reliability and debugging. Reversible computation is an emerging paradigm that extends the standard forwards-only mode of computation with the ability to execute in reverse, so that computation can run backwards as naturally as it can go forwards.

  Main persons involved: Giachino, Lanese (vice-chair of the action).

- ICT COST Action IC1402 ARVI (Runtime Verification beyond Monitoring) Initiated in December 2014 and with a 4-year duration, this COST Action studies runtime verification, a computing analysis paradigm based on observing a system at runtime to check its expected behaviour.

  Main persons involved: Bravetti, Lanese.

- SMAll (Smart Mobility for All) SMAll is an EIT project that runs during 2016.

  The aim of the project is to develop a service-oriented platform, called the SMAll platform [0], to support the creation of a liquid market for transportation, facilitating the publication, retrieval, and orchestration of functionalities for transportation, owned by different operators.

  Jolie plays a prominent part in the development of the SMAll platform: it is the main language for the development of both the platform — the architecture of services that support publishing, organisation, and interaction among the functionalities for transportation — and of the services for mobility.

8.2.3. Collaborations with Major European Organizations

Simone Martini is a member of the Executive Board of EQANIE (European Quality Assurance Network for Informatics Education), from October 2014.

We list here the cooperations and contacts with other groups, without repeating those already listed in previous sections.

- ENS Lyon (on concurrency models and resource control). Contact person(s) in Focus: Dal Lago, Martini, Sangiorgi, Vignudelli. Some visit exchanges during the year, in both directions. A new joint PhD started in september 2016 (Adrien Durier).

- Inria EPI Spades (on models and languages for components, reversibility). Contact person(s) in Focus: Lanese. Some visit exchanges during the year, in both directions.

- Laboratoire d'Informatique, Université Paris Nord, Villetaneuse (on implicit computational complexity). Contact person(s) in Focus: Dal Lago, Martini. An Italian PhD student (Marco Solieri) is working on his PhD thesis with joint supervision (Martini, Guerrini).

- Institut de Mathématiques de Luminy, Marseille (on lambda-calculi, linear logic and semantics). Contact person(s) in Focus: Dal Lago, Martini.

- Team PPS, IRIF Lab, University of Paris-Diderot Paris 7 (on logics for processes, resource control). Contact person(s) in Focus: Dal Lago, Martini, Sangiorgi. Some short visits in both directions during the year.

---

[0]https://github.com/small-dev/SMAll.Wiki/wiki

- IRILL Lab, Paris (on models for the representation of dependencies in distributed package based software distributions). Contact person(s) in Focus: Mauro, Zavattaro. Some short visits in both directions during the year.

- EPI Carte, Inria-Nancy Grand Est and LORIA (on implicit computational complexity). Contact person(s) in Focus: Dal Lago.

- LMU Munich (M. Hofmann) (on implicit computational complexity and IntML). Contact person(s) in Focus: Dal Lago.

- IMDEA Software, Madrid (G. Barthe) (on implicit computational complexity for cryptography). Contact person(s) in Focus: Dal Lago,Sangiorgi. Some visits during the year.

- Facultad de Informatica, Universidad Complutense de Madrid (on web services). Contact person(s) in Focus: Bravetti. Bravetti is an external collaborator in the project "Desarrollo y Análisis formal de sistemas complejos en contextos DistribuidOS: fundamentos, herramientas y aplicaciones (DArDOS)" (Development and formal analysis of complex systems in distributed contexts: foundations, tools and applications) January 2016 - December 2018, funded by the Spanish Ministerio de Economia y Competitividad.

8.3. International Initiatives

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

8.3.1.1. CRECOGI

Title: Concurrent, Resourceful and Effectful Computation, by Geometry of Interaction

International Partner (Institution - Laboratory - Researcher):

Tokyo (Japan) - Department of Computer Science, Graduate School of Information Science and Technology - Ichiro HASUO

Start year: 2015

See also: http://crecogi.cs.unibo.it

Game semantics and geometry of interaction (GoI) are two closely related frameworks whose strength is to have the characters of both a denotational and an operational semantics. They offer a high-level, mathematical (denotational) interpretation, but are interactive in nature. The formalization in terms of movements of tokens through which programs communicate with each other can actually be seen as a low-level program. The current limit of GoI is that the vast majority of the literature and of the software tools designed around it have a pure, sequential functional language as their source language. This project aims at investigating the application of GoI to concurrent, resourceful, and effectful computation, thus paving the way to the deployment of GoI-based correct-by-construction compilers in real-world software developments in fields like (massively parallel) high-performance computing, embedded and cyberphysical systems, and big data. The presence of both the japanese GoI community (whose skills are centered around effects and coalgebras) and the french GoI community (more focused on linear logic and complexity analysis) will bring essential, complementary, ingredients.

8.4. International Research Visitors

8.4.1. Visits of International Scientists

The following researchers have visited Focus for short periods; we list them together with the title of the talk they have given during their stay, or the topic discussed during their stay.

- Marco Bernardo: "Disjunctive Probabilistic Modal Logic is Enough for Bisimilarity on Reactive Probabilistic Systems."

- Guillermo Roman Diez: "Resource Analysis."

- Lukasz Mikulski: "On Concurrency Paradigms."
- Jean-Pierre Jouannaud: "Coq modulo theory."
- Paul Blain Levy: "Trace semantics of well-founded processes via commutativity."
- Akihisa Yamada: "Certifying Safety and Termination Proofs for Integer Transition Systems" (long visit).
- Ryo Tanaka: semantics of higher-order functional languages (long visit).
- Antonio Ravara: "Behavioural Type Inference for Object-Oriented Languages".
- Lukasz Mikulski: "On concurrency paradigms".
- Ludovic Henrio, "Deadlock analysis in distributed object systems".

8.4.2. *Visits to International Teams*

- Ugo Dal Lago: has spent two weeks in April at ENS Lyon, and 1 month at IRIF, Université Paris 7, in May/June.
- Charles Grellois has taken part in the programme "Automata, Logic and Games", 5 weeks (August-September), Singapore.
- Valeria Vignudelli has spent six months in the Inria Comète team, Inria Saclay/Ecole Polytechnique, Paris.
- Abel Garcia has spent 6 months at the Department of Computer Science, TUD Darmstadt.

8.4.2.1. *Sabbatical programme*

Maurizio Gabbrielli is, since 15 September 2014, Head of the EIT ICT Labs Doctoral School with Paris as his principal location.

<p align="center" style="color:red">INDES Project-Team</p>

6. Partnerships and Cooperations

6.1. National Initiatives

6.1.1. ANR AJACS

The AJACS project (Analyses of JavaScript Applications: Certification & Security) is by the ANR for 42 months, starting December 2014. The goal of AJACS project is to provide strong security and privacy guarantees on the client side for web application scripts. The Indes members are involved in the tasks WP2 Certified Analyses and WP3 Security of JavaScript Applications. The partners of this project include Inria teams Celtique (coordinator), Toccata, and Prosecco.

6.1.2. FUI UCF

The 3 years long UCF project aims at developing a reactive Web platforms for delivering multimedia contents. The partners of the project are the startups Alterway, OCamlPro, and XWiki, and the academic research laboratories of University Pierre et Marie Curie, and Denis Diderot.

6.1.2.1. Actions marquante

Inria Sophia-Antipolis Actions Marquante is a special funding for 2 postdocs during one year to explore a new research direction. The joint project with DIANA team "User discrimination on the Web: measurement, causation and prevention" has obtained this funding. The goal of this project is to detect when users get discriminated on the Web, what are the technologies used to discriminate users and how we can prevent it without breaking the functionality and sometimes useful personalisation within Web applications.

6.2. European Initiatives

6.2.1. FP7 & H2020 Projects

6.2.1.1. RAPP

Program: http://rapp-project.eu

Title: Robot App Store

Collaborator: Inria Hephaistos

Abstract: RAPP is a 36 months pan-european FP7 project, started in December 2013. Hop.js technology is used by partner academic and SME R&D teams to develop a distributed software platform and applications for assistive robotics.

6.2.2. Collaborations in European Programs, Except FP7 & H2020

6.2.2.1. ICT Cost Action IC1201 BETTY

Program:BETTY

Project acronym: BETTY

Project title: Behavioural Types for Reliable Large-Scale Software Systems

Duration: October 2012 - October 2016

Coordinator:Simon Gay, University of Glasgow

Other partners: several research groups, belonging to 22 european countries

Abstract: The aim of BETTY is to investigate and promote behavioural type theory as the basis for new foundations, programming languages, and software development methods for communication-intensive distributed systems. Behavioural type theory encompasses concepts such as interfaces, communication protocols, contracts, and choreography.

6.2.2.2. ICT Cost Action IC1405 on Reversible Computation

Program: COST

Project acronym: RC

Project title: Reversible computation - extending horizons of computing

Duration: November 2014 - November 2018

Coordinator: Irek Ulidowski, University of Leicester

Other partners: several research groups, belonging to 23 european countries

Abstract: Reversible computation is an emerging paradigm that extends the standard mode of computation with the ability to execute in reverse. It aims to deliver novel computing devices and software, and to enhance traditional systems. The potential benefits include the design of reversible logic gates and circuits - leading to low-power computing and innovative hardware for green ICT, new conceptual frameworks and language abstractions, and software tools for reliable and recovery-oriented distributed systems. This is the first European network of excellence aimed at coordinating research on reversible computation.

6.2.2.3. Bilateral PICS project SuCCeSS

Program: PICS

Project acronym: SuCCeSS

Project title: Security, Adaptability and time in Communication

Duration: June 2016 - June 2019

Coordinator: Cinzia Di Giusto, I3S, Sophia Antipolis

Other partners: I3S, University of Gröningen

Abstract: The project SuCCeSS is a CNRS-funded "Projet coopératif" (PICS 07313), involving 2 French teams in Sophia Antipolis (the MDSC team at the laboratory I3S, acting as coordinator, and the INDES team) and one Dutch team at the University of Gröningen. The project started in June 2016 and is due to end in June 2019. The objective of the project is to study formal models for reliable distributed communication-centric software systems. The project focusses on analysis and validation techniques based on behavioural types, aimed at enforcing various properties (safety, liveness, security) of structured communications.

6.3. International Research Visitors

6.3.1. Visits of International Scientists

6.3.1.1. Internships

Raimil Cruz

Date: 01/05/16 - 30/07/16

Institution: University of Chile

<h2 style="text-align:center;color:red">PHOENIX Project-Team</h2>

9. Partnerships and Cooperations

9.1. Regional Initiatives

9.1.1. Independent living with intellectual disabilities – ANDDI – 2014 - 2017

ANDDI leverages the abilities of individuals with ID and the recent technological advances to develop a variety of assistive services addressing their daily needs. These services draw on our expertise in cognitive science and computer science, dedicated to assisting users with technologies. In particular, we use our platform, named HomeAssist, dedicated to the independently living of older adults. This project is funded by the Region of Aquitaine.

9.1.2. Platform for Assisted Living – HomeAssist 24 – 2013 – 2016

The objective of this project is to provide an open platform of digital assistance dedicated to aging in place. This project is in collaboration with researchers in Cognitive Science (University of Bordeaux) and the UDCCAS Gironde (Union Départementale des Centres Communaux d'Action Sociale) managing elderly care. This project includes a need analysis, the development of assistive applications and their experimental validation. To validate HomeAssist 24 homes of older adults are equipped during 9 months, and matched with 24 control, non-equipped participants. This work is funded by CARSAT, the Region of Aquitaine, and the District of Gironde.

9.1.3. Populational Study of HomeAssist – HomeAssist 500 – 2015 - 2017

We conduct a Randomized Controlled Trial (RCT) of HomeAssist with older adults, ranging from autonomous to mildly cognitively impaired (e.g., Alzheimer disease (AD) in its early stage). The RCT is considered as the gold standard of a true experimental design. Furthermore, it provides strong evidence for causal relationships, as well as the ability to generalize the results to people outside the study's sample. The study design will thus be a single-blinded RCT. It will include up to 500 participants, matched with non-equipped participants. The HomeAssist intervention will involve monitoring as well as compensation services to support independent living in place. The duration of the HomeAssist intervention is of 12 months. This project is funded by the Region of Aquitaine, the Districts of Gironde and Pyrénées Atlantique, CARSAT Aquitaine, UDCCAS, and CNSA.

9.2. National Initiatives

9.2.1. School Inclusion for Children with Autism

The objective of this project is to provide children with assistive technologies dedicated to the school routines. This project is in collaboration with the "Handicap et Système Nerveux" research group (EA 4136, Bordeaux University), the PsyCLÉ research center (EA 3273, Provence Aix-Marseille University) and the "Parole et Langage" research laboratory (CNRS, Provence Aix-Marseille University).

This work is funded by the French Ministry of National Education and Orange Foundation.

9.3. International Initiatives

9.3.1. Participation in Other International Programs

- Cooperation program with UB-University of Waterloo-Canada — Aging (2015-16), Coordinated by M. Fernandes and H. Sauzéon.
- International exchange program Idex (2016-17) — Pr. Luc Noreau, Centre Interdisciplinaire de Recherche en réadaptation et intégration sociale-University of Laval, Canada. Coordinated by P. Dehail.
- Mobility program Idex UB-University of Waterloo, Canada — Aging (2016-17), Coordinated by M. Fernandes and H. Sauzéon.

<h1 style="text-align:center;color:red;">RMOD Project-Team</h1>

9. Partnerships and Cooperations

9.1. Regional Initiatives

Participants: Anne Etien, Nicolas Anquetil, Olivier Auverlot, Stéphane Ducasse. From Sept 2016 to Dec. 2018.

Lille Nord Europe European Associated Team with the PreCISE research center of Pr. A. Cleve from Namur University (Belgium).

This project aims to study the co-evolution between database structure and programs and to propose recommendations to perform required changes on cascade. These programs are either internal to the schema as functions or triggers or external as applications written in Java or Php built on top of the DB. Our intuition is that software engineering techniques can be efficient for such issues. This project also aims to unify the abstract representation of the DB and its relationships with the internal or external program.

9.2. European Initiatives

9.2.1. *Collaborations with Major European Organizations*

Marco Naddéo is a PhD student co-supervised by Damien Cassou, Stéphane Ducasse and Viviana Bono from University of Turin (Italy).

9.3. International Initiatives

9.3.1. *Inria International Labs*

Inria Chile
Associate Team involved in the International Lab:

9.3.1.1. PLOMO2

Title: Infrastructure for a new generation of development tools

International Partner (Institution - Laboratory - Researcher):

> Universidad de Chile (Chile) - Computer Science Department, PLEIAD laboratory (DCC) - Alexander Bergel

Start year: 2014

See also: http://pleiad.cl/research/plomo2

Performing effective software development and maintenance are best achieved with effective tool support. Provided by a variety of tools, each one presenting a specific kinds of information supporting the task at hand. With Plomo2, we want to invent a new generation tools to navigate and profile programs by combining dynamic information with visualization to improve the development environment.

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

9.3.2.1. *Informal International Partners*

We are working with the Uqbar team from different argentinian universities. We hired three of the people: Nicolas Passerini(engineer), Esteban Lorenzano (engineer) and Pablo Tesone (PhD).

We are starting to work with Dr. Robert Pergl from the University of Prague.

9.3.3. Participation in Other International Programs

9.3.3.1. STIC AmSud projects

We were involved in two STIC AmSud projects:

Participants: Damien Cassou [correspondant], Gustavo Santos [RMoD], Martin Dias [RMoD], David Röthlisberger [UDP - Universidad Diego Portales, Santiago, Chile], Marcelo Almeida Maia [UFU - Federal University of Uberlândia, Brasil], Romain Robbes [Departamento de Ciencias de la Computación (DCC), Universidad de Chile, Santiago, Chile], Martin Monperrus [Spirals]. Project Partners: Inria RMOD, Inria Spirals, DCC Universidad de Chile, Universidad Diego Portale Chile, Federal University of Uberlândia, Brasil.

This project aims at facilitating the usage of frameworks and application programming interfaces (APIs) by mining software repositories. Our intuition is that mining reveals how existing projects instantiate these frameworks. By locating concrete framework instantiations in existing projects, we can recommend to developers the concrete procedures for how to use a particular framework for a particular task in a new system. Our project also tackles the challenge of adapting existing systems to new versions of a framework or API by seeking repositories for how other systems adapted to such changes. We plan to integrate recommendations of how to instantiate a framework and adapt to changes directly in the development environment. Those points taken together, considerably distinguish our approach from existing research in the area of framework engineering.

Thanks to this project, a PhD student of Federal University of Uberlândia in Brasil (Klérisson Vinícius Ribeiro da Paixão) did a six months internship in RMod, and prof. Marcelo Almeida Maia (from the same university) visited us for one week.

Participants: Nicolas Anquetil [correspondant], Anne Etien [RMoD], Gustavo Santos [RMoD], Marco Tulio Valente [UFMG - Federal University of Minas Gerais, Brazil], Alexander Bergel [Departamento de Ciencias de la Computación (DCC), Universidad de Chile, Santiago, Chile], Project Partners: Inria RMOD, DCC Universidad de Chile, Federal University of Minas Gerais, Brazil.

The goals of the collaboration is to provide tools to help software engineer restructure a large software system in an iterative and incremental way with input from both expert architect and advanced tool. The tools consist of: extraction of a model from source code, manipulation of the model to experiment with possible restructuring, architecture evaluation tool, recommendation tool to help the software engineers to define the new structure, and tool to back port the modification to the source code.

Pr. Marco Tulio Valente of Federal University of Minas Gerais (Brazil)visited RMod for one week.

9.4. International Research Visitors

9.4.1. Visits of International Scientists

- Prof. Serge Demeyer, 2 days
- Prof. Marcelo Almeida Maia, 1 week, November 2016;
- Prof. Alain Plantec, 5 days, November 2016;
- Prof. Alexandre Bergel, 1 week, December 2016;
- Prof. Marco Tulio Valente, 1 week, December 2016;
- Eliot Miranda, Cadence,1 week, August 2016;
- Dr. Andrei Chis, 3 days, Decembrer 2016.

9.4.1.1. Internships

- Klérisson Vinícius Ribeiro da Paixão, Federal University of Uberlândia, Uberlândia (MG), Brazil, from September, 2015 to July, 2016;
- Lionel Akue, University of Lomé, Togo, from Oct 2016 to Nov 2016
- Julien Delplanque, University of Mons, Belgium, from September 2016 to December 2016.

9.4.2. Visits to International Teams

The whole RMod team spent two days in January at the Vrije Universiteit Brussel (Belgium) to discuss with the Software Languages Lab team: Coen De Roover, Elisa Gonzalez Boix, and their students.

Stéphane Ducasse and Damien Cassou visited Dr. Robert Pergl's team at Czech Technical University in Prague, one week in April.

9.4.2.1. Research Stays Abroad

Marcus Denker: Visit PLEIAD DCC University of Chile, Santiago de Chile 04/12-21/12. Visit in the context of the Inria Associated Team PLOMO2.

TACOMA Team

8. Partnerships and Cooperations

8.1. Regional Initiatives

Project: Modélisation des activités de site consommateur d'énergie pour favoriser l'autoconsommation d'énergies renouvelables produites localement

Partner: OKWIND

Starting: Nov 2016; ending: Nov 2019

Abstract: OKWind [0] is a company specialized in local production of renewable energy. This project, with Inria DiverSE and TACOMA teams, aims at building a system that optimizes the use of different sources of renewable energy, choosing the most suitable source for the current demand and anticipating future needs, so as to favor the consumption of locally produced electricity. The system must be able to model clients' activities. It must also trigger actions (local consumption vs. local storage). The final goal is to use " locally produced" energy in a smarter way and to tend towards a self-consumption optimum.

Project: EkoHub

Partners: Ekolis, Delaye transport

Starting: Nov 2014; ending: Nov 2017

Abtract: The EkoHub project has been architectured around hors multi-technologies gateway and leverages on the one developped in the ITSSv6 European project. In addition to the multiple interfaces of our platforms, sensor devices have been incorporated into the project and we studied different scenarios elaborated with our professional partners (Layaye Logistics). Intelligent data management schemes are being studied to adapt to the communication environment and the needs of the application consuming the data.

8.2. National Initiatives

Project: Pervasive_RFID

Partner: IETR

Starting: July 2013; ending: July 2016

Abtract: Pervasive_RFID is a joint effort (within the CominLabs initiative, see http://www.cominlabs.ueb.eu/) started in July 2013 with IETR (institut d'électronique et de télécommunications de Rennes) to study and design innovative RFID reading protocols in the context of pervasive computing applications. Some limitations of existing RFID technology become challenging: unlike standard RFID application scenarios, pervasive computing often involves uncontrolled environment for RFID, where tags and reader have to operate in much more difficult situations that those usually encountered or expected for classical RFID systems.

Project: GLIE - Guidage Lumineux par l'Intelligence de l'Environnement

Partner: OyaLight

Starting: December 2014; ending: April 2016

Abstract: GLIE is a collaborative projet with OYALIGT and TACOMA group. The objective of the project is to design and demonstrate a new service combining connected LEDs provided by OYALIGHT and a software tool developed by TACOMA. By integrating and analyzing data transmitted by the sensors integrated into LEDs, the service must be able to detect a given context and to react accordingly.

---

[0] http://www.okwind.fr/

Project: Greenfeed

http://greenfeed.org

Partner: BeNomad, Mines St Etiennes, Enedis, G2MOBILITY, GreedPocket

Starting: July 2013; ending: Nov 2016

Abstract: Greenfeed aims at improving electro-mobility, which means the ease with which users can travel using electric cars. In order to achieve its goal, the project focuses three main operators: electro-mobility service provider (EMSP), distribution service operator (DSO), and charging station operator (CSO). During the project, the role of these actors have been precisely defined, so were the role of the systems they were in charge of. A great effort has been put on interoperability, so that the developed systems could collaborate with each other. One of the key use case was to enable the smart management of available power on a 10 charging site. This led to a demonstration in which a Renault Zoé, customized by the Institut Védécom, was able to negotiate a charge planning with the electric power grid. Then a grid initiated renegotiation was demonstrated, once the initial smart charging process had began. This was the first time this behavior had been achieved with a vehicle in France.

8.3. European Initiatives

8.3.1. FP7 & H2020 Projects

Project acronym: SCOOP@F part 2

Partners: MEDE, Renault, PSA

Starting: January 2016; ending: Dec 2018

Abstract: SCOOP@F is a Cooperative ITS pilot deployment project that intends to connect approximately 3000 vehicles with 2000 kilometers of roads. It consists of 5 specific sites with different types of roads: Ile-de-France, "East Corridor" between Paris and Strasbourg, Brittany, Bordeaux and Isère. SCOOP@F is composed of SCOOP@F Part 1 from 2014 to 2015 (ongoing) and SCOOP@F Part 2 from 2016 to 2018. Its main objective is to improve the safety of road transport and of road operating staff during road works or maintenance. The project includes the validations of Cooperative ITS services in open roads, cross border tests with other EU Member States (Spain, Portugal and Austria) and development of a hybrid communication solution (3G-4G/ITS G5).

8.3.2. Collaborations in European Programs, Except FP7 & H2020

Project acronym: SEAS (ITEA3)

Partners: Telecom Paris Tech, Telecom Saint Etienne, Mines Saint Etienne, Engie, Kerlink, BeNomad, ICAM, CNR, VTT

Starting: Feb 2014; ending: Jan 2017

Abstract: The SEAS project addresses the problem of inefficient and unsustainable energy consumption, which is due to a lack of sufficient means to control, monitor, estimate and adapt the energy use of systems versus the dynamic use situations and circumstances influencing the energy use. The objective of the SEAS project is to enable energy, ICT and automation systems to collaborate at consumption sites, and to introduce dynamic and refined ICT-based solutions to control, monitor and estimate energy consumption. Proposed solution should enable energy market participants to incorporate micro-grid environments and active customers. We are involved in the project to design a distributed system architecture and to implement two proofs of concept: the first one is related to the electric vehicle charging and the other one to the prevision of solar energy production.

<h1 style="text-align:center; color:red;">COATI Project-Team</h1>

9. Partnerships and Cooperations

9.1. National Initiatives

9.1.1. ANR

9.1.1.1. ANR Blanc STINT, 2014-2017

Participants: Pierre Aboulker, Jean-Claude Bermond, David Coudert, Frédéric Havet, Luc Hogie, William Lochet, Nicolas Nisse, Stéphane Pérennes, Michel Syska.

The STINT project (*STructures INTerdites*) is led by the MC2 group (LIP, ENS-Lyon) and involves the G-SCOP laboratory (Grenoble).

The aim of STINT is to answer the following fundamental question: *given a (possibly infinite) family ψ of graphs, what properties does a ψ-free graph have?* To this end, it will firstly establish bounds on some classical graph parameters (e.g., clique number, stability number, chromatic number) for ψ-free graphs. Then, it will design efficient algorithms to recognize ψ-free graphs and to determine or approximate some parameters for those graphs. These studies shall result in the development of new proof techniques.

(http://www.ens-lyon.fr/LIP/MC2/STINT/)

9.1.2. PEPS

9.1.2.1. PEPS MoMis SYSTEMIC, 2015 (extended in 2016)

Participant: Frédéric Giroire.

The SYSTEMIC project was led by COATI and involves the LAMA (Paris Est), GREDEG (Sophia Antipolis) and CREM (Rennes) laboratories.

The aim of SYSTEMIC was to bring together the expertises of researchers in economics, graph theory and financial mathematics to propose new models to evaluate the systemic risk of networks of financial institutions, and to propose new methods to mitigate the risk of contagions in such networks. The novelty of the project was in particular to consider strategies for a dynamic control of heterogeneous networks.

9.1.3. GDR Actions

9.1.3.1. Action ResCom, ongoing (since 2006)

Réseaux de communications, working group of GDR RSD, CNRS.

(http://rescom.asr.cnrs.fr/)

9.1.3.2. Action Graphes, ongoing (since 2006)

Action Graphes, working group of GDR IM, CNRS.

(http://gtgraphes.labri.fr/)

9.2. European Initiatives

9.2.1. Collaborations with Major European Organizations

AOR (Vassilis Zissimopoulos) : University of Athens, Department of Informatics and Telecommunications (Greece)

Combinatorial Optimization, Games and Applications (COGA), June 2015- September 2016

Participants : Jean-Claude Bermond, David Coudert, Frédéric Giroire, Nicolas Nisse, Stéphane Pérennes

9.3. International Initiatives

9.3.1. Inria International Labs

Inria Chile

Associate Team involved in the International Lab:

9.3.1.1. ALDYNET

Title: distributed ALgorithms for DYnamic NETworks

International Partner (Institution - Laboratory - Researcher):

Universidad Adolfo Ibañez (Chile) - Facultad de Ingeniería y Ciencias - Karol SUCHAN

Start year: 2016

See also: https://team.inria.fr/coati/projects/aldynet/

This associated team would be the natural continuation of the fruitful EA AlDyNet (2013-2015, https://team.inria.fr/coati/projects/aldynet/)

The main goal of this Associate Team is to design and implement practical algorithms for computing graph structural properties. We will then use these algorithms on a concrete case of study which concerns the transportation network of the Santiago agglomeration. We are both interested in theoretical results concerning the feasibility of computing graph properties, and by their practical implementation (using SageMath, www.sagemath.org/) for our application and their diffusion in the scientific community. There are three main objectives:

1) Design efficient algorithms to compute important graph properties (hyperbolicity, treelength, centrality, treewidth...) in real networks. We are not only interested by the worst-case time-complexity of these algorithms but by their performance in practice.

2) Implement and document our algorithms using the open-source framework SageMath. One advantage of using SageMath is that it has interfaces with other graph libraries (igraph, Boost...) and with Linear Programming solver (GLPK, Cplex...). Moreover, the success of SageMath (which has accumulated thousands of users over the last 10 years) will participate to the diffusion of our algorithms.

3) Apply our algorithms on the Santiago transportation network that have been collected by our Chilean partner during the last year of AlDyNet (2013-2015). Based on the results, propose tools for decision support in designing bus routes, timetables, etc. More precisely, we have collected information about the use of public transport (data of smart cards for automatic fare collection - BIP-, bus routes and bus schedules, etc.), urban infrastructure information, schools' addresses, and approximate locations where students live. We have started to clean and consolidate these data. We will then develop decision support tools, for example, for improving quality education accessibility.

9.3.2. Inria International Partners

9.3.2.1. Informal International Partners

Apart from formal collaboration COATI members maintain strong connections with the following international teams, with regular visits of both sides.

Univ. of Southern Denmark, Prof. Jorgen Bang Jensen

RWTH Aachen Univ., Lehrstuhl II für Mathematik, Germany, Prof. Arie M.C.A. Koster

Concordia Univ. - Montréal, Quebec, Canada, Prof. Brigitte Jaumard

9.3.3. Participation in Other International Programs

GAIATO : Graphs and Algorithms Applied to Telecommunications, International Cooperation FUNCAP/FAPs/Inria/INS2i-CNRS, no. INC-0083-00047.01.00/13, with Federal University of Ceará, Brasil, 2014-2016.

9.4. International Research Visitors

9.4.1. Visits of International Scientists

Daniela Aguirre Guerrero

Universitat de Girona, Girona, Spain, Visiting PhD Student, from Sep 2016 until Nov 2016.

Jean Francois Baffier

Japanese-French Laboratory for Informatics UMI 3527, Japan, Visiting Scientist, June 2016.

Jorgen Bang Jensen

University of Southern Denmark, Odensee, Denmark, Visiting Scientist, from June 2016 until Jul 2016.

Augustin Chaintreau

Columbia University, New York, US, Visiting Scientist, 19-21st January 2016.

Clément Charpentier

Université Joseph Fourier, Grenoble, France, Visiting Scientist, 21-26th February 2016.

Romuald Elie

Université Paris-Est Marne-la-Vallée, Visiting Scientist, October 24-November 2, 2016.

Takako Kodate

Tokyo Woman's Christian Univ., Japan, Visiting Scientist, Apr 2016.

Christian Konrad

Reykjavik University, Iceland, Visiting Scientist, February 28th to March 3rd, 2016.

Aurélie Lagoutte

Université de Princeton, USA, 9-11th March, 2016.

Zvi Lotker

Ben Gurion University of the Negev, Israel, 22-27th February, 2016.

Ana Karolinna Maia De Oliveira

Univ. Federal do Ceara, Fortaleza, Brazil, Visiting Scientist, Oct 2016.

Colin McDiarmid

University of Oxford, UK, Visiting Scientist, September 26-30th 2016.

Ioannis Milis

Athens University of Economics and Business, Athens, Greece, Visiting Scientist, Feb 2016.

Eduardo Moreno

Univ. Adolfo Ibanez, Santiago, Chile, Visiting Scientist, Sep 2016.

Julio Cesar Silva Araujo

Univ. Federal do Ceara, Fortaleza, Brazil, Visiting Scientist, Oct 2016.

Guillem Perarnau-Llobet

University of Birmingham, UK, Visiting Scientist, May 9-13rd 2016.

Jean-Sébastien Sereni

CNRS, France, 22-25th February.

Yllka Velaj

Gran Sasso Science Institute, L'Aquila, Italia, Visiting PhD Student, from Feb 2016 until Apr 2016.

Joseph Yu

University of the Fraser Valley, Abbotsford, Canada, Visiting Scientist, Apr 2016.

Vassilis Zissimopoulos

> National and Kapodistrian University of Athens, Athens, Greece, Visiting Scientist, Feb 2016.

9.4.2. Visits to International Teams

9.4.2.1. Research Stays Abroad

Julien Bensmail

> LaBRI, University of Bordeaux, October 10-14, 2016;
>
> LIF, Aix-Marseille University, October 17-19, 2016.

Jean-Claude Bermond

> Department of Informatics and Telecommunications of the National and Kapodistrian University of Athens, Greece, June7-21, 2016.

David Coudert

> LIP6, UPMC, Paris, October 11-13, 2016;
>
> Univ. Adolfo Ibañez and Univ. Chile, Santiago, Chile, in the context of Inria associated team AlDyNet, October 24-November 11, 2016.

Frédéric Giroire

> Orange Labs, Chatillon, May 17-20, 2016;
>
> Computer Science and Software Engineering department, Concordia University, Montréal, Canada, September 28-October 7, 2016.

Nicolas Huin

> Concordia University, Montreal, Canada, August 22-November 22, 2016.

William Lochet

> Université libre de Bruxelles, Belgique, June 20-25th, 2016.

Nicolas Nisse

> Univ. Federal do Ceará, Fortaleza, Brazil, April, 2016;
>
> LIF, Aix-Marseille University, July 18-22, 2016;
>
> Univ. Adolfo Ibañez and Univ. Chile, Santiago, Chile, in the context of Inria associated team AlDyNet, October 24-November 11, 2016.

Bruce Reed

> National Institute of Informatics Tokyo Japan, June 1-28th 2016;
>
> Pacific Institute of Mathematical Sciences, June 28th-September 5th 2016;
>
> National Institute of Informatics Tokyo Japan, October 1st-December 31th 2016.

<p style="text-align:center;color:red;">DANTE Project-Team</p>

9. Partnerships and Cooperations

9.1. National Initiatives

9.1.1. ANR

9.1.1.1. Equipex FIT (Futur Internet of Things)
Participant: Éric Fleury [correspondant].

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

9.1.1.2. ANR GRAPHSIP (Graph Signal Processing)
Participants: Paulo Gonçalves Andrade [correspondant], Éric Fleury, Thomas Begin, Sarra Ben Alaya, Hadrien Hours.

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

9.1.1.3. ANR INFRA DISCO (DIstributed SDN COntrollers for rich and elastic network services)
Participants: Thomas Begin [correspondant], Anthony Busson, Isabelle Guérin Lassous, Huu Nghi Nguyen.

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

9.1.1.4. ANR REFLEXION (REsilient and FLEXible Infrastructure for Open Networking)
Participants: Thomas Begin [correspondant], Anthony Busson, Isabelle Guérin Lassous, Guillaume Artero Gallardo, Zidong Su.

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

9.1.1.5. ANR CONTINT CODDDE
Participants: Éric Fleury [correspondant], Christophe Crespelle, Márton Karsai, Hadrien Hours.

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

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

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

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

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

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

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

9.1.1.7. ANR DylNet
Participants: Jean Pierre Chevrot, Éric Fleury [correspondant], Márton Karsai.

The DylNet project aims to observe and to characterise the relationships between childhood sociability and oral-language learning at kindergarten. With a view to this, it takes an multidisciplinary approach combining work on language acquisition, sociolinguistics, and network science. It will be implemented by following all the children (≈ 150) and teaching staff in one kindergarten over a 3-year period. The use of wireless proximity sensors will enable collection of social contacts throughout the study. The data on sociability will be linked to the results of language tests and recordings of verbal interactions used to follow the childrenâs progress on both a psycholinguistic level (lexicon, syntax, pragmatics) and a sociolinguistic level (features showing belonging to a social group). The aim is to better understand the mechanisms of adaptation and integration at work when young children first come into contact with the school context.

9.2. European Initiatives

9.2.1. FP7 & H2020 Projects

9.2.1.1. EMBERS

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

Programm: H2020

Duration: December 2015 - November 2018

Coordinator: UPMC

Partners:

Fraunhofer Gesellschaft Zur Forderung Der Angewandten Forschung Ev (Germany)

Technische Universitat Berlin (Germany)

Universite Pierre et Marie Curie - Paris 6 (France)

Ubiwhere Lda (Portugal)

Inria contact: Eric Fleury

EMBERS will bring to market a back-end for smart city mobility that is developed by a European small enterprise based upon its smart parking and smart traffic management products that two municipalities in Portugal currently deploy. The Mobility Back-end as a Service (MBaaS) replaces such all-in-one systems, in which a municipality purchases the full set of components from a single vendor. Instead, the city manager can purchase best-of-breed devices and apps developed by third parties, with the only constraint being that they interoperate with the back-end via a free, open, smart city mobility API. This domain-specific API lowers barriers to entry for app and device developers, making it easier for innovative SMEs to enter the market. Furthermore, the API is offered via a variety of generic interfaces, including oneM2M, ETSI M2M, OMA LWM2M, and FIWARE NGSI. EMBERS thus clears the way for developers and to municipalities that have adopted any one of these potential emerging machine-to-machine (M2M) communication standards. Beyond its primary goal of bringing the MBaaS to market, EMBERS will stimulate development of an entire ecosystem around the MBaaS smart city mobility API. Separating out the back-end from the other components will, however, require rigorous testing. EMBERS will experiment with the system on two testbeds that are part of the FIRE OneLab facility: the FUSECO Playground, for M2M communications, and FIT IoT-LAB, for wireless sensor devices. EMBERS will host a hackathon and an app challenge to bring in third party developers. The project will also include three demonstrators by third parties via an open call. These activities will contribute back to FIRE by demonstrating successful experimentation by SMEs developing close-to-market products. The project will also conduct real world pilots in two or more cities as a final step in bringing the MBaaS to market.

9.2.1.2. ARMOUR

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

Programm: H2020

Duration: 2015 Dec to 2018

Coordinator: UPMC

Partners:

Synelixis Lyseis Pliroforikis Automatismou & Tilepikoinonion Monoprosopi EPE (Greece)

Smartesting Solutions & Services (France)

Unparallel Innovation, Lda (Portugal)

Easy Global Market (France)

ODIN Solutions (Spain)

Universite Pierre et Marie Curie - Paris 6 (France)

Inria contact: Eric Fleury

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

9.3. International Initiatives

9.3.1. Inria International Partners

9.3.1.1. Declared Inria International Partners

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

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

9.3.1.2. Informal International Partners

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

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

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

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

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

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

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

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

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

9.3.2. Participation in Other International Programs

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

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

9.3.2.2. STIC AMSUD UCOOL: Understanding and predicting human demanded COntent and mObiLity
Participants: Éric Fleury, Márton Karsai, Christophe Crespelle.

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

9.4. International Research Visitors

9.4.1. Visits of International Scientists

Jacob Eisenstein

Date: May 2016

Institution: Georgia Tech (USA)

Alfred Hero

Date: May 2016

Institution: University of Michigan (USA)

Kimmo Kaski

Date: May 2016

Institution: Aalto University (Finland)

Nicola Perra

Date: June 2016

Institution:Greenwich University (England)

Alejandro Ribeiro

Date: June 2016

University of Pennsylvania (US)

János Kertész

Date: June-July 2016

Central European University (Hungary)

9.4.2. Visits to International Teams

9.4.2.1. Sabbatical programme

Begin Thomas

Date: Sep 2015 - Aug 2016

Institution: DIVA lab – University of Ottawa (Canada) on a CNRS grant and Inria sabbatical grant.

Christophe Crespelle

Date: Sep 2015 - Aug 2016

Institution: Institute of Mathematics, Vietnam Academy of Science and Technology, Hanoi (Vietnam) on a CNRS grant.

9.4.2.2. Research Stays Abroad

- Márton Karsai stayed 1 month at Aalto University Espoo, Finland
- Christophe Crespelle stayed 2 weeks at University of Bergen, Norway

<p style="text-align:center; color:red; font-weight:bold;">DIANA Project-Team</p>

8. Partnerships and Cooperations

8.1. Inria internal funding

- **User Discrimination on the Web:** we have been awarded funding for two post-doc positions each for one year with the the "Inria Actions Marquantes" with Nataliia Bielova from the INDES project-team. Natasa Sarafijanovic-Djukic have just started her post-doc on this project.
- **ADT ElectroSmart:** in the context of the Inria ADT call, we have a funding for a two year engineering position on the ElectroSmart project for the 2017-2019 period.
- **Transverse Master Interships:** we have a funding for a 6-month internship with Nataliia Bielova on Pixel Tracking.
- **ACQUA:** in the context of the Inria ADT call, we have a funding for a two year engineering position on the ACQUA project for the 2015-2017 period. Thierry Spetebroot is hired on this position.

8.2. UCN@Sophia Labex and UCA Idex funding

- **ElectroSmart:** this project has a funding for a two year engineering position from the UCN@Sophia Labex for the 2016-2018 period (Ravi Mondi is hired on this position) and 30KEuros fron the UCA (Université Côte d'Azur) RISE Academy.
- **PhD sholarships:** our team has currently four ongoing PhD thesis (Karyna Gogunska, Mohamed Naoufal Mahfoudi, Vitalii Poliakov and Luigi Vigneri) funded by the UCN@Sophia Labex.

8.3. Regional Initiatives

- **Plate-forme Telecom (Com4innov)** (2011-2017) is a DGCIS funded project, in the context of the competitivity cluster SCS, that aims at providing to PACA region industrials wishing to develop or validate new products related to future mobile networks and services and M2M application, a networking infrastructure and tools helpful for development, test and validation of those products. Other partners : 3Roam, Audilog Groupe Ericsson, Ericsson, Eurecom, Inria, iQsim, MobiSmart, Newsteo, OneAccess, Orange Labs, SCS cluster, ST Ericsson, Telecom Valley. Our contribution is centred around providing a test methodology and tools for wireless networks experimentation. In the context of this project we have realized a study on MPTCP performance in a wireless-wired environment with Orange Labs Sophia. The software tools that were developed in the project have been integrated in the R^2lab anechoic chamber.

8.4. National Initiatives

8.4.1. ANR

- **ANR FIT** (2011-2018): FIT (Future Internet of Things) aims at developing an experimental facility, a federated and competitive infrastructure with international visibility and a broad panel of customers. It will provide this facility with a set of complementary components that enable experimentation on innovative services for academic and industrial users. The project will give French Internet stakeholders a means to experiment on mobile wireless communications at the network and application layers thereby accelerating the design of advanced networking technologies for the Future Internet. FIT is one of 52 winning projects from the first wave of the French Ministry of Higher Education and Research's Equipements of Excellence (Equipex) research grant programme. The project will benefit from a 5.8 million euro grant from the French government. Other partners are UPMC, IT, Strasbourg University and CNRS. See also http://fit-equipex.fr/.

- **ANR DISCO** (2014-2016): DISCO (DIstributed SDN COntrollers for rich and elastic network services) aims at exploring the way how Software Defined Networking changes network monitoring, control, urbanisation and abstract description of network resources for the optimisation of services. The project works throughout experimentations and application use cases on the next generation of Software-Defined Networking solutions for large and critical distributed systems. The project studied the distribution of the current SDN control plane and the optimization of network operations that the integrated system view of cloud computing-based architectures allows. See also http://anr-disco.ens-lyon.fr/.

- **ANR REFLEXION** (2015-2017): REFLEXION (REsilient and FLEXible Infrastructure for Open Networking) research project will study the robustness and scalability of the current SDN architectures and the flexibility leveraged by SDN for provisioning resources and virtualized network functions (VNF). The project will address four main scientific objectives: (1) Fault and disruption management for virtualized services, (2) Robust and scalable control plane for next generation SDN, (3) Dynamic performance management of low level resources in SDN/NFV environments and (4) Distribution and optimization of virtual network functions in SDN environments. Our contribution in this project will be focused on fault and disruption management for virtualized services. See also http://anr-reflexion.telecom-paristech.fr/.

- **ANR BottleNet** (2016-2019): BottleNet aims to deliver methods, algorithms, and software systems to measure Internet Quality of Experience (QoE) and diagnose the root cause of poor Internet QoE. This goal calls for tools that run directly at users' devices. The plan is to collect network and application performance metrics directly at users' devices and correlate it with user perception to model Internet QoE, and to correlate measurements across users and devices to diagnose poor Internet QoE. This data-driven approach is essential to address the challenging problem of modeling user perception and of diagnosing sources of bottlenecks in complex Internet services. ANR BottleNet will lead to new solutions to assist users, network and service operators as well as regulators in understanding Internet QoE and the sources of performance bottleneck.

8.5. European Initiatives

8.5.1. FP7 & H2020 Projects

Program: FP7 FIRE programme

Project acronym: Fed4Fire+

Project title: Federation for FIRE Plus

Duration: January 2017 - December 2021

Coordinator: iMinds (Belgium)

Other partners: 20 european partners including IMEC (Belgium), UPMC (Fr), Fraunhofer (Germany), TUB (Germany), etc.

Web site: http://www.fed4fire.eu/

Abstract: The Fed4FIRE+ project has the objective to run and further improve Fed4FIRE's best-in-town federation of experimentation facilities for the Future Internet Research and Experimentation initiative. Federating a heterogeneous set of facilities covering technologies ranging from wireless, wired, cloud services and open flow, and making them accessible through common frameworks and tools suddenly opens new possibilities, supporting a broad range of experimenter communities covering a wide variety of Internet infrastructures, services and applications. Fed4FIRE+ will continuously upgrade and improve the facilities and include technical innovations, focused towards increased user satisfaction (user-friendly tools, privacy-oriented data management, testbed SLA and reputation, experiment reproducibility, service-level experiment orchestration, federation ontologies, etc.). It will open this federation to the whole FIRE community and beyond, for experimentation by industry and research organisations, through the organization of Open Calls and Open Access

mechanisms. The project will also establish a flexible, demand-driven framework which allows test facilities to join during the course of its lifetime by defining a set of entry requirements for new facilities to join and to comply with the federation. FIRE Experimental Facilities generate an ever increasing amount of research data that provides the foundation for new knowledge and insight into the behaviour of FI systems. Fed4FIRE+ will participate in the Pilot on Open Research Data in Horizon 2020 to offer open access to its scientific results, to the relevant scientific data and to data generated throughout the project's lifetime. Fed4FIRE+ will finally build on the existing community of experimenters, testbeds and tool developers and bring them together regularly (two times a year) in engineering conferences to have maximal interaction between the different stakeholders involved.

8.6. International Initiatives

8.6.1. *Inria Associate Teams Not Involved in an Inria International Labs*

8.6.1.1. *UHD-on-5G*

Title: Ultra High Definition video streaming on future 5G networks

International Partner (Institution - Researcher):

National Institute of Information and Communications Technology (NICT) (Japan) - Hitoshi Asaeda

Start year: 2016

See also: https://team.inria.fr/diana/uhd-on-5g/

The aim of this collaboration is to design and develop efficient mechanisms for streaming UHD video on 5G networks and to evaluate them in a realistic and reproducible way by using novel experimental testbeds.

Our approach leverages and extends when necessary ICN and SDN technologies to allow very high quality video streaming at large scale. We also plan to use Virtual Network Functions (VNF) in order to place easily and dynamically different functions (e.g. transcoding, caching) at strategic locations within the network. Specifically, the placement of these functions will be decided by SDN controllers to optimize the quality of experience (QoE) of users. Moreover, we plan to integrate ICN functionalities (e.g., name-based forwarding and multipath transport using in-network caching) with SDN/NFV to provide better QoE and mobility services support to users than traditional IP architectures. Monitoring mechanisms such as the Contrace tool we developed in a previous associated team (SIMULBED) will be helpful to provide an accurate view of the network at the SDN controllers side. In addition, we will build a large-scale testbed to evaluate our solutions through reproducible experimentations based on two testbeds: the ICN wired CUTEi tesbed developed by NICT and the wireless R^2lab testbed developed by Inria.

8.7. International Research Visitors

8.7.1. *Visits of International Scientists*

Max Ott from Data61/CSIRO (previously NICTA) visited us in November 2016. He gave a seminar on "Confidential Computing - Analysing Data Without Seeing Data" and an invited talk at the R^2lab inauguration ceremony.

8.7.1.1. Internships

Ramon Dos Reis Fontes

>   Date: from Apr 2016 until Sep 2016
>
>   Institution: PhD intern, University of Campinas
>
>   Supervisor: Thierry Turletti
>
>   Subject: Evaluating and Validating Mininet-WiFi

Anastasia Kuznetsova

>   Date: from Mar 2016 until Aug 2016
>
>   Institution: Ubinet Master intern, University of Nice Sophia Antipolis
>
>   Supervisor: Arnaud Legout
>
>   Subject: User discrimination on Pinterest

Ahmed Loukili

>   Date: from Mar 2016 until Aug 2016
>
>   Institution: Ubinet Master intern, University of Nice Sophia Antipolis
>
>   Supervisor: Damien Saucez
>
>   Subject: Content Distribution over Software Defined Networks

Hakob Melkonyan

>   Date: from Mar 2016 until Aug 2016
>
>   Institution: Ubinet Master intern, University of Nice Sophia Antipolis
>
>   Supervisor: Arnaud Legout
>
>   Subject: ElectroSmart Android Project for Exploring Electromagnetic Exposition

Farzaneh Pakzad

>   Date: from November 2016 to December 2016
>
>   Institution: PhD intern, University of Queensland
>
>   Supervisor: Thierry Turletti and Walid Dabbous
>
>   Subject: Using R^2lab to evaluate MANET routing protocols

Jimmy Rogala

>   Date: from May 2016 until Aug 2016
>
>   Institution: ENS Rennes intern
>
>   Supervisor: Arnaud Legout
>
>   Subject: Collecting statistics on Pinterest users

Nawfal Abbassi Saber

>   Date: from Mar 2016 until Aug 2016
>
>   Institution: Ubinet Master intern, University of Nice Sophia Antipolis
>
>   Supervisor: Chadi Barakat
>
>   Subject: Experimenting and modeling YouTube Quality of Experience

8.7.2. *Visits to International Teams*

Walid Dabbous, Thierry Turletti and Hardik Soni visited NICT in Tokyo Japan in the context of the UHD-on-5G associated team in December 2016.

<p style="text-align:center; color:red;">**DIONYSOS Project-Team**</p>

9. Partnerships and Cooperations

9.1. National Initiatives

9.1.1. ANR

- Adlen Ksentini is participating at 20% of his time to the IRT BCOM granted by the ANR.
- Yassine Hadjadj-Aoul is participating at 20% of his time to the IRT BCOM granted by the ANR.
- Yann Busnel is a member of the two following projects: Inhare granted by the ANR (ANR-15-CE19-0024) and DeSCeNt granted by the LabEx CominLabs (ANR-10-LABX-07-01).

9.2. Inria Project Labs

Participants: Yassine Hadjadj-Aoul, Gerardo Rubino, Bruno Tuffin.

Inria Project Labs' (IPL) initiatives enable the launch of ambitious research projects directly linked with the institute.

9.2.1. BetterNet

BetterNet aims at building and delivering a scientific and technical collaborative observatory to measure and improve the Internet service access as perceived by users. In this Inria Project Lab, we will propose new original user-centered measurement methods, which will associate social sciences to better understand Internet usage and the quality of services and networks. Our observatory can be defined as a vantage point, where:

- tools, models and algorithms/heuristics will be provided to collect data,
- acquired data will be analyzed, and shared appropriately with scientists, stakeholders and civil society,
- and new value-added services will be proposed to end-users.

Inria Project Teams involved: Diana, Dionysos, Inria Chile, Madynes, Muse, Spirals

9.3. European Initiatives

9.3.1. FINTEROP

Program: H2020-ICT-12-2015

Project acronym: F-Interop

Project title: FIRE+ online interoperability and performance test tools to support emerging technologies from research to standardization and market launch

Duration: November 2015 – October 2018

Coordinator: UPMC-LIP6

Other partners: 9 partners including our team Dionysos (F. Sismondi and C. Viho), and Eva (T. Watteyne)

Abstract: The goal of F-Interop is to extend FIRE+ with online interoperability and performance test tools supporting emerging IoT-related technologies from research to standardization and to market launch for the benefit of researchers, product development by SME, and standardization processes.

9.3.2. Collaborations with Major European Organizations

Partner 1: Sapienza University of Rome, Italy.

We work with Nicoló Rivetti and Leonardo Querzoni on the analysis of stream processing systems.

9.4. International Initiatives

9.4.1. Inria International Partners

9.4.1.1. MOCQUASIN

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

International Partner (Institution - Laboratory - Researcher):

University of Montreal (Canada)

Duration: started in 2013

See also: http://www.irisa.fr/dionysos/pages_perso/tuffin/MOCQUASIN/

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

9.4.1.2. Collaborations with the UTFSM at Valparaíso, Chile

We maintain a strong line of collaborations with the Technical University Federico Santa María (UTFSM), Valparaíso, Chile. Over the years, this has taken different forms (associated team Manap, Stic AmSud project "AMMA", Stic AmSud project "DAT", see next module). Currently, we have a joint PhD work running (PhD of Nicolás Jara, to be defended in 2017), and a new joint PhD to be started in 2017 (PhD of Jonathan Olavarría). The first one is on optical network analysis and design, the second one on modeling evaluation techniques.

9.4.1.3. International Initiatives

DAT

Title: Dependability Analysis Tool

International Partners:

Prof. H. Cancela, Univ. of the Republic, Computer Science, Uruguay;

Prof. R. Vallejos, UTFSM, Valparaíso, Electrical Eng., Chile;

G. Rubino, Dionysos, Inria, general responsible for the project.

Duration: 2015 - 2016

Start year: 2015

The main scientific objective of this project is to develop new techniques to assess the most important dependability properties of a complex system subject to the failures and possible repairs of its components. The central argument behind our proposal is our previous work in the area and some unpublished preliminary and promising results that we believe deserve deep exploration and that should lead to faster evaluation procedures than those available today. We also intend to implement these techniques in an integrated software package usable both in industry and for teaching purposes. Concerning applications, again based on the skills of the participating teams and our past common work, we will illustrate our findings on problems coming from the wireless and optical networking domains.

SM-HCD-HDD

Title: Statistical methods for highly complex and/or high dimensional data

International Partners:

Prof. Ricardo Fraiman, Mathematics, Univ. of the Republic, Uruguay, head of the project;

many partners in Uruguay, Argentina and Chile,

G. Rubino for Dionysos, Inria

Duration: 2016 - 2017

Start year: 2016

The aim of this project is to develop theoretical and computational tools to solve statistical problems that occur when data leaves in high dimensional spaces and/or lives in complex spaces that induce complex geometries.

9.5. International Research Visitors

9.5.1. *Visits of International Scientists*

Jebali Ameni, from INSAT (Tunisia)

Jorge Graneri, from UDELAR, Uruguay

Héctor Cancela, from UDELAR, Uruguay

Franco Robledo, from UDELAR, Uruguay

Claudio Risso, from UDELAR, Uruguay

Reinaldo Vallejos, from UTFSM, Chile

Marta Barría, from university of Valparaíso, Chile

9.5.1.1. Research Stays Abroad

Yann Busnel has been granted as an invited professor at La Sapienza Universitá di Roma, Italy, for 3 months from March to June 2016.

DYOGENE Project-Team

9. Partnerships and Cooperations

9.1. Regional Initiatives

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

Dyogene participates in LINCS https://www.lincs.fr/, a research centre co-founded by Inria, Institut Mines-Télécom, UPMC and Alcatel-Lucent Bell Labs (currently Nokia Bell Labs) dedicated to research and innovation in the domains of future information and communication networks, systems and services. V. Anantharam [UC Berkeley] was invited professor by LINCS in June-July 2016. He was a speaker at the LINCS Shannon Day organized by M. Lelarge and F. Baccelli in June 2016.

9.2. National Initiatives

9.2.1. 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.

9.2.2. GdR IM

Members of Dyogene participate in GdR-IM (Informatique-Mathématiques), https://www.gdr-im.fr/, working groups ALEA and SDA2 (Systèmes dynamiques, Automates et Algorithmique).

9.2.3. GdR RO

Members of Dyogene participate in GdR-RO (Recherche Opérationelle; GdR CNRS 3002), http://gdrro.lip6.fr/, working group COSMOS (Stochastic optimization and control, modeling and simulation), lead by A. Busic and E. Hyon (LIP 6); http://gdrro.lip6.fr/?q=node/78

9.2.4. PGMO

Gaspard Monge Program for Optimization and Operations Research project Decentralized control for renewable integration in smart-grids (2015-17). PI: A. Busic.

9.2.5. 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 Versaillese-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.

9.3. International Initiatives

9.3.1. Inria Associate Teams Not Involved in an Inria International Labs

9.3.1.1. PARIS

Title: Probabilistic Algorithms for Renewable Integration in Smart Grid

International Partner (Institution - Laboratory - Researcher):

University of Florida (United States) — 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. Renewable generation has brought unforeseen volatility to the grid that require new techniques in distributed and probabilistic control. In a series of recent papers the two PIs have brought together their complementary skills in optimization, Markov modeling, simulation, and stochastic networks that may help to solve some pressing open problems in this area. This new research also opens many exciting new scientific questions.

9.3.2. Inria International Partners

9.3.2.1. Informal International Partners

- B. Blaszczyszyn is collaborationg with T. Rolski, R. Szekli, (University of Wroclaw), D. Yogeshwaran (Indian Statistical Institute) and Y. Yukich (Lehigh University)
- A. Busic is participating to the ARPA-E Powernet project led by Ram Rajagopal (Stanford); https://web.stanford.edu/~ramr/powernet.htm

9.4. International Research Visitors

9.4.1. Visits of International Scientists

- Sean Meyn [Professor, University of Florida, Jun 2016]
- Adithya Munegowda Devraj [PhD student, University of Florida, May – Jul 2016]
- Sebastien Ziesche [PdD student, Karlsruhe Institute of Technology, March 2016]

<p style="color:red; text-align:center; font-weight:bold">EVA Project-Team</p>

9. Partnerships and Cooperations

9.1. National Initiatives

9.1.1. ANR

The Inria-EVA team has not been involved in an ANR project in 2016.

9.1.2. Competitivity Clusters

9.1.2.1. SAHARA

Participants: Pascale Minet, Erwan Livolant.

Period: 2011 - 2016.

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

SAHARA is a FUI project, labeled 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.

This project ended in March 2016. After a presentation of the SAHARA project at the IEEE WISEE 2015 conference (Wireless for Space and Extreme Environments), we were selected to write a book chapter entitled "Multichannel Wireless Sensor Networks for Aircraft: Challenges and Issues" in the Wiley book "Wireless sensor systems for extreme environments: space, underwater, underground and industrial".

9.1.2.2. 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 the Cluster Connexion project, the goal for the EVA team was to design and implement new functionnalities for the OCARI wireless sensor network to allow it to:

- support the mobility of some sensor nodes (targeted application: remote dosimetry to monitor the exposition of people to radiations),

- transmit commands to sensors/actuators (e.g. configuration parameters, regeneration order),

- ensure data gathering during node recoloring,

- remotely manage the parameters of the OCARI network,

- aggregate in a single frame several heterogeneous measures originated from different sensors on a same wireless node,

- use a generic format for the measures: type, length, value.

- integrate this network to the middleware of context-aware services, OPC-UA/ROSA.

The demonstrator "a mobile connected worksite" developed in the Cluster Connexion project meets several objectives:

- Make the wireless sensor networks more reliable in an ionisating environment ionisant;

- Make easier the diagnostic and the repairing by means of the aggregation of data originated from heterogeneous sources;

- Take into account the requirements of information security in the architectures;

- Ensure a continuum of solutions for the industrial involved.

The Industrial IoT (Internet of Things) solution proposed by Connexion is an integrated chain, from the wireless sensor& actuator network up to the surveillance, diagnostic and health infrastructure monitoring applications, using a context-aware middleware fitting the industrial environment.

At the end of the Cluster Connexion project, we made the demonstration of a command/control loop for the regeneration of wireless sensor nodes in collaboration with CEA, Predict, Telecom ParisTech, EDF, ATOS and Inria highlighting the following steps:

- the upstream flow of health indicators from electronic devices,

- detection of an abnormal behavior by a monitoring software (KASEM),

- generation of a regeneration command and transmission of this command to the misbehaving sensor node.

- regeneration of the involved sensor

- insertion of the regenerated sensor in the OCARI network.

When the Cluster Connexion project ended, the results obtained with regard to the OCARI network and the OPC-UA/ROSA middleware have been transferred to the Task Force ConnexSensors hosted by AFNeT. The goals of the ConnexSensors TaskForce are:

- Federate industrial companies around an IoT solution IoT including wireless sensor & actuator networks and a standardized industrial middleware.

- Jointly valorize the OCARI wireless sensor & actuator network and the OPC-UA/ROSA middleware.

- Deploy the Connexion demonstrator in the basemenet of interested industrials.

- Ensure that industrials will keep the mastership of their data.

- Ensure the perennity of the solution proposed.

9.1.3. *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. 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 E3Network project (E-band transceiver for the backhaul infrastructure of the future networks). The transceiver designed in the E3Network project will use modern digital multi-level modulations to achieve high spectral efficiency. This together with the huge bandwidth will enable high capacities above 10 Gbps.

9.2.2. Collaborations in European Programs, Except H2020

The Inria-EVA team has not participated in non-H2020 European Programs in 2016.

9.2.3. Collaborations with Major European Organizations

European Telecommunications Standards Institute (ETSI)

co-organize two ETSI 6TiSCH plugtests in 2016 (in Paris in February, in Berlin in July).

9.3. International Initiatives

9.3.1. Inria International Labs

9.3.1.1. REALMS Associate Team

Type: Associate Team

Inria International Lab: Inria@SiliconValley

Title: Real-Time Real-World Monitoring Systems

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: http://www.snowhow.io/

Inria contact: **Thomas Watteyne**

9.3.1.2. DIVERSITY Associate Team

Type: Associate Team

Inria International Lab: Inria@SiliconValley

Title: Measuring and Exploiting Diversity in Low-Power Wireless Networks

Associate teams: Inria-EVA, Prof. Bhaskar Krishnamachari's team, USC, CA, USA

Duration: 2016-2018

Objective: The Grand Challenge of the DIVERSITY associate team is to develop the networking technology for tomorrow's Smart Factory. The two teams come with a perfectly complementary background on standardization and experimentation (Inria-EVA) and scheduling techniques (USC-ANRG). The key topic addressed by the joint team will be networking solutions for the Industrial Internet of Things (IIoT), with a particular focus on reliability and determinism.

Inria contact: **Thomas Watteyne**

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

9.3.2.1. Tassili

The Tassili project (N° MDU 17MDU988 - Campus France N° 37459VF) "Gestion des caches et orchestration intelligentes dans un environnement réseau virtulaisé" is a project in collaboration with Algeria and France. On the French side, the project is leaded by Samia Bouzefrane (associated professor at CNAM) and **Paul Muhlethaler** (EVA team Inria). On the Algerian side is leaded by the University Mouloud Mammeri of Tizi-Ouzou (UMMTO) représenté by Mehammed Daoui (associated professor).

This project will start in January 2017 and will last three years. Three PhD theses will be conducted in cotutelle between CNAM and UMMTO. This project will support the stay of the tree PhD candidates for a four months visit in France. These two PhD theses will be co-directed by **Paul Muhlethaler**. The first subject is "New intelligent caching and mobility strategies for MEC/ICN based architectures" and the second subject concern the design of a safe architecture for Name Data Networking.

9.3.3. Inria International Partners

9.3.3.1. Declared Inria International Partners

University of California, Berkeley, CA, USA (Glaser)

- 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 .

- Joint publication in 2016:
    - Long-term Monitoring of the Sierra Nevada Snowpack Using Wireless Sensor Networks. Ziran Zhang, Steven Glaser, Thomas Watteyne, Sami Malek. IEEE Internet of Things Journal, special issue on Large-scale Internet of Things: Theory and Practice, to appear in 2016.

- Demo: SierraNet: Monitoring the Snow Pack in the Sierra Nevada. Keoma Brun-Laguna, Carlos Oroza, Ziran Zhang, Sami Malek, Thomas Watteyne, Steven Glaser. ACM International Conference on Mobile Computing and Networking (MobiCom), Workshop on Challenged Networks (CHANTS), 7 October 2016, New York, NY, USA.

- (Not so) Intuitive Results from a Smart Agriculture Low-Power Wireless Mesh Deployment. Keoma Brun-Laguna, Ana Laura Diedrichs, Diego Dujovne, Rémy Léone, Xavier Vilajosana, Thomas Watteyne. ACM International Conference on Mobile Computing and Networking (MobiCom), Workshop on Challenged Networks (CHANTS), 7 October 2016, New York, NY, USA.

- SOL: An End-to-end Solution for Real-World Remote Monitoring Systems. Keoma Brun-Laguna, Thomas Watteyne, Sami Malek, Ziran Zhang, Carlos Oroza, Steven Glaser, Branko Kerkez. IEEE International Symposium on Personal, Indoor and Mobile Radio Communications (PIMRC), Valencia, Spain, 4-7 September 2016.

University of Southern California, CA, USA

- Collaboration with Prof. Bhaskar Krishnamachari through the DIVERSITY associate team, see Section 9.3.1.2 .

- Joint publication in 2016:

  - Insights into Frequency Diversity from Measurements on an Indoor Low Power Wireless Network Testbed. Pedro Henrique Gomes, Ying Chen, Thomas Watteyne, Bhaskar Krishnamachari. IEEE Global Telecommunications Conference (GLOBECOM), Workshop on Low-Layer Implementation and Protocol Design for IoT Applications (IoT-LINK), Washington, DC, USA, 4-8 December 2016.

  - Reliability through Time-Slotted Channel Hopping and Flooding-based Routing. Pedro Henrique Gomes, Thomas Watteyne, Pradipta Gosh, Bhaskar Krishnamachari. International Conference on Embedded Wireless Systems and Networks (EWSN), Dependability Competition, ACM, Graz, Austria, 14-15 February 2016.

Universidad Tecnologica Nacional, Mendoza, Argentina

- Collaboration with Ana Laura Diedrichs, Juan Carlos Taffernaberry, Gustavo Mercado through the SticAmSud PEACH project.

- Joint publication(s) in 2016:

  - PEACH: Predicting Frost Events in Peach Orchards Using IoT Technology. Thomas Watteyne, Ana Laura Diedrichs, Keoma Brun-Laguna, Javier Emilio Chaar, Diego Dujovne, Juan Carlos Taffernaberry, Gustavo Mercado. EAI Endorsed Transactions on the Internet of Things, to appear in 2016.

  - A Demo of the PEACH IoT-based Frost Event Prediction System for Precision Agriculture. Keoma Brun-Laguna, Ana Laura Diedrichs, Javier Emilio Chaar, Diego Dujovne, Juan Carlos Taffernaberry, Gustavo Mercado, Thomas Watteyne. IEEE International Conference on Sensing, Communication and Networking (SECON), poster and demo session, London, UK, 27-30 June 2016

University of Michigan, Ann Arbor, MI, USA

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

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.

9.3.3.2. Informal International Partners

University of California, Berkeley, CA, USA (Pister)

- Collaboration with Prof. Kris Pister through the IETF 6TiSCH working group.
- Joint publication in 2016:
  - Simple Distributed Scheduling with Collision Detection in TSCH Networks. Kazushi Muraoka, Thomas Watteyne, Nicola Accettura, Xavi Vilajosana, Kris Pister. IEEE Sensors Letters, to appear in 2016.

Open University of Catalunya, Spain

- Collaboration with Xavi Vilajosana and Pere Tuset through IETF 6TiSCH working group and the OpenWSN project.
- Joint publication(s) in 2016:
  - Distributed PID-based Scheduling for 6TiSCH Networks. Marc Domingo-Prieto, Tengfei Chang, Xavier Vilajosana, Thomas Watteyne. IEEE Communications Letters, vol PP, Issue 99, March 2016.
  - Poster Abstract: A Benchmark for Low-power Wireless Networking. Simon Duquennoy, Olaf Landsiedel, Carlo Alberto Boano, Marco Zimmerling, Jan Beutel, Mun Choon Chan, Omprakash Gnawali, Mobashir Mohammad, Luca Mottola, Lothar Thiele, Xavier Vilajosana, Thiemo Voigt, Thomas Watteyne. ACM Conference on Embedded Networked Sensor Systems (ACM Sensys), Stanford, CA, USA, 14-16 November 2016.
  - Rover: Poor (but Elegant) Man's Testbed. Zacharie Brodard, Hao Jiang, Tengfei Chang, Thomas Watteyne, Xavier Vilajosana, Pascal Thubert, Geraldine Texier. ACM International Symposium on Performance Evaluation of Wireless Ad Hoc, Sensor, and Ubiquitous Networks (PE-WASUN), Valletta, Malta, 13-17 November 2016.
  - Determinism Through Path Diversity: Why Packet Replication Makes Sense. Jesica de Armas, Pere Tuset, Tengfei Chang, Ferran Adelantado, Thomas Watteyne, Xavier Vilajosana. International Conference on Intelligent Networking and Collaborative Systems (INCoS), Ostrava, Czech Republic, 7-9 September 2016.
  - OpenWSN & OpenMote: Demo'ing A Complete Ecosystem for the Industrial Internet of Things. Tengfei Chang, Pere Tuset-Peiro, Jonathan Munoz, Xavier Vilajosana, Thomas Watteyne. IEEE International Conference on Sensing, Communication and Networking (SECON), poster and demo session, London, UK, 27-30 June 2016.
  - OpenMote+: a Range-Agile Multi-Radio Mote. Pere Tuset, Xavier Vilajosana, Thomas Watteyne. International Conference on Embedded Wireless Systems and Networks (EWSN), NexMote Workshop, ACM, Graz, Austria, 14-15 February 2016.
  - Numerous IETF Internet-Drafts.

University of Science and Technology, Beijing, China

- Collaboration with Qin Wang through IETF 6TiSCH working group. Tengfei Chang, engineer at Inria-EVA, comes from her team
- Joint publication(s) in 2016:
  - On-the-Fly Bandwidth Reservation for 6TiSCH Wireless Industrial Networks. Maria-Rita Palattella, Thomas Watteyne, Qin Wang, Kazuki Muraoka, Nicola Accettura, Diego Dujovne, Alfredo Grieco, Thomas Engel. IEEE Sensors Journal, 15 January 2016.

     – LLSF: Low Latency Scheduling Function for 6TiSCH Networks. Tengfei Chang, Thomas Watteyne, Qin Wang, Xavier Vilajosana. IEEE International Conference on Distributed Computing in Sensor Systems (DCOSS), Washington, DC, USA, 26-28 May 2016.

University of Bari, Italy

- Collaboration with Savio Sciancalepore, Giuseppe Piro and Gennaro Boggia through IETF 6TiSCH and OpenWSN.
- Joint publication in 2016:
  - Link-layer Security in TSCH Networks: Effect on Slot Duration. Savio Sciancalepore, Malisa Vucinic, Giuseppe Piro, Gennaro Boggia, Thomas Watteyne. Wiley Transactions on Emerging Telecommunications Technologies (ETT), to appear in 2016.

University of Trento, Italy

- Collaboration with Oana Iova through IETF 6TiSCH working group.
- Joint publication(s) in 2016:
  - The Love-Hate Relationship between IEEE802.15.4 and RPL. Oana Iova, Fabrice Theoleyre, Thomas Watteyne, Thomas Noel. IEEE Communications Magazine, to appear in 2016.

TU Berlin, Germany

- Collaboration with Vlado Handziski, Adam Wolisz through IETF 6TiSCH working group.
- Joint publication(s) in 2016:
  - Industrial Wireless IP-based Cyber Physical Systems. Thomas Watteyne, Vlado Handziski, Xavier Vilajosana, Simon Duquennoy, Oliver Hahm, Emmanuel Baccelli, Adam Wolisz. Proceedings of the IEEE, Vol. PP, Issue 99, pp. 1-14, March 2016.

Mandat International, Switzerland

- Collaboration with Sebastien Ziegler through the H2020 F-Interop project
- Joint publication(s) in 2016:
  - F-Interop – Online Platform of Interoperability and Performance Tests for the Internet of Things. Sébastien Ziegler, Serge Fdida, Cesar Viho, Thomas Watteyne. Conference on Interoperability in IoT (InterIoT), Paris, France, 26-28 October 2016.

KU Leuven, Belgium

- Collaboration with Prof. Danny Hughes, Prof. Wouter Joosen, Dr. Nelson Matthys, Fan Yang, Wilfried Daniels on MicroPnP.

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

9.3.4. Participation in Other International Programs

9.3.4.1. 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: Propose 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.

9.4. International Research Visitors

9.4.1. Visits of International Scientists

- Professors/Researchers:
    - **Mario Gerla**, Professor, UCLA, USA, visit 10-20 December 2016
    - **Leila Saidane**, Professor, ENSI, Tunis, Tunisia, visit November 2016
    - **Felipe Lalanne**, Reseacher, Inria Chile, Chile, visit 19–26 October 2016
    - **Mario Gerla**, Professor, UCLA, USA, visit 31 August - 23 September 2016
    - **Diego Dujovne**, Professor, Universidad Diego Portales, Chile, visit 22-31 July 2016
    - **Ruben Milocco**, Universidad Nacional Comahue, Argentina, visit July 2016
    - **Branko Kerkez**, Professor, U. Michigan, USA, visit 17-22 June 2016
    - **Steven Glaser**, Professor, UC Berkeley, USA, visit 21-25 March 2016
    - **Xavi Vilajosana**,Professor, UOC/OpenMote, Spain, visit 2-4 February 2016
- PhD Students:
    - **Travis Massey**, PhD Student, UC Berkeley, USA, visit 22 July 2016
    - **Carlos Oroza**, PhD Student, UC Berkeley, USA, visit 23-29 July 2016
    - **David Burnett**, PhD Student, UC Berkeley, USA, visit 13-15 June 2016
    - **Filip Barac**, PhD Student, Mid Sweden University, Sweden, visit 8-19 February 2016

9.4.2. Internships

- **Jiangnan Yang**, internship on simulation of wireless TDMA networks with NS3, March-August 2016.

9.4.3. Visits to International Teams

9.4.3.1. Research Stays Abroad

- **Keoma-Brun Laguna**, stay in Prof. Glaser's lab at UC Berkeley, USA, August 2016.
- **Thomas Watteyne**, stay in Prof. Glaser and Prof. Pister's labs at UC Berkeley, USA, August 2016.

<p align="center" style="color:red">FUN Project-Team</p>

9. Partnerships and Cooperations

9.1. Regional Initiatives

9.1.1. Tracaverre

Participants: Nathalie Mitton [correspondant], Gabriele Sabatino.

Title: Tracaverre

Type: FUI

Duration: November 2012 - Dec 2016

Coordinator: Saver Glass

Others partners: Inria FUN IEMN Courbon Camus La Grande Marque LIRIS DISP

Tracaverre studies the use of RFID for traceability of prestigious bottles. Tracaverre has yielded to the implementation of the T-Scan software.

9.1.2. StoreConnect

Participants: Nathalie Mitton [correspondant], Valeria Loscri.

Title: StoreConnect

Type: FUI

Duration: September 2016 - October 2018

Coordinator: NEOSENSYS

Others partners: Inria FUN, SPIRALS and STARS, TeVolys, Ubudu, Smile, STIME, Leroy Merlin

The aim of StoreConnect is to provide French large retailers with efficient and powerful tools in the in-store customer interaction.

9.1.3. PIPA

Participants: Nathalie Mitton [correspondant], Farouk Mezghani, Cristina Cano Bastidas.

Title: Partager de l'Info PArtout à bas coût

Type: Chercheur citoyen

Duration: Dec 2015 - Dec 2017

Coordinator: Inria FUN

Others partners: SpotTrotter

PIPA project aims to provide an innovative low cost solution to share information in places where communication infrastructure are lacking, insuffisant or not adapted, going beyond technical, economical or political limitations.

9.2. National Initiatives

9.2.1. Inria Project Lab

9.2.1.1. CityLab@Inria

Participants: Valeria Loscri, Abdoul Aziz Mbacke, Nathalie Mitton [correspondant].

- Title: CityLab@Inria
- Type: IPL
- Duration: 2015 - 2019
- Coordinator: Valerie Issarny
- 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. Obviously, running urban-scale experiments is a central concern of the Lab, so that we are able to confront proposed approaches to actual settings. The Lab's research leverages relevant effort within Inria project-teams that is further revisited as well as integrated to meet the challenges of smart cities. Research themes span: energy-efficient wireless communication protocols, urban-scale social and physical sensing, privacy by design, cloud-based urban data management, data assimilation, visual analysis, and urban system software engineering. In addition, CityLab Inria research builds upon collaborative effort at the International level, and especially collaboration in the context of the Inria SiliconValley program. This project has yield to the set up of a full course on Smart Cities via a MOOC.

9.2.2. ADT

9.2.2.1. RFunID

Participants: Clement Fumey, Nathalie Mitton [correspondant], Julien Vandaele.

Duration: September 2015 - August 2017

Coordinator: Inria FUN

The purpose of this project is to deploy a large scale experimental RFID platform that enables remote programmation of RFID scenario on heterogeneous devices.

9.2.2.2. ARUNTA

Participants: Emilio Compagnone, Valeria Loscri [correspondant], Julien Vandaele.

Title: Arduino-based Robots for Ubiquitous Network (ARUNTA)

Type: ADT

Duration: September 2014 - August 2016

Coordinator: Inria FUN

Abstract: This ADT focuses on the use of Arduino, an open-source electronics prototyping platform, really flexible and easy-to-use [1] to allow a fleet of robots to perform specific tasks. The goal of the ADT is to make experiments on Arduino-based robotic platforms, by implementing two robot cooperation algorithms that have been already tested through simulation tools. In order to extend the users' community and to allow more people to benefit from this research on robot cooperation, this ADT will output a tutorial and a test-bed will be developed. Moreover, the final project will be shared with the Arduino community and every interested user.

9.2.3. Equipements d'Excellence

9.2.3.1. FIT

Participants: Nathalie Mitton [correspondant], Julien Vandaele.

Title: Future Internet of Things

Type: EquipEx

Duration: March 2010 - December 2019

Coordinator: UPMC

See also: http://fit-equipex.fr/

Abstract: FIT (Future Internet of Things) aims to develop an experimental facility, a federated and competitive infrastructure with international visibility and a broad panel of customers. It will provide this facility with a set of complementary components that enable experimentation on innovative services for academic and industrial users. The project will give French Internet stakeholders a means to experiment on mobile wireless communications at the network and application layers thereby accelerating the design of advanced networking technologies for the Future Internet. FIT is one of 52 winning projects from the first wave of the French Ministry of Higher Education and Research's "Equipements d'Excellence" (Equipex) research grant program. Coordinated by Professor Serge Fdida of UPMC Sorbonne Universités and running over a nine-year period, the project will benefit from a 5.8 million euro grant from the French government. This project has yield to several publications in 2016: [44], [43].

9.3. European Initiatives

9.3.1. FP7 & H2020 Projects

9.3.1.1. VITAL

Participants: Salvatore Guzzo Bonifacio, Valeria Loscri, Nathalie Mitton [correspondant], Riccardo Petrolo.

Title: Virtualized programmable InTerfAces for innovative cost-effective IoT depLoyments in smart cities

Programm: FP7

Duration: September 2013 - December 2016

Coordinator: National University of Ireland Galway (NUIG)

Partners:

        Research and Education Laboratory in Information Technologies (Greece)

        Atos Spain (Spain)

        Camden Town Center (United Kingdom)

        Images & Co (United Kingdom)

        Istanbul Metropolitan Municipality (Turkey)

        Istanbul Teknik Universitesi (Turkey)

        National University of Ireland, Galway (Ireland)

        Santer Reply Spa (Italy)

        Singularlogic Anonymi Etairia Pliroforiakon Sistimaton Kai Efarmogon Pliroforikis (Greece)

Inria contact: Nathalie Mitton

Internet-of-Things (IoT) applications are currently based on multiple architectures, standards and platforms, which have led to a highly fragmented IoT landscape. This fragmentation is evident in the area of smart cities, which typically comprise several technological silos (i.e. IoT systems that have been developed and deployed independently). Nowadays there is a pressing need to remove these silos in order to allow cities to share data across systems and coordinate processes across domains, thereby essentially improving sustainability and quality of life. In response to this need, VITAL will realize a radical shift in the development, deployment and operation of IoT applications, through introducing an abstract virtualized digital layer that will operate across multiple IoT architectures, platforms and business contexts. Specifically, VITAL will provide platform and business context agnostic access to Internet-Connected-Objects (ICO). Moreover, it will research virtualized filtering, complex event processing (CEP) and business process management mechanisms, which will be operational over a variety of IoT architectures/ecosystems. The mechanisms will compromise the diverse characteristics of the underlying ecosystems, thereby boosting interoperability at the technical and business levels. VITAL will also provide development and governance tools, which will leverage the project's interfaces for virtualized access to ICOs.VITAL will allow solution providers to (re)use a wider range of data steams, thereby increasing the scope of potential applications. It will also enable a more connected/integrated approach to smart city applications development, which will be validated in realistic deployments in London and Istanbul. The partners will contribute and adapt a host of readily available urban infrastructures, IoT platforms and novel IoT applications, which will ease the accomplishment of the project's goals based on an optimal value for EC money. Publications in 2016 in the framework of this project are: [21], [44], [43], [42].

9.3.1.2. VESSEDIA

Participant: Simon Duquennoy [correspondant].

Title: VERIFICATION ENGINEERING OF SAFETY AND SECURITY CRITICAL DYNAMIC INDUSTRIAL APPLICATIONS

Programm: H2020

Duration: January 2017 - Dec. 2019

TECHNIKON FORSCHUNGS UND PLANUNGSGESELLSCHAFT MBH (TEC) The VESSEDIA project will bring safety and security to many new software applications and devices. In the fast evolving world we live in, the Internet has brought many benefits to individuals, organisations and industries. With the capabilities offered now (such as IPv6) to connect billions of devices and therefore humans together, the Internet brings new threats to the software developers and VESSEDIA will allow connected applications to be safe and secure. VESSEDIA proposes to enhance and scale up modern software analysis tools, namely the mostly open-source Frama-C Analysis platform, to allow developers to benefit rapidly from them when developing connected applications. At the forefront of connected applications is the IoT, whose growth is exponential and whose security risks are real (for instance in hacked smart phones). VESSEDIA will take this domain as a target for demonstrating the benefits of using our tools on connected applications. VESSEDIA will tackle this challenge by 1) developing a methodology that allows to adopt and use source code analysis tools efficiently and produce similar benefits than already achieved for highly-critical applications (i.e. an exhaustive analysis and extraction of faults), 2) enhancing the Frama-C toolbox to enable efficient and fast implementation, 3) demonstrating the new toolbox capabilities on typical IoT (Internet of Things) applications including an IoT Operating System (Contiki), 4) developing a standardisation plan for generalizing the use of the toolbox, 5) contributing to the Common Criteria certification process, and 6) defining a label "Verified in Europe" for validating software products with European technologies such as Frama-C.

9.4. International Initiatives

9.4.1. *Inria International Labs*

9.4.1.1. PREDNET

Participants: Simon Duquennoy, Nathalie Mitton [correspondant], Viktor Toldov, Julien Vandaele.

Title: Predator network

Type: LIRIMA with Stellenbosch University, South Africa

Duration: January 2013 - December 2016

See also: https://iww.inria.fr/prednet/en/

Abstract: PREDNET (PREDator adhoc NETwork) proposes to do research on the most suitable topology and subsequent deployment of a wireless sensor network for sparsely populated outlying rural and wilderness areas, for effective monitoring and protection of resources and ecosystems. This collaboration gave birth to joint project submission, joint conference organization and several publications, among them for 2016 [47], [48], [48], [49].

9.4.2. Inria Associate Teams Not Involved in an Inria International Labs

9.4.2.1. DepIoT
Participants: Simon Duquennoy [correspondant], Nathalie Mitton.

Title: DepIoT: Coexistence and Security for Dependable Internet of Things

Type: North-European Inria Associate Team with SICS, Sweden

Duration: Sept 2016 - August 2018

Abstract: In order to foster the adoption of IoT technologies, dependability must be guaranteed. We will tackle this challenge by ensuring operation even in the presence of other networks sharing the same frequency band (coexistence) and by enabling a secure communication.

9.4.3. Inria International Partners

9.4.3.1. Declared Inria International Partners

Université Mediterranea di Reggio Calabria (UNIC) (Italy) Objective of this collaboration is the design of an innovative architecture that enables autonomic and decentralized fruition of the services offered by the network of smart objects in many heterogeneous and dynamic environments, in a way that is independent of the network topology, reliable and flexible. The result is an 'ecosystem' of objects, self-organized and self-sustained, capable of making data and services available to the users wherever and whenever required, thus supporting the fruition of an 'augmented' reality thanks to a new environmental and social awareness. This collaboration has allowed students and researchers exchanges and joint publications, among them for 2016: [20], [19].

9.4.3.2. Informal International Partners
Southern University, China

The purpose of this collaboration is to study the green (or energy-efficient) communication problem in vehicular ad hoc networks (VANETs) and the application of vehicular network communication in green transportation. In this framework, Nathalie Mitton visited the Nanjing University. It gave birth to joint project submission, joint conference organization (UIC 2016) and joint publications, one in 2016 [27].

Arun Sen from Arizona State University, USA

The purpose of this collaboration is to study the joint scheduling and trajectory of RFID readers in a mobile environment. In this framework, Arun Sen visited the FUN team for 6 months in 2015 and in July 2016. It gave birth to joint project submission, joint conference submission and joint publications, among them in 2016 [30], [29].

Anna-Maria Vegni from Roma Tre University, Italy

The purpose of this collaboration is to study alternative communication paradigms and investigate their limitations and different effects on performances. In this framework, joint publications have been obtained, among them in 2016 [51], [26], [53], [50], [46], [40], [16], [55], [15], [45], [25].

9.4.3.3. PhD co-supervision
Participants: Nathalie Mitton [correspondant], Mouna Masmoudi.

Since January 2013, Nathalie Mitton co-supervises Mouna Rekik as a PhD student with Pr Zied Chtourou from Université de Sfax, Tunisia. Her topic is about swarm intelligence based multi-path geographic routing for wireless sensor and actuator networks.

This work has led to the following publications in 2016: [23]. Mouna defended her PhD on July 26th 2016.

Since 2014, Simon Duquennoy co-supervised Anwar Hithnawi as a PhD student with Pr Friedemann Mattern from ETH Zurich, Sweden. Her research is on low-power wireless systems coexistence, and mitigation of cross-technology inteference. This work has led to the following publications in 2016: [39]. Anwar defended her PhD on November 8, 2016.

9.4.4. Participation in Other International Programs

9.4.4.1. CROMO

Participants: Valeria Loscri, Nathalie Mitton [correspondant], Riccardo Petrolo, Abdoul Aziz Mbacke.

Title: Crowd Data In the mobile cloud

Duration: January 2015 - December 2019

CroMo (Crowd Data In the mobile cloud) is a submission to the CAPES-COFECUB project call lead by Inria from the French side and University of Rio de Janeiro from Brazilian Side. Other partner institutions are Université Pierre et Marie Curie and Université de la Rochelle.

Mobile cloud computing is an emerging paradigm to improve the quality of mobile applications by transferring part of the computational tasks to the resource-rich cloud. The multitude data sources combined with the known difficulties of wireless communications represent an important issue for mobile cloud computing. Therefore, the additional computational power added by the cloud has to deal with the constraints of the wireless medium. One could imagine a situation where different sensors collect data and require intensive computation. This data must be transmitted at high rates before becoming stale. In this case, the network becomes the main bottleneck, not the processing power or storage size. To circumvent this issue, different strategies can be envisioned. As usual alternatives, wireless data rates must be increased or the amount of data sent to the cloud must be reduced. CROMO tackles challenges from all these three components of the mobile clouds (data generation, collect and processing) to then integrate them as a whole enhanced mobile cloud with improved network performances in terms of delay, energy consumption, availability, and reliability.

In this context, joint exchanges and crossed visits have been done (Aziz went to Rio, Dianne went to Lille). The project yield to several publications such as [35], [36], [37].

9.5. International Research Visitors

9.5.1. Visits of International Scientists

9.5.1.1. Senior researchers

Several researchers have visited our group in 2016, mainly from our partner universities but not only:

- Zied Chtourou, Univ. Sfax, Tunisia, July 2016
- Arun Sen, Arizona State University, USA, July 2016
- Ahmet Sekercioglu, Monash University, Australia, July 2016
- Riaan Wolhuter, Univ. Stellenbosch, South Africa, July 2016
- Anwar Hithnawi, ETH Zurich, Switzerland, March 2016
- Hossein Shafagh, ETH Zurich, Switzerland, March 2016
- Cédric Chauvenet from ERDF, May 2016

9.5.1.2. Internships

Other students have visited us from our partner universities in the framework of the joint project we run together. This is the case for William Pretorius (2 months) who came from Stellenbosch university, South Africa, in the framework of the PredNET program and Rahul Vyas from IIIT Allahabad, India (2 months).

9.5.2. Visits to International Teams

- Riccardo Petrolo visited Ericsson group in Finland in April 2016.
- Nathalie Mitton visited Southeast university in Nanjing, China in June 2016.
- Simon Duquennoy visited SICS in Sweden in September 2016 and May 2016.
- Aziz Mbacke visited UFRJ in Brazil in November 2016.

<p style="text-align:center; color:red;">GANG Project-Team</p>

8. Partnerships and Cooperations

8.1. Regional Initiatives

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

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.

8.2. National Initiatives

8.2.1. *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 Post-Doc.

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.

8.2.2. *ANR DESCARTES*

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

Cyril Gavoille (U. Bordeaux) leads this project that grants 1 Post-Doc. H. Fauconnier is the local coordinator (This project began in October 2016).

Despite the practical interests of reusable frameworks for implementing specific distributed services, many of these frameworks still lack solid theoretical bases, and only provide partial solutions for a narrow range of services. We argue that this is mainly due to the lack of a generic framework that is able to unify the large body of fundamental knowledge on distributed computation that has been acquired over the last 40 years. The DESCARTES project aims at bridging this gap, by developing a systematic model of distributed computation that organizes the functionalities of a distributed computing system into reusable modular constructs assembled via well-defined mechanisms that maintain sound theoretical guarantees on the resulting system. DESCARTES arises from the strong belief that distributed computing is now mature enough to resolve the tension between the social needs for distributed computing systems, and the lack of a fundamentally sound and systematic way to realize these systems.

8.3. European Initiatives

8.3.1. *FP7 & H2020 Projects*

Amos Korman has 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.

8.3.2. LIA Struco

Pierre Charbit is director of the LIA STRUCO, which is an Associated International Laboratory of CNRS between IÚUK, Prague, and IRIF, Paris. The director on the Czech side is Pr. Jaroslav Nešetřil. The primary theme of the laboratory is graph theory, more specifically: sparsity of graphs (nowhere dense classes of graphs, bounded expansion classes of graphs), extremal graph theory, graph coloring, Ramsey theory, universality and morphism duality, graph and matroid algorithms and model checking.

STRUCO focuses on high-level study of fundamental combinatorial objects, with a particular emphasis on comprehending and disseminating the state-of-the-art theories and techniques developed. The obtained insights shall be applied to obtain new results on existing problems as well as to identify directions and questions for future work.

One of the main goals of STRUCO is to provide a sustainable and reliable structure to help Czech and French researchers cooperate on long-term projects, disseminate the results to students of both countries and create links between these students more systematically. The chosen themes of the project indeed cover timely and difficult questions, for which a stable and significant cooperation structure is needed. By gathering an important number of excellent researchers and students, the LEA will create the required environment for making advances, which shall be achieved not only by short-term exchanges of researchers, but also by a strong involvement of Ph. D students in the learning of state-of-the-art techniques and in the international collaborations.

STRUCO is a natural place to federate and organize these many isolated collaborations between our two countries. Thus, the project would ensure long-term cooperations and allow young researchers (especially PhD students) to maintain the fruitful exchanges between the two countries in the future years, in a structured and federated way.

8.4. International Initiatives

8.4.1. Inria International Partners

8.4.1.1. 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. This collaboration has been formally established by signing a contract between the CNRS and the Weizmann Institute of Science, as part of the ERC project.

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).

8.4.2. Participation in Other International Programs

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: IRIF and LaBRI (France), UNAM (Mexico).

8.5. International Research Visitors

8.5.1. Visits of International Scientists

Eli Gafni (1 month – June 2016)

Zvi Lotker, guest of Amos Korman (2 months – May, June 2016)

Thomas Sauerwald, guest of Adrian Kosowski (1 month – November 2016)

8.5.2. Visits to International Teams

Sergio Rasjbaum's Team (UNAM), C. Delporte and H. Fauconnier, 10 days (March 2016)

<p align="center" style="color:red">INFINE Project-Team</p>

8. Partnerships and Cooperations

8.1. Regional Initiatives

8.1.1. LiveGrid

Participants: Cedric Adjih, Emmanuel Baccelli.

Infine is one of the teams from Inria participating to LiveGrid: LiveGrid is a consortium of the main actors of industry, research organisations, local authorities and competitive cluster from the Paris-Saclay campus. The goal of LiveGrid is make the Paris-Saclay campus one of the leader regions of smart grids. Infine expertise is in infrastructure: testbeds, communication protocols, embedded open source OS.

8.2. National Initiatives

8.2.1. Equipex FIT

Participants: Cedric Adjih, Emmanuel Baccelli, Alexandre Abadie, Philippe Lubrano, Ichrak Amdouni, Alaeddine Weslati, Vincent Ladeveze.

Partners: Inria (Lille, Sophia-Antipolis, Grenoble), INSA, UPMC, Institut Telecom Paris, Institut Télécom Evry, LSIIT Strasbourg.

FIT (Future Internet of Things) aims to develop an experimental facility, a federated and competitive infrastructure with international visibility and a broad panel of customers. It provides this facility with a set of complementary components that enable experimentation on innovative services for academic and industrial users. The project gives french internet stakeholders a means to experiment on mobile wireless communications at the network and application layers thereby accelerating the design of advanced networking technologies for the future internet. FIT was one of 52 winning projects from the first wave of the French Ministry of Higher Education and Research's "Équipements d'Excellence" (Equipex) research grant program, in 2011.

One component of the FIT platform is the sets of IoT-LAB testbeds (see the IoT-LAB web site). These were motivated by the observation that the world is moving towards an "Internet of Things", in which most communication over networks will be between objects rather than people.

The Infine team is more specifically managing the FIT IoT-LAB site formerly at Rocquencourt, which recently moved to Saclay (on-going re-deployment), and is participating in the deployment of an additional IoT-lab testbed in Berlin (at Freie Universitaet Berlin).

The Infine team is actively collaborating with UPEC on wireless sensor network testbeds (and protocols): in 2015 and 2016, the testbed from UPEC with 45 Arduino nodes has been integrated with the FIT IoT-LAB testbed.

8.3. European Initiatives

8.3.1. FP7 & H2020 Projects

8.3.1.1. AGILE (H2020 project)

Participants: Emmanuel Baccelli, Cedric Adjih.

> Program: H2020 ICT-30-2015 Topic: Internet of Things and Platforms for Connected Smart Objects
>
> Project acronym: AGILE
>
> Project title: Adoptive Gateways for dIverse muLtiple Environments

Duration: 2015-2017

Coordinator: Emmanuel Baccelli

Other partners: Canonical (UK), Eclipse IoT Foundation (IE), Mobistar (BE), Libelium (ES), Startupbootcamp IoT (SP), CREATE-NET (IT), iMinds (BE), Atos (SP), Rulemotion (UK), Jolocom (DE), Passau University (DE), Sky-Watch (DN), BioAssist (GR), Graz Technical University (AT), Eurotech (IT), IoTango (US).

Abstract:

The AGILE project is a 3-year H2020 project started in January 2016, which will deliver an integrated framework of open source tools and platforms that interoperate for enabling the delivery of adaptive, self-configurable and secure IoT elements (both software and hardware) that can be utilized in a variety of scenarios. Such tools target actors with heterogeneous skills, including entrepreneurs, researchers, and individuals, aiming to enable the realization of IoT applications respecting user privacy and data ownership.

8.3.1.2. ARMOUR (H2020 project)
Participants: Cedric Adjih, Emmanuel Baccelli, Oliver Hahm.

Program: H2020 ICT-12-2015 Topic: Integrating experiments and facilities in FIRE+

Project acronym: ARMOUR

Project title: Large-Scale Experiments of IoT Security Trust

Duration: 2016-2018

Coordinator: Serge Fdida (UPMC)

Other partners: UPMC (France), Synelixis (Greece), SMA (France), UI (Portugal), JRC (Belgium), EGM (France), OdinS (Spain).

Abstract:

The ARMOUR project is a 2-year H2020 project started in February 2016. The ARMOUR project is aimed at providing duly tested, benchmarked and certified Security & Trust technological solutions for large-scale IoT using upgraded FIRE large scale IoT/Cloud testbeds properly-equipped for Security & Trust experimentations. To this, ARMOUR will: (1) Enhance two outstanding FIRE testbeds (> 2700 nodes; 500 users) with the ARMOUR experimentation toolbox for enabling large-scale IoT Security & Trust experiments; (2) Deliver six properly experimented, suitably validated and duly benchmarked methods and technologies for enabling Security & Trust in the large-scale IoT; and (3) Define a framework to support the design of Secure & Trusted IoT applications as well as establishing a certification scheme for setting confidence on Security & Trust IoT solutions.

8.3.2. Collaborations in European Programs, Except FP7 & H2020

8.3.2.1. EU CHIST-ERA MACACO
Participants: Aline Carneiro Viana, Emmanuel Baccelli, Eduardo Mucelli.

Program: EU CHIST-ERA, topic Context- and Content-Adaptive Communication Networks

Project acronym: MACACO

Project title: Mobile context-Adaptive CAching for COntent-centric networking

Duration: 2013-2016

Coordinator: Aline Carneiro Viana

Other partners: INPT-ENSEEIHT at University of Toulouse, University of Birmingham (UK), SUPSI (Switzerland), CNR (Italy) and Federal University of Minas Gerais (Brazil)

Abstract:

MACACO (Mobile context-Adaptive CAching for COntent-centric networking) is a 3-year CHIST-ERA European Project addressing the topic Context- and Content-Adaptive Communication Networks. It is funded by ANR in France, SNSF in Switzerland, and ESPRC in UK. It focus on data offloading mechanisms that take advantage of context and content information. Our intuition is that if it is possible to extract and forecast the behaviour of mobile network users in the three dimensional space of time, location and interest (i.e. what, when and where users are pulling data from the network), it is possible to derive efficient data offloading protocols. Such protocols would prefetch the identified data and cache it at the network edge at an earlier time, preferably when the mobile network is less charged, or offers better quality of service. This project has officially started in November 2013.

8.4. International Initiatives

8.4.1. Inria International Partners

8.4.1.1. Declared Inria International Partners

- Renewed IOTPUSH collaboration with Freie Universitaet Berlin around the long-term stay of Emmanuel Baccelli in Berlin, on research topics about the Internet of Things, RIOT and Information-Centric Networking.
- The Inria teams Infine and Eva are part of the "D2D Communication for LTE Advanced Cellular Network" , a project funded by the Indo-French Centre for the Promotion of Advanced Research (CEFIPRA). With industrial partners, and also with Indian partners, this project is focusing on the evolution of cellular networks towards 5G: this includes exploration of device-to-device (D2D) communication, and more generally IoT communication in a cellular context. Research directions include efficient access for IoT devices (massive numbers of devices with low volume communication); combination of random access protocols/error coding/physical layer ; efficient neighbor discovery, ...

8.4.1.2. Informal International Partners

- On-going collaboration with Hamburg University of Applied Science around RIOT.
- Informal collaborations with UIUC and UMass.
- Informal collaborations with ENSI Tunis and Sesame Tunis.

8.4.2. Participation in Other International Programs

8.4.2.1. PHC PESSOA 2015

Participant: Aline Carneiro Viana.

PHC PESSOA 2015 with University of Coimbra (2015-2016).

Program: -FCT - Programa PESSOA

Project title: Routine-based Enhanced Connectivity under User Mobility

Duration: 2015-2016

Coordinator: Aline Carneiro Viana and João Paulo da Silva Machado Garcia Vilela (University of Coimbra)

Abstract: The main goal of this project is to improve WiFi connectivity of users under mobility. The steady growth of smart-phones usage has put cellular networks under great strain, justifying the need for WiFi offloading as a solution that transfers part of the demand on cellular networks to WiFi hotspots that are in many cases already available. However, this must be performed in a way that provides benefits to the cellular operator while ensuring users a similar level of connectivity that they would achieve with cellular networks, even under user mobility (e.g. walking, taking a bus/train, etc). In this work we aim at (1) developing prediction mechanisms for selection of best hotspots by users under mobility, and (2) develop lightweight security schemes to reduce the burden of the association/authentication process of WiFi networks, therefore making WiFi offloading an effective and secure alternative to the growing demand on cellular networks.

8.5. International Research Visitors

8.5.1. Visits to International Teams

8.5.1.1. Research Stays Abroad

Emmanuel Baccelli was Visiting Professor at Freie Universitaet (FU) Berlin in 2016, within the context of the formal collaboration IOTPUSH with this university on research topics about the Internet of Things, RIOT and Information-Centric Networking.

MADYNES Project-Team

8. Partnerships and Cooperations

8.1. Regional Initiatives

8.1.1. 6PO Research Region Lorraine and UL project

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

Funded by Region Lorraine and Université de Lorraine since 2013. Adel Belkadi (CRAN & LORIA) is co-directed by L. Ciarletta and Didier Theilliol (CRAN correspondant).

6PO ("Systèmes Cyber-Physiques et Commande Coopérative Sûre de Fonctionnement pour une Flotte de Véhicules sans Pilote") is a joint research project between the Loria and CRAN laboratories. As a part of the Aetournos ecosystem, it also aims at researching solutions for safe formation flying of collaborative UAVs seen as part of a collection of Cyber Physical Systems mixing computer science and automation solutions.

It is reinforced by a PhD grant from this federation that started in october 2014 (*Conception de méthodes de diagnostic et de tolérance aux fautes des systèmes multi-agents: Application à une flotte de véhicules autonomes*, Adel Belkadi).

This led to common publications, notably on the subjects of the robust control of a fleet or flock of UAVs (with or without leader, using agents paradigms and particle swarm optimisation [12] and [36]).

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

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

8.1.2. Hydradrone FEDER Région Lorraine project

Participants: Adrien Guenard, Zhixiang Liu, Laurent Ciarletta [contact].

Feder funding

The Madynes team has been working on the Hydradrone project since July 2014. It started as a collaborative R&D initiative funded by *Région Lorraine* and is now FEDER funded. This project started as a joint work between Madynes and PEMA (*Pedon Environnement et Milieux Aquatiques*), an SME/VSE (small and medium size Entreprise, PME/TPE). The consortium now includes Alerion another VSE, spinoff from Loria.

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

- starting with an actual need for automated and remote operation of environmental sensing expressed by PEMA
- based on an hybrid UxV (Unmanned Air, Surface... Vehicle),
- some Cyber Physical bricks in coherence with the Alerion's concepts (ease of use, safety, autonomy)
- and an integration in the Information System of the company

PEMA, as an environmental company, is providing the use cases and terrain (and business) validation, while Alerion is working on the integration and engineering of the solution.

This second year has been dedicated to the development of the initial controllers for the Hydradrones (smal and large one), and the beginning of the integration of the environmental sensors.

8.1.3. Satelor AME Lorraine regional project

Participants: François Despaux, Lei Mo, Mohamed Tlig, Bernardetta Addis, Evangelia Tsiontsiou, Ye-Qiong Song [contact].

The Madynes team is involved in Satelor, a regional research and development project funded by the AME (Agence de Mobilisation Economique) of Lorraine (October 2013 – September 2017). The consortium includes academic (Univ. of Lorraine, Inria), medical (OHS) and industrial (Diatelic-Pharmagest (lead), ACS, Kapelse, Salendra, Neolinks) partners. It aims at developing innovative and easily deployable ambient assisted living solutions for their effective use in the tele-homecare systems. The Madynes team is mainly involved in the data collection system development based on wireless sensors networks and IoT technology. The first topic consists in defining the basic functions of the future SATEBOX – a gateway box for interconnecting in-home sensors to the medical datacenter, based on our previously developed MPIGate software. A beta-version prototype of the future Satebox gateway has been realased. It now includes Zigbee wireless sensors, EnOcean battery-free sensors and Bluetooth Low Energy sensors. It provides a low-cost and easily deployable solution for the daily activity monitoring. After its first real-world deployment at a OHS hospital room, a second prototype testbed has been prepared for a further test deployment including several rooms. The second topic is related to improving the data transfer reliability while still keep minimum energy consumption. This has led us to focus on the multi-hop mesh network topology with multi-constrained QoS routing problem (PhD thesis of Evangelia Tsiontsiou) [33]. The third topic is related to the wireless charging of sensor nodes (PhD work of Lei MO) in order to keeping sensors in perpetual working state. A new direction has been also investigated which consists in using the CSI (channel signal information) of the omnipresent WiFi (IEEE802.11n) as a new generation of contactless sensors. A first test bed of using CSI to measure the respiration rate has been set up.

8.2. National Initiatives

8.2.1. ANR BottleNet

Participants: Isabelle Chrisment [contact], Thibault Cholez, Vassili Rivron, Paul Andrey, Quentin Rouy.

The Quality of Experience (QoE) when accessing the Internet, on which more and more human activities depend, is a key factor for today's society. The complexity of Internet services and of user's local connectivity has grown dramatically in the last years with the proliferation of proxies and caches at the core and access technologies at the edge (home wireless and 3G/4G access), making it difficult to diagnose the root cause of performance bottlenecks. The objective of BottleNet is to deliver methods, algorithms, and software systems to measure end-to-end Internet QoE and to diagnose the cause of experienced issues. The result can then be used by users, network and service operators or regulators to improve the QoE.

The ANR BottleNet project (https://project.inria.fr/bottlenet) started this year with a kick-off on the 1st of February 2016. It involves many partners in the field of computer networks and QoE: Inria Muse and Diana teams, Lille1 University, Telecom Sud-Paris, Orange, IP-Label. The objective of BottleNet is to deliver methods, algorithms, and software systems to measure Internet QoE and diagnose the root cause of poor Internet QoE. Our goal calls for tools that run directly at users' devices. We plan to collect network and application performance metrics directly at users' devices and correlate it with user perception to model Internet QoE, and to correlate measurements across users and devices to diagnose poor Internet QoE. This data-driven approach is essential to address the challenging problem of modeling user perception and of diagnosing sources of bottlenecks in complex Internet services. BottleNet will lead to new solutions to assist users, network and service operators as well as regulators in understanding Internet QoE and the sources of performance bottleneck.

Our first research question was to evaluate the impact of web advertisement on users' QoE. An interdisciplinary approach was developed at MADYNES, by which we extend the common notion of "quality of information" on free news websites (usually based on journalistic content) to a notion of quality of experience for the user, that takes into account the degraded delivery of information by the multiplication of third party contents. We implemented a measurement tool as a web browser extension and made a dataset by browsing many news websites accessed with and without ad-blockers. The first statistical results retrieved from the

dataset show that web-advertisement has a huge negative impact on QoE, for example multiplying the mean page load time by more than one order of magnitude and increasing the variance even more, while adblockers' profiles show faster and more uniform performances. These results have to be further refined but already show that web-advertisement, and more generally third-party content provider, play a huge role in poor Internet QoE and that it is a key parameter to investigate in the project. This study is leading to a structural analysis of the ad regulation mechanisms in the field of web journalism. Adblockers not only upgrades the QoE of visitors, but also contributes to define what "acceptable ads" should be.

This year the following task have been completed:

- Development of a platform to collect QoS & QoE on french news websites (Quentin Rouy, Telecom Nancy student). The first exploratory data collecting campaign measured the impact of Web Advertisement on client QoS, using FatHom plugin for Firefox (a tool from MUSE/Inria, partner of the BottleNet ANR project).

- Implementation of statistical treatment schemes (Paul Andrey, ENSAE student) to correlate QoS, economic models and adblocking effects on news websites.

- Preparation of a systematized measurement campaign on french and international news sites, in order to publish to a large audience.

8.2.2. ANR Doctor

Participants: Thibault Cholez [contact], Thomas Silverston [contact], Xavier Marchal, Cédric Enclos, Elian Aubry, Daishi Kondo, Olivier Festor.

The DOCTOR project http://www.doctor-project.org is an applied research project funded by the French National Research Agency (ANR), grant <ANR-14-CE28-000>, and supported by the French Systematic cluster. The project started on December 2014 for three years. It involves five partners specialized in network monitoring and security: Orange Labs (lead), Thales, Montimage, Université de technologie de Troyes and LORIA/CNRS. The DOCTOR project advocates the use of virtualized network equipment (Network Functions Virtualization), to enable the co-existence of new Information-Centric Networking stacks (e.g.: Named-Data Networking) with IP, and the progressive migration of traffic from one stack to the other while guaranteeing the good security and manageability of the network. Therefore in DOCTOR, the main goals of the project are: (1) the efficient deployment of NDN as a virtualized networking environment; (2) the monitoring and security of this virtualized NDN stack.

We presented the whole project at the IRTF Information-Centric Networking Research Group (ICNRG) in January.

This year, we made contributions in three critical points for the deployment of virtualized NDN network: security, performances and interoperability. First, we identified a critical vulnerability in the NDN protocol design that allows an attacker to perform efficient DoS attacks [46] by either self-answering to his own requests or answering to clients before the server. We proposed several remediation strategies to this problem.

On the performance topic, we designed and implemented a tool similar to Iperf, Ndnperf [22][0], that can measure the maximum throughput of a program serving NDN Data. We identified critical limitations that can harm real-time services (live streaming, VOIP, etc.), and proposed several recommendations and improvements that can increase the throughput up to 8 times when combined together.

Finally, we also designed and implemented an HTTP/NDN gateway that can be used to transport web content on an NDN network, thus benefiting from its caching and multicast properties while being totally transparent for the client and the server [47]. Those three contributions were published and demonstrated in the main conference of the domain: ACM ICN.

8.2.3. PIA LAR

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

---

[0]http://madynes.loria.fr/software/ndnperf_cpp.zip

LAR (Living Assistant Robot) is a PIA (Projet investissement d'avenir) national project getting together Inria (MAIA and MADYNES projects), *Crédit Agricole* (lead), Diatelic and Robotsoft. The aim is to develop an ambient assisted living system for elderly including both sensors and assistant robots. The task of Madynes team is the development of a WSN-based system integrating both sensors of the environment and sensors and actuators embedded on a mobile robot. The research issues include the QoS, energy and mobility management.

This project has ended in March 2016. Some new results are obtained including the use of Cooja simulator for RIOT OS based WSN simulation and an in-depth analysis of some timing inaccuracy problems introduced by MSPSim which is an emulator of MSP430 MCU [27]. A synthesis of our achievements on LAR project is reported in the PhD thesis of Kévin Roussel (http://www.theses.fr/196570603).

8.2.4. FUI HUMA

Participants: Jonathan Arnault, Giulia de Santis, Pierre-Olivier Brissaud, Jérôme François [contact], Abdelkader Lahmadi, Isabelle Chrisment.

The HUMA project (*L'HUmain au cœur de l'analyse de données MAssives pour la sécurité*) is funded under the national FUI Framework (Fonds Unique Interministerial) jointly by the BPI (Banque Publique d'Investissement) and the Région Lorraine. It has been approved by two competitive clusters: Systematic and Imaginove. The consortium is composed of three academic (ICube, Citi, Inria) and five industrial (Airbus Defence and Space, Intrinsec, Oberthur, Wallix, Sydo) partners. The leader is Intrinsec.

This project targets the analysis of Advanced Persistent Threat. APT are long and complex attacks which thus cannot be captured with standard techniques focused on short time windows and few data sources. Indeed, APTs may be several months long and involve multiple steps with different types of attacks and approaches. The project will address such an issue by leveraging data analytics and visualization techniques to guide human experts, which are the only one able to analyze APT today, rather than targeting a fully automated approach.

In 2016, our contribution focused on defining a clustering technique in order to group individual events into a common one. We applied our technique to darknet data as shown in section 6.2.1 . In addition, we also start the modeling of an attacker process by considering the first phase of APT, *i.e.* the reconnaissance phase by analyzing scanning activities using Hidden Markov Model in section 6.2.1 . We also technically contribute to the definition of APT scenarios by providing a very stealthy scanning approach (Wiscan described in 6.1.2). Finally, from a project management point of view, Inria is in charge of leading the work-package related to data analytics technique for analyzing security probe events.

8.2.5. Inria-Orange Joint Lab

Participants: Jérôme François [contact], Rémi Badonnel, Olivier Festor, Maxime Compastié, Paul Chaignon.

The challenges addressed by the Inria-Orange joint lab relate to the virtualization of communication networks, the convergence between cloud computing and communication networks, and the underlying software-defined infrastructures. This lab aims at specifying and developing a GlobalOS (Global Operating System) approach as a platform or a software infrastructure for all the network and computing resources required by the Orange network operator. Our work, started in November 2015, concerns in particular monitoring methods for software-defined infrastructures, and management strategies for supporting software-defined security in multi-tenant cloud environments.

8.2.6. CNRS-INS2I PEPS NEFAE

Participants: Thibault Cholez [contact], Wazen Shbair, Isabelle Chrisment, Jérôme François.

The need to monitor the increasing proportion of HTTPS traffic while preserving the privacy of users led us to propose a privacy-preserving monitoring framework that allows efficient identification of encrypted traffic (based on full TLS sessions), without relying on any decryption (no HTTPS proxy). It is based on a new set of well-tuned network features to characterise the service inside the encrypted traffic and on machine learning algorithms. The CNRS PEPS founded NEFAE project aims to specifically address the practical challenges toward real time identification of encrypted traffic by developing a next-generation firewall prototype.

This year we first built and made publicly available a new HTTPS dataset[0] (with complete raw data) so that researchers can compare their identification algorithms. We also improved our HTTPS monitoring framework to allow real-time identification of HTTPS services with only a few data packets instead of the full TLS session. We show better performances that the related work in all dimensions: better accuracy, earlier decision and more fine-grained identification). A running prototype is also under development to evaluate the scalability and overhead of our solution.

8.2.7. *CNRS-INS2I PEPS SURF*

Participants: Abdelkader Lahmadi [contact], Jérôme François, Isabelle Chrisment.

The SURF project, funded by the CNRS PEPS program, addresses the challenge of a developing a methodology for the joint modelling and the analysis of the Cyber security and the safety of industrial systems in the context of the factory of the future. The project involves partners from the Heudiasyc Laboratory of the University of Technology of Compiègne (UTC), the CRAN laboratory and the Inria Madynes team. The goal of the project is to make a joint effort from safety and cyber security communities to address the challenges of a joint modelling of industrial systems while including attacks, vulnerabilities and failures. During the year 2016, with the partners of the project, we have mainly identified the key challenges regarding this issue where we identified the common models, metrics and analysis methods that should be built. We have also organized a scientific day (http://surf.loria.fr) with many industrials (EDF, PSA and Sentryo) and academic to share with them our work and clearly identify the requirement and experience regarding this issue. This short term project is ended by this year, however a consortium is established for further long term projects (ANR, FUI or H2020) to address the identified challenge of a joint analysis of the cyber security and the safety of industrial control systems.

8.2.8. *ANR FLIRT*

Participants: Olivier Festor [contact], Rémi Badonnel, Thibault Cholez, Jérôme François, Abdelkader Lahmadi, Laurent Andrey.

FLIRT (Formations Libres et Innovantes Réseaux & Télécom) is an applied research project leaded by the Institut Mines-Télécom, for a duration of 4 years. It includes 14 academic partners (engineering schools including Telecom Nancy), 3 industrial partners (Airbus, Nokia Group and Orange), 2 innovative startups (the MOOC agency, and Isograd), as well as 3 professional or scientific societies (Syntec Numérique, Unetel, SEE). The project objective is to build a collection of 10 MOOCs (Massive Open Online Courses) in the area of networks and telecommunications, 3 training programmes based on this collection, as well as several innovations related to pedagogical efficiency (such as virtualization of practical labs, management of student cohorts, and adaptative assessment). The Madynes team is leading a working group dedicated to the building of a MOOC on network and service management. This MOOC will cover the fundamental concepts, architectures and protocols of the domain, as well as their evolution in the context of future Internet, and will include practical labs and exercises using widely-used tools and technologies.

8.2.9. *Technological Development Action (ADT)*

8.2.9.1. *ADT UASS*

The goal of this ADT is while still providing assistance in developing the Aetournos platform to help in the UAV Challenge Medical Express. Through this ADT, funded by Inria, Raphaël Cherfan has coordinated students work on the platform and tutoring the Aetournos team for the 2016 Outback Joe Search and Rescue / Medical Express Challenge, and help in the design and buidling of a novel Hybrid UAV.

8.2.9.2. *ADT VERTEX*

This ADT started on 2016 and will end on 2018. The Madynes project is a major partner funded at the level of 120k€. ADT VERTEX buildt upon the foundations of the Grid'5000 testbed aims to reinforce and extend it towards new use cases and scientific challenges. Several directions are being explored: networks and Software Defined Networking, Big Data, HPC, and production computation needs. Already developed prototypes are also being consolidated, and the necessary improvements to user management and tracking are also being performed.

---

[0]http://betternet.lhs.loria.fr/datasets/https/

8.2.9.3. ADT COSETTE

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

8.2.9.4. ADT RIOT

RIOT ADT is a multi-site project with Infine and Madynes teams, which started in December 2016 for a duration of two years. The high-level objective is to (1) contribute open source code, upstream, to the RIOT code base, (2) coordinate RIOT development within Inria, with other engineers and researchers using/developing RIOT, (3) coordinate RIOT development outside Inria, help maintain the RIOT community at large (see http://www.riot-os.org and http://www.github.com/RIOT-OS/RIOT) which aims to become the equivalent of Linux for IoT devices that cannot run Linux because of resource constraints.

This year MADYNES team has mainly contributed to the efficient MAC layer protocol implementation issues. We have built a general MAC protocol module (gnrc mac module) for providing critical development tools for MAC protocol developers in the RIOT community (https://github.com/RIOT-OS/RIOT/pull/5941; https://github.com/RIOT-OS/RIOT/pull/5942; https://github.com/RIOT-OS/RIOT/pull/5949; https://github.com/RIOT-OS/RIOT/pull/5950; https://github.com/RIOT-OS/RIOT/pull/6069; https://github.com/RIOT-OS/RIOT/pull/6072). Based on these generic functions, we first contributed to the functionality and performance improvement of an universal example MAC protocol (Lw-MAC) (https://github.com/RIOT-OS/RIOT/pull/5941). We then implemented iQueue-MAC, which is a robust, energy efficient and traffic adaptive MAC protocol (https://github.com/RIOT-OS/RIOT/pull/5618). Currently, we have finished to implement most of the designed features of iQueue-MAC, such as the low duty-cycle scheme, the adaptive slots allocation scheme and the multi-channel operation. Experimental results collected from samr21-Xplained-pro boards showed that iQueue-MAC is robust and has a extremely low packet drop ratio, even when interference is strong.

8.2.10. Inria Project Lab

8.2.10.1. IPL BetterNet
Participants: Isabelle Chrisment [contact], Thibault Cholez, Vassili Rivron.

The Inria Project Lab BetterNet (https://project.inria.fr/betternet) launched in October 2016. Its goal is to build and deliver a scientific and technical collaborative observatory to measure and improve the Internet service access as perceived by users. We will propose new original user-centered measurement methods, which will associate social sciences to better understand Internet usage and the quality of services and networks. Tools, models and algorithms will be provided to collect data that will be shared and analyzed to offer a valuable service to scientists, stakeholders and civil society.

The Madynes team leads the IPL and in particular Isabelle Chrisment who coordinates the project. Several actions have already been done over the first months:

- Organization of the Kick-Off the 19th November in Paris;

- Recruitment of a shared PhD with SPYRALS (Inria/University of Lille3) in order to develop probes and collecting platform;

- Servers installation in LHS (High Security Laboratory) for the hosting of the different BottleNet and BetterNet data collection and opendata platforms;

- Preparation of small and middle scale QoE and QoS data collection with users. Conception of incentives and rewards (value added services).

8.3. European Initiatives

8.3.1. FP7 & H2020 Projects

8.3.1.1. Flamingo

Title: Management of the Future Internet

Programm: FP7

Duration: November 2012 - December 2016

Coordinator: University Twente

Partners:

Iminds Vzw (Belgium),

Jacobs University Bremen Ggmbh (Germany),

University College London (United Kingdom),

Université de Lorraine (France),

Universitaet Der Bundeswehr Muenchen (Germany),

Universitat Politecnica de Catalunya (Spain),

Universiteit Twente (Netherlands),

Universitaet Zuerich (Switzerland)

Inria contact: Jérôme François

The goals of FLAMINGO are (a) to strongly integrate the research of leading European research groups in the area of network and service management, (b) to strengthen the European and worldwide research in this area, and (c) to bridge the gap between scientific research and industrial application.

In 2016, our research activities in Flamingo have been focused on (a) the analysis and evaluation of OpenFlow message usage for security applications, in particular to enable fast deployment and reconfiguration of mitigation technique (6.2.4) in cooperation with Universitaet Der Bundeswehr Muenchen; (b) passive monitoring of Internet-of-Things using the RPL protocol in cooperation with the Jacobs University Bremen; (c) monitoring of HTTPS traffic to identify user services without necessity of decrypting (6.1.4) and (d) low-footprint Internet wide scanning using our WISCAN software developed last year.

We have pursued leading the standardization activities of the project (WP leader).

8.3.2. Collaborations in European Programs, Except FP7 & H2020

8.3.2.1. RETINA

Program: Eurosatrs-2

Project acronym: RETINA

Project title: Real-Time support for heterogenous networks in automotive applications

Duration: April 2016 - March 2018

Coordinator: TCN (Time critical networks)

Other partners: TCN (Sweden), Alkit (Sweden), Viktoria (Sweden), TNO (Netherlands), Scuola Superiore Sant'Anna (Italy), Evidence (Italy), University of Lorraine (France)

Abstract: The project will develop integrated software tools to predict, simulate, test and support real-time communication in heterogeneous vehicular networks. The tool set will allow SMEs and larger industry to design, develop and evaluate time-critical applications such as advanced safety systems and autonomous vehicles. This will put high requirements on both in-vehicle infrastructure, as well as vehicle-to-vehicle and vehicle-to infrastructure utilizing the next generation of mobile networks for ITS.

8.4. International Initiatives

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

8.4.1.1. IoT4D

Title: Internet of Things for Developping countries

International Partner (Institution - Laboratory - Researcher):

UY (Cameroon) - MASECNeSS - Thomas DJOTIO NDIE

Start year: 2016

We want connect wireless sensors networks to the Internet through gateways. Wireless network should have several acessible gateways (depending on the size and quality of service needed) and gateways should be used by several wireless sensors networks. This is an optimization problem in this perticular context, with unreliable communications and equipments that are easily disturbed by the environment

8.4.1.2. Masdin

Title: MAnagement of Software-Defined INfrastructure

International Partner (Institution - Laboratory - Researcher):

University of Luxembourg (Luxembourg) - SnT (Interdisciplinary Centre for Security, Reliability and Trust) - Radu State

Start year: 2016

See also: https://project.inria.fr/masdin

Networking is deeply evolving with the rise of programmability and virtualization. The concept of SDI (Software-Defined Infrastructure) has emerged from SDN (Software-Defined Networking) and NFV (Network Function Virtualization) making thus the configuration of the network highly dynamic and adaptable in real-time. However, new methods and tools have to be defined to properly monitor and configure this type of infrastructure. Current works are mainly limited to apply former approaches of traditional network but do not exploit the novel capabilities offered by these technologies. The goal of the associate team is thus to define methodologies taking benefit of them for an efficient monitoring and use of SDI resources while investigating security issues it brings.

8.4.1.3. STIC-AmSud AKD Project
Participants: Rémi Badonnel [contact], Olivier Festor, Gaetan Hurel, Amedeo Napoli.

The AKD project, funded by the STIC-AmSud Program, addresses the challenge of autonomic knowledge discovery for security vulnerability prevention in self-governing systems. The partners include Federal University of Rio Grande do Sul (UFRGS, Brazil), Republic University of Uruguay (INCO, Uruguay), Technical University of Federico Santa Maria (UTFSM, Chile), and Inria (Orpailleur, Madynes). Computer vulnerabilities constitute one of the main entry points for security attacks, and therefore, vulnerability management mechanisms are crucial for any computer systems. However autonomic mechanisms for assessing and remediating vulnerabilities can degrade the performance of the system and might contradict existing operational policies. In that context, this project focuses on the design of solutions able to pro-actively understand the behavior of systems and networks, in order to prevent vulnerable states. For that purpose, our work concerns more specifically the exploitation and integration of knowledge discovery techniques within autonomic systems for providing intelligent self-configuration and self-protection. It also investigates the building of flexible and dynamic security management mechanisms taking benefits from software-defined methods and techniques.

<p align="center">**MAESTRO Project-Team**</p>

9. Partnerships and Cooperations

9.1. National Initiatives

9.1.1. ANR Marmote

Participants: Alain Jean-Marie, Issam Rabhi.

ANR Program: Modèles Numériques (MN) 2012, number ANR-12-MONU-0019

Project title: MARkovian MOdeling Tools and Environments

Duration: January 2013 - June 2017

Coordinator: Alain Jean Marie (Inria)

Partners: Inria (project-teams DYOGENE, MAESTRO and MESCAL), Univ. Versailles-Saint-Quentin (DAVID lab.), Telecom SudParis (SAMOVAR lab.), Univ. Paris-Est Créteil (LACL), and Univ. Pierre-et-Marie-Curie (LIP6)

Abstract: ANRMARMOTE aims, among other goals, at realizing the prototype of a software environment dedicated to modeling with Markov chains. It brings together seven partner teams, expert in Markovian analysis, who will develop advanced solution algorithms and applications in different scientific domains: reliability, distributed systems, biology, physics and economics.

https://wiki.inria.fr/MARMOTE/Welcome

9.2. European Initiatives

9.2.1. Collaborations in European Programs, Except FP7 & H2020

Participant: Konstantin Avrachenkov.

Program: EU COST

Project acronym: ACROSS

Project title: Autonomous Control for a Reliable Internet of Services

Duration: November 2013 - November 2017

Coordinator: Rob Van Der Mei (CWI) and J.L. Van Den Berg (TNO), The Netherlands

Other partners: see http://www.cost-across.nl/

Abstract: Currently, we are witnessing a paradigm shift from the traditional information-oriented Internet into an Internet of Services (IoS). This transition opens up virtually unbounded possibilities for creating and deploying new services. Eventually, the ICT landscape will migrate into a global system where new services are essentially large-scale service chains, combining and integrating the functionality of (possibly huge) numbers of other services offered by third parties, including cloud services. At the same time, as our modern society is becoming more and more dependent on ICT, these developments raise the need for effective means to ensure quality and reliability of the services running in such a complex environment. Motivated by this, the aim of this Action is to create a European network of experts, from both academia and industry, aiming at the development of autonomous control methods and algorithms for a reliable and quality-aware IoS.

Program: EU COST

Project acronym: COSTNET

Project title: European Cooperation for Statistics of Network Data Science

Duration: May 2016 - April 2020

Coordinator: Ernst Wit (NL), Gesine Reinert (UK)

Other partners: see http://www.cost.eu/COST_Actions/ca/CA15109

Abstract: A major challenge in many modern economic, epidemiological, ecological and biological questions is to understand the randomness in the network structure of the entities they study: for example, the SARS epidemic showed how preventing epidemics relies on a keen understanding of random interactions in social networks, whereas progress in curing complex diseases is aided by a robust data-driven network approach to biology.

Although analysis of data on networks goes back to at least the 1930s, the importance of statistical network modelling for many areas of substantial science has only been recognized in the past decade. The USA is at the forefront of institutionalizing this field of science through various interdisciplinary projects and networks. Also in Europe there are excellent statistical network scientists, but until now cross-disciplinary collaboration has been slow.

This Action aims to facilitate interaction and collaboration between diverse groups of statistical network modellers, establishing a large and vibrant interconnected and inclusive community of network scientists. The aim of this interdisciplinary Action is two-fold. On the scientific level, the aim is to critically assess commonalities and opportunities for cross-fertilization of statistical network models in various applications, with a particular attention to scalability in the face of Big Data. On a meta-level, the aim is to create a broad community which includes researchers across the whole of Europe and at every stage in their scientific career and to facilitate contact with stakeholders.

9.3. International Initiatives

9.3.1. Inria Associate Teams Not Involved in an Inria International Labs

9.3.1.1. THANES

Participants: Eitan Altman, Konstantin Avrachenkov, Jithin Kazhuthuveettil Sreedharan, Philippe Nain, Giovanni Neglia.

Title: THeory and Application of NEtwork Science

International Partners (Institution - Laboratory - Researcher):

CMU (Brazil) - Department of Computer Science - Bruno Ribeiro

UFRJ (Brazil) - Department of Computer and Systems Engineering - Edmundo de Souza e Silva, Daniel Ratton Figueiredo, Daniel Sadoc

Duration: 2014 – 2017

See also: https://team.inria.fr/thanes/

Our goal is to study how services in Online Social Networks (OSN) can be efficiently designed and managed. This research requires to answer 3 main questions: 1) How can the topology of an OSN be discovered? Many services need or can take advantage of some knowledge of the network structure that is usually not globally available and in any case changes continuously due to structural dynamics. 2) How does services' adoption spread across the OSN? On the one hand the popularity of a service is determined by word-of-mouth through the links of the OSN and, on the other end, the service may contribute to reshape the structure of the OSN (e.g. by creating new connections). 3) How do different services compete for the finite attention and money of OSN users? In particular our purpose is to provide analytical models (corroborated by simulations and experiments on real networks) to understand such complex interactions.

9.3.2. Inria International Partners

9.3.2.1. Informal International Partners

MAESTRO has continued collaborations with researchers from GERAD, Univ. Montreal (Canada), Flinders Univ. (Australia), National Univ. of Rosario (Argentina), Technion - Israel Institute of Technology (Israel), Univ. of Arizona (USA), Univ. of Illinois at Urbana-Champaign (USA), Univ. of Liverpool (UK), Univ. of Massachusetts at Amherst (USA), Univ. of Florence (Italy), Univ. of Palermo (Italy), Univ. of Twente (The Netherlands) and Petrozavodsk State Univ. (Russia); Ghent Univ. (Belgium); see Sections 9.4.1.1 and 9.4.2.1 .

9.3.3. Participation in Other International Programs

MAESTRO has continued collaborations with researchers from IIT Mumbai and IISc Bangalore. In 2015, these collaborations where partly supported by IFCAM and Cefipra.

9.3.3.1. International Initiatives

DyGaMe

Title: Dynamic Games Methods: theory, algorithmics and application

International Partners (Institution - Laboratory - Researcher):

Univ. de Chile (Chile) - Department of Industrial Engineering - Fernando Ordóñez

Univ. Nacional de Rosario (Argentina) - Facultad de Ciencias Exactas, Ingeniería y Agrimensura - Eugenio Della Vecchia

CNRS (France) - LIP6 - Emmanuel Hyon

Duration: 2016 - 2017

Start year: 2016

See also: https://project.inria.fr/dygame

Stochastic Dynamic Game Theory is developing in Engineering sciences and is in need of more theoretical results, algorithms and applications. This project brings together researchers from Applied Mathematics, Operations Research and Economics, with the objective of contributing to these aspects. It will more specifically concentrate on agent rationality and the game structure, look for efficient solution algorithms by crossing Applied Mathematics and Operations Research techniques, and apply the results to problems originating from, on the one hand, security/conservation concerns, and on the other hand, sustainable development problems.

CEFIPRA Grant Monte Carlo, no.5100-IT1

Title: Monte Carlo and Learning Schemes for Network Analytics

International Partners (Institution - Laboratory - Researcher):

IIT Bombay (India) - Department of Electrical Engineering - Prof. V.S. Borkar;

IIS Bangalore (India) - Department of Electrical Engineering - Prof. R. Sundaresan.

Duration: 2014 - 2017

Start year: 2014

The project aims to approach various computation problems in network analytics by means of Markov Chain Monte Carlo (MCMC) and related simulation techniques as well as machine learning algorithms such as reinforcement learning, ant colony optimization, etc. This will include network diagnostics such as ranking, centrality measures, computation on networks using local message passing algorithms, resource allocation issues pertaining to networks and network-based systems such as the internet, peer-to-peer networks, social networks. The work will involve both development of analytical tools and extensive validation thereof using simulation studies. The research will draw upon techniques from graph theory, probability, optimization, and distributed computation.

9.4. International Research Visitors

9.4.1. Visits of International Scientists

9.4.1.1. Professors / Researchers

Bernardo Amorim

Date: 4-8 April 2016

Institution: Federal Univ. of Rio de Janeiro (Brazil)

Vivek Borkar

Date: 26-29 May and 4-17 September 2016

Institution: IIT Mumbai (India)

Damiano Carra

Date: 22-27 February and 18-22 July 2016

Institution: Univ. of Verona (Italy)

Francesco De Pellegrini

Date: 19-22 December 2016

Institution: CREATE-NET (Italy)

Ioannis Dimitriou

Date: 5-10 September 2016

Institution: Univ. of Patras (Greece)

Daniel Figueiredo

Date: 4-8 April 2016

Institution: Federal Univ. of Rio de Janeiro (Brazil)

Michele Garetto

Date: 4-5 April 2016

Institution: Univ. of Torino (Italy)

Moshe Haviv

Date: 15-19 June 2016

Institution: Univ. of Jerusalem (Israel)

Nidhi Hegde

Date: 10-13 June 2016

Institution: Nokia Bell Labs (France)

Giulio Iacobelli

Date: 11-21 January and 4-8 April 2016

Institution: Federal Univ. of Rio de Janeiro (Brazil)

Philippe Jacquet

Date: 1 December 2016

Institution: Nokia Bell Labs (France)

Jean-Yves Le Boudec

Date: 2 June 2016

Institution: EPFL (Switzerland)

Emilio Leonardi

Date: 6-16 December 2016

Institution: Politecnico di Torino (Italy)

Nelly Litvak

Date: 1-4 December 2016

Institution: Univ. of Twente (Netherlands)

Natalia Markovich

Date: 18-27 June 2016

Institution: Russian Academy of Sciences (Russia)

Evzey Morozov

Date: 21-29 July 2016

Institution: Petrozavodsk Univ. (Russia)

Fernando Ordóñez

Date: 27-30 September

Institution: Univ. of Chile (Chile)

Sreenath Ramanath

Date: 17-27 May 2016

Institution: IIT Bombay (India)

Bruno Ribeiro

Date: 10-20 June 2016

Institution: Carnegie Mellon Univ. (USA)

Daniel Sadoc

Date: 4-8 April 2016

Institution: Federal Univ. of Rio de Janeiro (Brazil)

Matteo Sereno

Date: until March 2016 and 28 Nov-2 Dec 2016

Institution: Univ. of Torino (Italy)

Vinod Sharma

Date: 15-30 November 2016

Institution: IIS Bangalore (India)

Flora Spieksma

Date: 5-7 July 2016

Institution: Univ. of Leiden (Netherlands)

Rajesh Sundaresan

Date: 05-26 May 2016

Institution: IIS Bangalore (India)

Josh Taylor

Date: 24 June 2016

Institution: Univ. of Toronto (Canada)

Don Towsley

Date: 1-3 December 2016

Institution: Univ. of Massachusetts (USA)

Kavitha Voleti Veeraruna

Date: 17-27 May 2016

Institution: IIT Bombay (India)

Uri Yechiali

Date: 15-28 April 2016

Institution: Tel Aviv Univ. (Israel)

9.4.1.2. Post-doc / Ph.D. students

Víctor Bucarey López

Date: 27-30 September 2016

Institution: Univ. of Chile

Ricardo Coelho Silveira

Date: from Sep 2016 until Nov 2016

Institution: Univ. of Rio de Janeiro (Brazil)

Eduardo Hargreaves
> Date: 20-23 June 2016
> Institution: Univ. of Rio de Janeiro (Brazil)

Yahui Tian
> Date: from Jun 2016 until Jul 2016
> Institution: Univ. of Texas (USA)

9.4.1.3. Internships

Mikhail Kamalov
> Date: from Jun 2016 until Jul 2016
> Institution: Saint Petersburg State Univ. (Russia)
> Supervisor: Konstantin Avrachenkov

Mohamed Lamghari
> Date: from Apr 2016 until Aug 2016
> Institution: UNS (France)
> Supervisor: Giovanni Neglia

Maksim Mironov
> Date: from Aug 2016 until Sept 2016
> Institution: MIPT (Russia)
> Supervisor: Konstantin Avrachenkov

9.4.2. Visits to International Teams

9.4.2.1. Research Stays Abroad

Konstantin Avrachenkov
> Date: 4 - 8 April 2016
> Institution: IIT Mumbai (India)
> Date: 25 April - 5 May 2016
> Institution: Moscow Institute of Physics and Technology and Yandex (Russia)
> Date: 10-11 August 2016
> Institution: Aaalto Univ. (Finland)

Alain Jean-Marie
> Date: 5 - 16 December 2016
> Institution: Univ. of Montreal (Canada)
> Date: 28 March - 1 April 2016
> Institution: Univ. National of Rosario (Argentina)
> Date: 3 - 14 April 2016
> Institution: Univ. de Chile (Chile)

Arun Kadavankandy
> Date: 12-30 April 2016
> Institution: Yandex (Russia)
> Date: 12-17 July 2016
> Institution: IIS Bangalore (India)

Giovanni Neglia
> Date: 14 - 22 February; 1 - 4 April; 20 - 25 September; 7 - 10 and 25 - 30 October 2016
> Institution: Univ. of Florence (Italy)
> Dates: 11 - 16 May; 21 - 23 December 2016
> Institution: Univ. of Palermo (Italy)

Dimitra Politaki
> Date: 18 October - 2 November and 12 - 20 December 2016
> Institution: Univ. of Torino (Italy)

<p style="text-align:center">**MUSE Team**</p>

7. Partnerships and Cooperations

7.1. National Initiatives

7.1.1. ANR

7.1.1.1. BottleNet: Understanding and Diagosing end-to-end communication problems

> Type: ANR Project (N ANR-15-CE25-0013-01)
>
> Instrument: PRCE
>
> Duration: February 2016 - 36 mois
>
> Coordinator: Renata Teixeira
>
> Other partners: Inria Paris, LORIA, Ip-label SaS, ORANGE SA , TSP (SAMOVAR) Telecom SudParis, University of Lille 1 (CRIStAL)
>
> Inria contact: Renata Teixeira
>
> Abstract: As our lives become more dependent on the Internet, it is easy to understand peoples frustration when poor Internet performance prevents them from accomplishing ever-more important online activities. The Quality of Experience (QoE) when accessing the Internet is thus a key factor for todays society. When users experience poor Internet QoE, they are often helpless. The complexity of Internet services and of users local connectivity has grown dramatically in the last years with the proliferation of proxies and caches at the core and of home wireless and 3G/4G access. However, it is hard even for experts to diagnose the sources of performance bottlenecks. We argue that the new rules for regulating Internet access and plans to improve it should focus on the end-to-end Internet QoE - i.e., the user experience when performing her usual online activities on the Internet - and should provide means for all different players to accurately diagnose the sources of poor Internet QoE. The objective of BottleNet is to deliver methods, algorithms, and software systems to measure Internet QoE and diagnose the root cause of poor Internet QoE. Our goal calls for tools that run directly at users devices. We plan to collect network and application performance metrics directly at users devices and correlate it with user perception to model Internet QoE, and to correlate measurements across users and devices to diagnose poor Internet QoE. This data-driven approach is essential to address the challenging problem of modeling user perception and of diagnosing sources of bottlenecks in complex Internet services. BottleNet will lead to new solutions to assist users, network and service operators as well as regulators in understanding Internet QoE and the sources of performance bottleneck.

7.1.2. CNRS Big Data Projects

7.1.2.1. BigGeoQUP: Big Geospatial Data Quality and User Privacy

> Type: CNRS Mission Interdisciplinarité (MI) DEFI MASTODONS "La qualité des données dans les Big Data"
>
> Instrument: AAP 2016
>
> Duration: Mars 2016 - 12 mois
>
> Coordinator: Dimitris Kotzinos (University of Cergy Pointoise)
>
> Other partners: Inria Paris, IGN-COGIT
>
> Inria contact: Vassilis Christophides

Abstract: Big Geo Data represents an important type of the crowd sourced data that are available today at a global scale. This kind of data refers to locations, i.e., Points of Interest (POIs), and is usually published in social media (e.g., Facebook, Google+) or in specialized platforms (e.g., Open Street Maps, Yelp). The quality (e.g., precision, accuracy, consistency) of geo-referenced crowd sourced content depends on the origin (machine vs. human generated), the level of detail of the extraction methods, as well as the obfuscation techniques used to protect users privacy. There is clearly a tradeoff between enhancing the quality of published geo data and the privacy risks entailed for the individuals, also known as geoprivacy, to uncover places visited, trajectories pursuit etc. Understanding the different aspects of geographic/geometric/geospatial quality involved in crowd-sourced geo data and assessing the privacy risks introduced by enhancing its quality in personal, social, and urban applications is a challenging topic. In this project we are interested in studying the following questions in concrete use-cases:

- How can we measure the quality of geographic/geometric/geospatial data involved in crowd-sourced content?

- How can we assess the privacy risks introduced by enhancing geospatial quality in personal, social and urban applications especially in the context of social media platforms?

In this project Inria (MUSE) is interested in the opportunities and privacy concerns of mobile location analytics supporting customers or travellers experience in venues of various types and sizes (e.g., retail stores, shopping malls, airports, theme parks, etc.). Such (indoor) location-based services in smart spaces presents new privacy risks as data continuously flows between visitors mobile devices, networked sensors embedded into the environment as well as the backend analytics platform in order to track users and anticipate their needs.

7.2. European Initiatives

7.2.1. FP7 & H2020 Projects

7.2.1.1. 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/

7.3. International Initiatives

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

- BetterNet (Inria Project Lab): An observatory to measure and Improve Internet Service Access from User Experience. Project Coordinator: Isabelle Chrisment, Partners: Inria teams Spirals, Diana, Muse, Dionysos and Madynes, Inria Chile

BetterNet intends to build and deliver a scientific and technical collaborative observatory to measure and improve the Internet service access as perceived by users. We will propose new original user-centered measurement methods, which will associate social sciences to better understand Internet usage and the quality of services and networks. Our observatory can be defined as a vantage point, where:

- tools, models and algorithms/heuristics will be provided to collect data,
- acquired data will be analyzed, and shared appropriately with scientists, stakeholders and civil society, and
- new value-added services will be proposed to end-users.

This project will also allow Inria to become a key reference in the digital field, not only for scientist researchers but also for policy makers, rulers, and, for citizens in general, by giving them a more accurate and reliable basis for decisions making at an individual scale (privacy strategies) or at a collective scale (legal norms). An originality of our proposal is to ensure that researchers from different disciplines (exact sciences, applied sciences and social sciences) will collaborate in the design of this observatory, in the dissemination of results for the research community, executives and public at large.

7.3.2. Inria International Partners

7.3.2.1. 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.

7.4. International Research Visitors

7.4.1. Internships

- Arash Molavi Kakhki, Ph.D Student, Northeastern University, from Nov 2016
- Julio Adriazola Soto, M2 Student, Inria Chile, from Jan 2016 until Mar 2016
- Michele Pittoni, M2 Student, Univ. Paris VI, from Feb 2016 until Jul 2016
- Adhir Chakravarti, M2 Student, Univ. Paris VI, from Feb 2016 until Jul 2016
- Zied Ben Houidi Bell Labs (Alcatel), from Apr 2016

RAP Project-Team

6. Partnerships and Cooperations

6.1. International Research Visitors

6.1.1. Visits of International Scientists

- Louigi Addario-Berri (McGill)
- Gabor Lugosi (ICREA and Pompeu Fabra)
- Christina Goldschmidt (Oxford)
- Hui He (Beijing Normal University)
- Elie de Panafieu (Bell Labs France)
- Minmin Wang (Buenos Aires)
- Neil Walton (UK)

6.1.1.1. Internships

- Thanhh-Huy, Nguyen, M1 student at Polytechnique (Avril-July 2016). Internship on"Resource allocation in vehicle-sharing systems".

6.1.2. 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.
- *Philippe Robert* (17-27 April 2016) and *Wen Sun* (25-29 April 2016) have visited the Department of Applied Mathematics at Brown University.

<p align="center" style="color:red">SOCRATE Project-Team</p>

8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. Equipex FIT- Future Internet of Things

The FIT projet is a national equipex (*equipement d'excellence*), headed by the Lip6 laboratory. As a member of Inria, Socrate is in charge of the development of an Experimental Cognitive Radio platform that is used as test-bed for SDR terminals and cognitive radio experiments. This has been operational since 2014 and is maintained for a duration of 7 years. To give a quick view, the user will have a way to configure and program through Internet several SDR platforms (MIMO, SISO, and baseband processing nodes).

8.1.2. ANR - MetalibM

The goal of the Metalibm - "Automatic Generation of Function and Filters" (2014-2017, 200 keuros) project is to provide a tool for the automatic implementation of mathematical (libm) functions. A function f is automatically transformed into machine-proven C code implementing an polynomial approximation in a given domain with given accuracy. This project is led by Inria, with researchers from Socrate and AriC; PEQUAN team of Laboratoire d'Informatique de Paris 6 (LIP6) at Université Pierre et Marie Curie, Paris; DALI team from Université de Perpignan Via Domitia and Laboratoire d'Informatique, Robotique et Microélectronique de Montpellier (LIRMM); and SFT group from Centre Européen de Recherche Nucléaire (CERN).

8.1.3. FUI SMACS

The SMACS projet - "SMart And Connected Sensors" (2013-2016, 267 keuros) targets the deployement of an innovating wireless sensor network dedicated to many domains sport, health and digital cities. The projet involves Socrate (Insavalor), HIKOB and wireless broadcasting company Euro Media France. The main goal is to develop a robust technologie enabling real-time localization of mobile targets (like cyclist for instance), at a low energy (more generaly low cost). The technology will be demonstrated at real cycling races (Tour de France 2013 and 2014). One of the goal is to include localisation information with new radio technology. Another subject of study is distributed wireless consensus algorithms for maintaining a neighborhood knowledge with a low energy budget that scales (more than 200 cycles together)

8.1.4. ADT Sytare

The SYTARE project (Développement d'un SYsTème embArqué faible consommation à mémoiRE persistante - ADT Inria 2015-2017) aims to develop and study novel operating system mechanisms for NVRAM-based embedded systems. The term NVRAM collectively describes an emerging generation of memory technologies which are both non-volatile and byte-addressable. These two properties together make the classical RAM+ROM memory architecture obsolete, and enable the design of embedded systems running on intermittent power. This is very attractive in the context of energy-constrained scenarios, for instance systems harvesting their power from the environment. But working with NVRAM also poses novel challenges in terms of software programming. For instance, application state consistency must be guaranteed accross reboots, even though the system includes both NVRAM and volatile elements (e.g. CPU, hardware peripherals). The SYTARE project is funded by Inria via the ADT program.

8.1.5. ADT CorteXlab

The Socrate project-team is in charge of the FIT/CorteXlab platform (section 5.6). This platform (ADT Inria 2015-2017) makes use of many complex technologies from signal processing to computer science through micro-electornics and FPGA. The objectiv of the CorteXlab ADT is to maintain a support to the user of the FPGA-based platform of CorteXlab and to provide tutorial and running experiment that will help them in builing experimentation using the PicoSDR machines.

8.1.6. Taiwan III

In the context of the MoU signed between Inria and The National Science Council of Taiwan. Taiwan's Institute for Information Industry (III) and Socrate signed a one-year contract on 5G M2M (2015-2016) for a research proposal containing two items: a first to study the OFDMA-based RACH access from theoretical or mathematical models and a second to set up an experiment in CorteXlab that will emulate a given number of M2M device using a narrow band radio protocol and record the resulting radio environment.

8.1.7. ANR - Ephyl

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

8.1.8. ANR - Arburst

In this project Arburst - "Acheivable region of bursty wireless networks" (2016-2020, 195 KEuros), we propose an original approach complementary to other existing projects. Instead of proposing one specific technical solution, our objective is to define a unified theoretical framework devoted to the study of IoT networks fundamental limits. We aim at establishing the fundamental limits for a decentralized system in a bursty regime which includes short packets of information and impulsive interference regime. We are targeting the fundamental limits, their mathematical expression (according to the usual information theory framework capturing the capacity region by establishing a converse and achievability theorems). We will use the recent results relative to finite block-length information theory and we will evaluate the margin for improvement between existing approaches and these limits and we will identify the scientific breakthrough that may bring significant improvements for IoT/M2M communications. This project will contribute to draw the roadmap for the development of IoT/M2M networks and will constitute a unified framework to compare existing techniques, and to identify the breakthrough concepts that may afford the industry the leverage to deploy IoT/M2M technical solutions.

8.2. European Initiatives

8.2.1. FP7 & H2020 Projects

8.2.1.1. CYBERNETS

> Title: Cybernetic Communication Networks: Fundamental Limits and Engineering Challenges
>
> Programm: H2020
>
> Duration: June 2015 - June 2017
>
> Coordinator: Inria
>
> Inria contact: Samir M. Perlaza
>
> This Reintegration Panel proposal, CYBERNETS, focuses on the study of Cybernetic Communication Networks (CCN). CCNs are wireless networks that are context-aware, possess learning capabilities and artificial intelligence to guarantee reliability, efficiency and resilience to changes, failures or attacks via autonomous, self-configuring and self-healing individual and network behavior. Typical examples of CCNs are beyond-5G cellular systems and critical communication systems, e.g., law enforcement, disaster relief, body- area, medical instruments, space, and indoor/outdoor commercial applications. A practical implementation of a CCN requires extending classical communication systems to embrace the dynamics of fully decentralized systems whose components might exhibit either cooperative, non-cooperative or even malicious behaviors to improve individual and/or global performance. In this context, CYBERNETS aims to develop a relevant understanding of the interactions

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

8.2.1.2. COM-MED

Title: COMMunication systems with renewable Energy micro-griD

Programm: H2020

Duration: October 2016 - October 2019

Coordinator: Inria

Inria contact: Samir M. Perlaza

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

8.3. International Initiatives

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

8.3.1.1. CoWIN

Title: Cognitive Wireless Networks from Theory to Implementation

International Partner: Princeton University, School of Engineering and Applied Science. Princeton N.J. USA. Prof. H. Vincent Poor

Start year: 2015

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

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

8.3.1.2. Informal International Partners

Socrate has strong collaborations with several international partners.

- **Princeton University**, School of Applied Science, Department of Electrical Engineering, NJ. USA. This cooperation with Prof. H. Vincent Poor is on topics related to decentralized wireless networks. Samir M. Perlaza has been appointed as Visiting Research Collaborator at the EE Department for the academic period 2016-2017. Scientific-Leaders at Inria: Samir M. Perlaza and Jean-Marie Gorce.

- **Technical University of Berlin**, Dept. of Electrical Engineering and Computer Science, Germany. This cooperation with Prof. Rafael Schaffer is on secrecy and covert communications. Scientific-Leaders at Inria: Samir M. Perlaza.

- **National University Singapore (NUS)**, Department of Electrical and Computer Engineering, Singapore. This collaboration with Prof. Vincent Y. F. Tan is on the study of finite block-length transmissions in multi-user channels and the derivation of asymptotic capacity results with non-vanishing error probabilities. Scientific-Leaders at Inria: Samir M. Perlaza

- **University of Sheffield**, Department of Automatic Control and Systems Engineering, Sheffield, UK. This cooperation with Prof. Inaki Esnaola is on topics related to information-driven energy systems and multi-user information theory. Scientific-in-charge at Inria: Samir M. Perlaza.

- **Rutgers University**, Winlab, Orbit testbed. This cooperation with Ivan Seskar is related to experimental wireless testbed. Orbit has been one of the first wireless testbeds of its type. Tanguy Risset and Leonardo Sampaio-Cardoso have visited Winlab and I. Seskar visited the Socrate team for one week. Their collaboration is on the development of tools to ease experiment handling on wireless testbeds: visualisation, synchronization etc. Scientific-Leader at Inria: Tanguy Risset

- **University of Arizona**, Department of Electrical and Computer Engineering, Tucson, AZ, USA. This cooperation with Prof. Ravi Tandon is on topics related to channel-output feedback in wireless networks. Scientific-Leader at Inria: Samir M. Perlaza.

- **University of Cyprus**, Department of Electrical and Computer Engineering, University of Cyprus, Nicosia, Cyprus. This cooperation with Prof. Ioannis Krikidis is on topics related to energy-harvesting and wireless communications systems. Scientific-Leaders at Inria: Guillaume Villemaud and Samir M. Perlaza.

- **Universidade Federal do Ceará**, GTEL, Departamento de Teleinformática, Fortaleza, Brazil. This recently started cooperation with Prof. Tarcisio Ferreira Maciel is on topics related to the optimization of radio ressources for massive MIMO in 5G and 5G-like wireless communications systems. Scientific-in-charge at Inria: Leonardo Sampaio-Cardoso.

- **Universidad Nacional del Sur**, LaPSyC laboratory, Bahía Blanca , Argentina. This cooperation with Prof. Juan Cousseau is on topics related to Full-Duplex communications and Interference Alignment. Scientific-in-charge at Inria: Guillaume Villemaud.

- **Bell Labs New Jersey, USA**, This cooperation with Prof. Antonia Tulino (affiliated to Bell Labs and to University of Napoli, Italy) is on caching in wireless networks. The objective is to demonstrate the efficiency of caching at the edge of wireless networks through experimentations on CorteXlab. This work will be published in 2017 in a special issue of IEEE Communication magazine (Yasser

Fadlallah, Antonia M. Tulino, Dario Barone, Giuseppe Vettigli, Jaime Llorca and Jean-Marie Gorce: Coding for caching in 5G networks, IEEE Communication Magazine, 2017, accepted for publication). Scientific leader at Inria : Jean-Marie Gorce.

8.4. International Research Visitors

8.4.1. Visits of International Scientists

Dr. Martin Kumm, from University of Kassel, spent one week at CITI to work on FPGA arithmetic.

8.4.2. Short-Term Visits to International Teams

- Samir M. Perlaza was visiting the Department of Automatic Control and Systems Engineering at the University of Sheffield, UK, hosted by Prof. Iñaki Esnaola.
- Samir M. Perlaza and David Kibloff were visiting the Department of Telecommunication Systems at the Technical University of Berlin, Germany, hosted by Prof. Rafael Schaefer.
- Selma Belhadj Amor was visiting the Center for Wireless Communication and Signal Processing Research (CWCSPR), ECE Department, New Jersey Institute of Technology (NJIT), USA, hosted by Prof. Osvaldo Simeone.
- Florin Hutu was visiting the Department of Electrical and Electronics Engineering", University of Buea, Cameroun, hosted by Pr. Emmanuel Tanyi.
- Lionel Morel was visiting the SCI-STI-MM Multimedia Group at École Polytechnique Fédérale de Lausanne, hosted by Dr Marco Mattavelli.

8.4.2.1. Research Stays Abroad

- Selma Belhadj Amor was hosted by the Electrical Engineering Department at Princeton University, New Jersey, USA, as a Visiting Scholar. Host: Prof. H. Vincent Poor.
- Selma Belhadj Amor hosted by the Electrical and Computer Engineering Department at the National University Of Singapore (NUS), Singapore. Host: Prof. Vincent F. Y. Tan.

9. Partnerships and Cooperations

9.1. Regional Initiatives

- BQR INSA CROME 12/2013-12/2016
  Participants: Fabrice Valois
  The partners in this project are the CITI DynaMid team and LIRIS. The project studies the coordination of a fleet of mobile robots for the multi-view analysis of complex scenes.

- Labex IMU Priva'Mov 10/2013-10/2016
  Participants: Stéphane D'Alu, Hervé Rivano, Razvan Stanica
  The partners in this project are DRIM LIRIS, Inria Privatics, INSA EVS, and LET ENTPE. The aim of this project is to develop and deploy a crowdsensing platform to collect mobility traces from a sample of real users equipped with android devices, while carrying research on privacy preservation issues. Our contribution consists on developing the platform and using the collected data to analyze cellular network offloading strategies.

- Labex IMU UrPolSens 10/2015-10/2018
  Participants: Ahmed Boubrima, Leo Le Taro, Walid Bechkit, Hervé Rivano
  The partners in this project are Ifsttar, LMFA, EVS, TUBA, and Air Rhone-Alpes, with Inria Urbanet leading the project. UrPolSens deals with the monitoring of air pollution using low-cost sensors interconnected by a wireless networks. Although they are less accurate than the high-end sensors used today, low-cost autonomous air quality sensors allow to achieve a denser spatial granularity and, hopefully, a better monitoring of air pollution. The main objectives of this project are to improve the modeling of air pollution dispersion; propose efficient models to optimize the deployment the sensors while considering the pollution dispersion and the impact of urban environment on communications; deploy a small-scale network for pollution monitoring as a proof of concept; compare the measured and estimated levels of exposure; study the spatial disparities in exposure between urban areas.

- Capt-PolAir 01/2016-12/2016
  PEPS project CNRS and Université de Lyon
  Participants: Ahmed Boubrima, Leo Le Taro, Walid Bechkit, Hervé Rivano
  The partners in this project are Ifsttar, LMFA, EVS, and TUBA, with Inria Urbanet leading the project. This project deals with the practical issues of the low cost wireless sensor deployment for air pollution monitoring. This projet complete the experimental part of UrPolSens.

- ARC6 "Robot fleet mobility under communication constraints" 10/2016-09/2019
  Participants: Fabrice Valois
  This work is a joint project with the Inria Chroma research group. Considering a fleet of drones moving in a 3D area, looking for a given target, we focus on how to maintain the wireless connectivity of the network of drones while the drones patroll autonomously.The other partners in this project are University of Grenoble and Viameca.

9.2. National Initiatives

9.2.1. ANR

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

9.2.2. DGA

- DGA CLOTHO 10/2016-03/2018.
  Particpants: Junaid Khan, Romain Pujol, Razvan Stanica, Fabrice Valois
  The partners in the DGA CLOTHO project are Traqueur and Sigfox. The objective of the project is to reduce the energy consumption of the device tracking functionality, by taking profit of short-range communications between the tracked objects.

9.2.3. PIA

- PIA ADAGE 07/2016-06/2018.
  Particpants: Razvan Stanica
  The partners in the PIA ADAGE project are Orange, LAAS-CNRS and Inria Privatics. The objective of the ADAGE project is to design and evaluate anonymization algorithms for the specific case of mobile traffic data. Our role in the project is focused on evaluating whether the anonymized data is still usable for adaptive networking mechanisms.

9.2.4. Pôle ResCom

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

9.2.5. EquipEx

- SenseCity
  We have coordinated the participation of several Inria teams to the SenseCity EquipEx. Within the SenseCity project, several small reproduction of 1/3rd scale city surroundings will be built under a climatically controlled environment. Micro and nano sensors will be deployed to experiment on smart cities scenarios, with a particular focus on pollution detection and intelligent transport services. Urbanet will have the opportunity to tests some of its capillary networking solutions in a very realistic but controlled urban environment. A proof of concept test site has been built in 2015. We have deployed an experiment on low cost sensor network for vehicle detection and one on atmospheric pollution sensor calibration. The operational site is under construction and should be finalized in 2017.

9.2.6. Inria Project lab

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

9.3. International Initiatives

9.3.1. Inria International Partners

9.3.1.1. Informal International Partners

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

9.4. International Research Visitors

9.4.1. Visits of International Scientists

- Catherine Rosenberg, Professor, University of Waterloo, Canada: invited professor at INSA Lyon (Spring semester, 2016).
- Michele Noguiera, Professor, University of Parana, Brazil : visiting professor (one week, February 2016).
- Wei Wennie Shu, Professor, University of New Mexico, USA : visiting professor (one month, December 2016).
- Min-You Wy, Professor, University of Shanghai Jiao Tong, China : visiting professor (one month, December 2016).

9.4.2. Visits to International Teams

9.4.2.1. Research Stays Abroad

- Alexis Duque visited the group of Dr. Domenico Giustinano, at IMDEA Networks, Madrid, Spain (one week, Nov. 2016).
- Alexis Duque visited the group of Prof. Josep Paradells Aspas, at Universitat Politecnica de Catalunya, Barcelona, Spain (one week, Nov. 2016).