
RESEARCH CENTER

FIELD
**Networks, Systems and Services, Distributed Computing**

Activity Report 2018

# Section Contracts and Grants with Industry

Edition: 2019-03-07

**Coast Project-Team**

# 7. Bilateral Contracts and Grants with Industry

## 7.1. Bilateral Contracts with Industry

### *7.1.1. Contrat Open Group 2017-2020*

**Participants:** Claudia-Lavinia Ignat, François Charoy [contact], Gérald Oster, Olivier Perrin, Anis Ahmed Nacer.

The objective of the project is to propose and validate a model of service composition for middleware services for software as a service architecture. The composition must take into account middleware service quality attributes and service plan in order to optimise the operational cost while ensuring a level of quality of service.

**CTRL-A Project-Team**

# 7. Bilateral Contracts and Grants with Industry

## 7.1. Bilateral Contracts with Industry

Our cooperation with CEA (an EPIC, industrial and commercial public institution) concerns the LETI/LIST DACLE laboratory at Grenoble Minatec; it is bilateral, involving the CEA PhD grant of Adja Sylla (finished end of january 2018), to work with F. Pacull and M. Louvel on high-level programming on top of a rule-based middleware (See Sections 6.1.3 and 6.2.2.1 ).

## 7.2. Bilateral Grants with Industry

### *7.2.1. Orange*

We have a cooperation with Orange labs, around a CIFRE PhD grant, on the topic of autonomic device management (see Section 6.2.2.2 ). This activity is part of the Inria/Orange joint laboratory.

### *7.2.2. Nokia / Bell labs*

We are starting a research action with Nokia / Bell labs, around a post-doctorate, co-advised with project-team Dyonisos at Inria Rennes, on the topic of the integration of FPGA-based accelerators in network nodes, and their reconfiguration management in coordination with higher level Software Defined Networks management. This activity is part of the Inria/ Nokia / Bell labs joint laboratory, and is in cooperation with the Dyonisos EPI at Inria Rennes Bretagne Atlantique (Yassine Hadjhadj), and the post-doctorate topic of Quang Pham Tran Anh.

**DELYS Team**

# 6. Bilateral Contracts and Grants with Industry

## 6.1. Bilateral Contracts with Industry

DELYS has a CIFRE contract with Scality SA:

- Dimitrios Vasilas is advised by Marc Shapiro and Brad King. He works on secondary indexing in large-scale storage systems under weak consistency.

DELYS has two CIFRE contracts with Magency SA:

- Damien Carver is advised by Julien Sopena and Sébatien Monnet. He works on designing kernel-level mechanisms that automatically give more memory to the most active containers.
- Lyes Hamidouche is advised by Pierre Sens and Sébatien Monnet. He works on efficient data dissemination among a large number of mobile devices. He defended his thesis in April 2018.

DELYS has two contracts with Orange within the I/O Lab joint laboratory:

- Guillaume Fraysse is advised by Jonathan Lejeune, Julien Sopena, and Pierre Sens. He works on distributed resources allocation in virtual network environments.
- Jonathan Sid-Otmane is advised by Marc Shapiro. He studies the applications of distributed databases to the needs of the telco industry in the context of 5G.

**MIMOVE Project-Team**

# 8. Bilateral Contracts and Grants with Industry

## 8.1. Bilateral Grants with Industry

"Application Performance Bottleneck Detection", Comcast Gift to R. Teixeira 2018.

**MYRIADS Project-Team**

# 8. Bilateral Contracts and Grants with Industry

## 8.1. Bilateral Grants with Industry

### *8.1.1. Thales Research and Technology (2016-2018)*

**Participants:** Baptiste Goupille-Lescar, Christine Morin, Nikos Parlavantzas.

Our collaboration with Thales Research and Technology focuses on the development of distributed Cyber-Physical Systems, such as those developed by Thales to monitor and react to changing physical environments. These systems need to be highly adaptable in order to cope with the dynamism and diversity of their operating environments. Notably, they require distributed, parallel architectures that support dynamic sets of applications, not known in advance, while providing strong QoS guarantees. The objective of this collaboration is to explore adaptive resource management mechanisms for such systems that can adapt to changes in the requirements and in the availability of resources. This contract funds Baptiste Goupille-Lescar's PhD grant.

**SPIRALS Project-Team**

# 8. Bilateral Contracts and Grants with Industry

## 8.1. ip-label

**Participant:** Romain Rouvoy [correspondant].

A software exploitation license of the APISENSE® crowd-sensing platform has been sold to the ip-label company. They use this platform as a solution to monitor the quality of the GSM signal in the wild. The objective is to provide developers and stakeholders with a feedback on the quality of experience of GSM connection depending on their location.

## 8.2. Scalair

**Participants:** Yahya Al-Dhuraibi, Philippe Merle [correspondant].

This collaboration (2015–18) aims at proposing a framework to deal with elasticity in cloud computing environments. This framework must cover all kinds of resources, IaaS, PaaS, SaaS, must provide a solution for interoperability between different clouds and virtualization technologies, and must enable the specification and composition of reactive and predictive strategies.

This collaboration is conducted in the context of the PhD thesis of Yahya Al-Dhuraibi defended in December 2018.

## 8.3. Davidson

**Participants:** Romain Rouvoy [correspondant], Lionel Seinturier.

This collaboration (2017–20) aims at proposing new solutions for optimizing the energy footprint of ICT software infrastructures. We want to be able to measure and assess the energy footprint of ICT systems while preserving various quality of service parameters, such as performance and security. We aim at proposing a testbed for assessing the energy footprint of various programming languages. This testbed will also incorporate frameworks for web and mobile programming. Finally, we want to be able to issue recommendations to developers in order to assist them in improving the energy footprint of their programs. This collaboration will take advantage of the POWERAPI software library.

The PhD of Mohammed Chakib Belgaid takes place in the context of this collaboration.

## 8.4. Orange Labs #1

**Participants:** Philippe Merle [correspondant], Lionel Seinturier.

This collaboration (2017–18) aims at defining a computational model for software infrastructures layered on top of virtualized and interconnected cloud resources. This computational model will provide application programming and management facilities to distributed applications and services. This computational model will define a pivot model that will enable the interoperability of various existing and future standards for cloud systems such as OCCI and TOSCA. This pivot model will be defined with the Alloy specification language [54]. This collaboration takes advantage of the expertise that we are developing since several years on reconfigurable component-based software systems [66], on cloud systems [60], and on the Alloy specification language [58].

This collaboration with Orange Labs is a joint project with Jean-Bernard Stefani from the Spades Inria project-team.

## 8.5. Orange Labs #2

**Participants:** Zakaria Ournani, Romain Rouvoy [correspondant], Lionel Seinturier.

This collaboration (2018–21) aims at proposing new solutions for modeling the energy efficiency of software systems and to design and implement new methods for measuring and reducing the energy consumption of software systems at development time. We especially target software systems deployed on cloud environments.

The CIFRE PhD of Zakaria Ournani takes place in the context of this collaboration.

## 8.6. Amaris

**Participants:** Sacha Brisset, Romain Rouvoy [correspondant], Lionel Seinturier.

This collaboration (2018–21) aims at proposing new solutions for automatically spotting and fixing recurrent user experience issues in web applications. We are interested in developing an autonomic framework that learns and classifies the behaviors and figures out causality links between data such as web GUI events, support tickets and user feedback, source version management events (e.g. recent commits). The ultimate objective is to implement an AI-powered recommendation system to guide the maintenance and even to automatically predict and solve user issues.

The CIFRE PhD of Sacha Brisset takes place in the context of this collaboration.

**WHISPER Project-Team**

# 8. Bilateral Contracts and Grants with Industry

## 8.1. Bilateral Contracts with Industry

- Orange Labs, 2016-2018, 120 000 euros. The purpose of this contract is to apply the techniques developed in the context of the PhD of Antoine Blin to the domain of Software Defined Networks where network functions are run using virtual machines on commodity multicore machines.
- Thales Research, 2016-2018, 45 000 euros. The purpose of this contract is to enable the usage of multicore architectures in avionics systems. The PhD of Cédric Courtaud is supported by a CIFRE fellowship as part of this contract.

## 8.2. Bilateral Grants with Industry

- Oracle, 2018-2019, 100 000 dollars. Operating system schedulers are often a performance bottleneck on multicore architectures because in order to scale, schedulers cannot make optimal decisions and instead have to rely on heuristics. Detecting that performance degradation comes from the scheduler level is extremely difficult because the issue has not been recognized until recently, and with traditional profilers, both the application and the scheduler affect the monitored metrics in the same way.

  The first objective of this project is to produce a profiler that makes it possible to find out whether a bottleneck during application runtime is caused by the application itself, by suboptimal OS scheduler behavior, or by a combination of the two. It will require understanding, analyzing and classifying performance bottlenecks that are caused by schedulers, and devising ways to detect them and to provide enough information for the user to understand the root cause of the issue. Following this, the second objective of this project is to use the profiler to better understand which kinds of workloads suffer from poor scheduling, and to propose new algorithms, heuristics and/or a new scheduler design that will improve the situation. Finally, the third contribution will be a methodology that makes it possible to track scheduling bottlenecks in a specific workload using the profiler, to understand them, and to fix them either at the application or at the scheduler level. We believe that the combination of these three contributions will make it possible to fully harness the power of multicore architectures for any workload.

**WIDE Project-Team**

# 7. Bilateral Contracts and Grants with Industry

## 7.1. Bilateral Contracts with Industry

### *7.1.1. CIFRE Technicolor: Distributed troubleshooting of edge-compute functions (2018-2021)*

**Participant:** François Taïani.

This project seeks to explore how recent generations of end-user gateways (or more generally end-user devices) could implement an edge-compute paradigm powered by user-side micro-services. Our vision is that the devices distributed among the homes of end-users will expose (as a service) their computing power and their ability to quickly deploy compute functions in an execution environment. In order for service and application providers to actually use the system and deploy applications, the system must however ensure an appropriate level of reliability, while simultaneously requiring a very low level of maintenance in order to address the typical size and economics of gateway deployments (at least a few tens of million units). Providing a good level of reliability in such a large system at a reasonable cost is unfortunately difficult. To address this challenge, we aim in this thesis to exploit the *natural distribution* of such large-scale user-side device deployments to quickly pinpoint problems and troubleshoot applications experiencing performance degradations.

## 7.2. Bilateral Grants with Industry

### *7.2.1. Google Focussed Grant Web Alter Ego (2013-2018)*

**Participants:** George Giakkoupis, François Taïani.

This project addresses the problem of extracting the alter-egos of a Web user, namely profiles of like-minded users who share similar interests, across various Internet applications. The project, in collaboration with the team of Rachid Guerraoui at EPFL, runs until August 2018 and funds the PhD of Olivier Ruas, who is co-supervised by François Taïani and Anne-Marie Kermarrec.

**ALPINES Project-Team**

# 8. Bilateral Contracts and Grants with Industry

## 8.1. Bilateral Contracts with Industry

- Contract with Total, February 2015 - August 2018, that funds the PhD thesis of Hussam Al Daas on enlarged Krylov subspace methods for oil reservoir and seismic imaging applications. Supervisor L. Grigori.
- Contract with IFPen, February 2016 - April 2019, that funds the Phd thesis of Zakariae Jorti on adaptive preconditioners using a posteriori error estimators. Supervisor L. Grigori.
- Contract with IFPen, October 2016 - October 2019, that funds the Phd thesis of Julien Coulet on the virtual element method (VEM). Supervisor F. Nataf and V. Girault.
- Contract with Total, February - September 2018, that funded an internship on Helmholtz domain decomposition solvers for multiple right hand sides. Supervisor F. Nataf.

**AVALON Project-Team**

# 8. Bilateral Contracts and Grants with Industry

## 8.1. Bilateral Contracts with Industry

### *8.1.1. IFPEN*

We have a collaboration with IFPEN (http://ifpenergiesnouvelles.com/). IFPEN develops numerical codes to solve PDE with specific adaption of the preconditioning step to fit the requirement of their problems. With a PhD student (Adrien Roussel) we have studied the parallel implementation of multi-level decomposition domains on many-core architecture and KNL processor.

### *8.1.2. Nokia Bell Labs*

AVALON has been actively collaborating with Nokia, formerly Alcatel-Lucent Bell Labs, in the framework of the Nokia/Alcatel-Lucent Inria Joint Laboratory. We was involved in the following Research Actions (Actions de Recherche (ADR) in French) of this laboratory. ADR Nokia Bell Labs /Inria: Procedural Generation of Networks for Security Research & Experimentations. The objective of this project is to address such challenge. We aim at devising a new way where researchers can communicate in a comprehensive and accurate way the experimentation set-up used in their work. The main objective would be to research and develop the procedural generation of credible network topologies and test beds resembling real operational infrastructures of various kinds (e.g. classical ICT, virtualized Cloud or SDN based, SCADA infrastructures etc.), as a method of creating data algorithmically as opposed to manually. This work is done with a postdoc position: Cyril Seguin.

## 8.2. Bilateral Grants with Industry

### *8.2.1. Orange*

We have a collaboration with Orange. This collaboration is sealed through a CIFRE Phd grant. The research of the Phd student (Arthur Chevalier) focuses on placement and compliance aspects of software licenses in a Cloud architecture. Today, the use of software is regulated by licenses, whether they are free, paid for and with or without access to its sources. The number of licenses required for specific software can be calculated with several metrics, each defined by the software vendor. Our goal is to propose a deployment algorithm that takes into account different metrics.

**DATAMOVE Project-Team**

# 7. Bilateral Contracts and Grants with Industry

## 7.1. Bilateral Contracts with Industry

- **BULL-ATOS SE (2016-2019)**. Two PhD grants (Michael Mercier and Adrien Faure). Job and resource management algorithms.
- **CEA DAM (2016-2018)**. PhD grant support contract (PhD of Estelle Dirand, funded by CEA). In situ analysis for Molecular Simulations.

**HIEPACS Project-Team (section vide)**

**KERDATA Project-Team**

# 6. Bilateral Contracts and Grants with Industry

## 6.1. Bilateral Contracts with Industry

### *6.1.1. Total: In situ Visualization with Damaris (2017-2018)*

**Participants:** Hadi Salimi, Matthieu Dorier, Gabriel Antoniu, Luc Bougé.

The goal of this expertise contract is to 1) disseminate the usage of Damaris for engineers at Total; 2) to realize a feasibility study for the usage of Damaris for in situ analysis of data for Total's HPC reservoir simulations.

### *6.1.2. Huawei: HIRP Low-Latency Storage for Stream Data (2017–2018)*

**Participants:** Alexandru Costan, Ovidiu-Cristian Marcu, Gabriel Antoniu.

The goal of this project is to explore the plausible paths towards a dedicated storage solution for low-latency stream storage. Such a solution should provide on the one hand traditional storage functionality and on the other hand stream-like performance (i.e., low-latency I/O access to items and ranges of items).

We have investigated the main requirements and challenges, evaluated the different design choices (e.g., a standalone component vs. an extension of an existing Big Data solution like HDFS) and proposed a new converged architecture for smart storage.

**POLARIS Project-Team**

# 8. Bilateral Contracts and Grants with Industry

## 8.1. Bilateral Contracts with Industry

- Bilateral contrat with Enedis (Linky-Lab), Post-doctoral position for 18th months (Mouhcine Mendil).
- ULTRON, bilateral contract with Huawei over 18 months, supporting two postdoctoral researchers, Amélie Heliou and Luigi Vigneri.
- Inria/Orange Labs Laboratory. Polaris is involved in this partnership with Orange Labs by supervising two PhD students in the context of this common laboratory.
- Cifre contract with Schneider Electric. The PhD thesis of Benoit Vinot (supervised by Nicolas Gast and Florent Cadoux (G2Elab)) is supported by this collaboration.

**ROMA Project-Team**

# 8. Bilateral Contracts and Grants with Industry

## 8.1. Bilateral Contracts with Industry

- In 2018, in the context of the MUMPS consortium (http://mumps-consortium.org), we worked in close collaboration with Toulouse INP to:
  - sign or renew membership contracts with AIRBUS, FFT-MSC, and SHELL, on top of the ongoing contracts with EDF, ALTAIR, Michelin, LSTC, Siemens, ESI Group, Total, SAFRAN, LBNL,
  - organize point-to-point meetings with several members,
  - provide technical support and scientific advice to members,
  - provide experimental releases to members in advance,
  - organize the fourth consortium committee meeting, at SAFRAN (Saclay).

  Three engineers have been funded by the membership fees in 2018, for software engineering and software development, performance study and tuning on modern architectures, business development, management of the consortium, and organization of the future of the consortium. Half a year of a PhD student was also funded by the membership fees (see Section 9.1 ). On top of their membership, an additional contract was finalized with Michelin to study a new functionality and understand how to best exploit MUMPS recent features in their computing environment.

# STORM Project-Team (section vide)

**TADAAM Project-Team**

# 8. Bilateral Contracts and Grants with Industry

## 8.1. Bilateral Grants with Industry

### *8.1.1. Intel*

INTEL granted $30k and provided information about future many-core platforms and memory architectures to ease the design and development of the HWLOC software with early support for next generation hardware.

### *8.1.2. Bull/Atos*

Bull/ATOS granted the CIFRE PhD thesis on Nicolas Denoyelle on advanced memory hierarchies and new topologies.

### *8.1.3. EDF*

With Yvan Fournier from EDF R&D we co-advise the PhD thesis of Benjamin Lorendeau under a CIFRE funding.

### *8.1.4. CEA*

CEA/DAM granted the CIFRE PhD thesis of Hugo Taboada on non-blocking MPI collectives.

DIVERSE Project-Team

# 7. Bilateral Contracts and Grants with Industry

## 7.1. Bilateral Contracts with Industry

### *7.1.1. ADR Nokia*

- Coordinator: Inria
- Dates: 2017-2021
- Abstract: The goal of this project is to integrate chaos engineering principles to IoT Services frameworks to improve the robustness of the software-defined network services using this approach, to explore the concept of equivalence for software-defined network services, and to propose an approach to constantly alter the attack surface of the network services.

### *7.1.2. BCOM*

- Coordinator: UR1
- Dates: 2018-2024
- Abstract: The purpose of the Falcon project is to investigate how to improve the resale of available resources in private clouds to third parties. In this context, the collaboration with DiverSE mainly aims to work on efficient techniques for the design of consumption models and resource consumption forecasting models. These models are then used as a knowledge base in a classical autonomous loop.

### *7.1.3. GLOSE*

- Partners: Inria/CNRS/Safran
- Dates: 2017-2021
- Abstract: The GLOSE project develops new techniques for heterogeneous modeling and simulation in the context of systems engineering. It aims to provide formal and operational tools and methods to formalize the behavioral semantics of the various modeling languages used at system-level. These semantics will be used to extract behavioral language interfaces supporting the definition of coordination patterns. These patterns, in turn, can systematically be used to drive the coordination of any model conforming to these languages. The project is structured according to the following tasks: concurrent xDSML engineering, coordination of discrete models, and coordination of discrete/continuous models. The project is funded in the context of the network DESIR, and supported by the GEMOC initiative.

### *7.1.4. OneShotSoftware*

- Partners: Inria/Orange
- Dates: 2017-2019
- Abstract: The OSS project investigates an extreme version of moving target defense where a slightly different version of the application is deployed each time it is used (e.g., for crypto functions or payment services). We investigate the analysis, synthesis and transformation techniques to support diversification at five locations of a software construction pipeline, which once combined yield up to billions of variants. We also evaluate the support of diversification as a first class property in DevOps.

### *7.1.5. Agileo*

- Partners: Inria/Agileo
- Dates: 2017-2018

- Abstract: In this project we mainly design a systematic mapping study on modeling for Industry 4.0 in order to share a common scientific roadmap.

### *7.1.6. Obeo*

- Partners: Inria/Obo
- Dates: 2017-2020
- Abstract: Web engineering for domain-specific modeling languages, Fabien Coulon's PhD Cifre project.

### *7.1.7. OKWind*

- Partners: UR1/OKWind
- Dates: 2017-2020
- Abstract: Models@runtime to improve self-consumption of renewable energies, Alexandre Rio's PhD Cifre project. .

### *7.1.8. Orange*

- Partners: UR1/Orange
- Dates: 2016-2019
- Abstract: Security level modelling of user interface, Youssou Ndiaye's PhD Cifre project. .

### *7.1.9. Keolis*

- Partners: UR1/Keolis
- Dates: 2018-2021
- Abstract: Urban mobility: machine learning for building simulators using large amounts of data, Gauthier LYAN's PhD Cifre project. .

### *7.1.10. FaberNovel*

- Partners: UR1/FaberNovel
- Dates: 2018-2021
- Abstract: Abstractions for linked data and the programmable web, Antoine Cheron's PhD Cifre project. .

**EASE Team**

# 7. Bilateral Contracts and Grants with Industry

## 7.1. Bilateral Contracts with Industry

**Project: SIMHet**

Partner: YoGoKo

Coordinator: JM. Bonnin

Starting: Nov 2015 - Ending: October 2018

Abstract: The SIMHet project is performed in partnership with YoGoKo, a start-up that develops innovative communication solutions for cooperative intelligent transport systems. The SIMHet project aims to develop a decision making mechanism that would be integrated in the ISO/ETSI ITS communication architecture. It will allow mobile devices or mobile routers to choose the best network interface for each embedded application/flow. For example, in a vehicular environment this mechanism could manage global (Internet) and local connections for each on board device/application, in order to ensure that applications and services are always best connected. Aware that "best" concept is context-dependent, such a decision making mechanism should take into account requirements from different actors (e.g., applications, user, network administrators) and contextual information. One of the difficulties is to take advantage of the knowledge the system could have about near future connectivity. In the vehicular context such information about the movement and the availability of network resources is available. If taking into account the future makes the decision making more complex, this could allow a better usage of network resources when they are available. Once current solutions in the market are based on very simple decisions (use WiFi if available and 3G elsewhere), this smart mechanism will give competitive advantage for YoGoKo over its competitors.

## 7.2. Bilateral Grants with Industry

**OKWIND**

Coordinator: Y. Maurel

Starting: April 2017 - Ending: April 2020

Abstract: OKWind [0] is a company specialized in local production of renewable energy. This project, with Inria DiverSE and EASE 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. This contract funds Alexandre Rio's PhD grant.

**Orange Labs**

Coordinator: JM. Bonnin

Starting: Jan 2016 - Ending: Jan 2019

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

Abstract: The objective of this thesis is to propose a new management architecture for optimizing the upstream bandwidth allocation in PON while acting only on manageable parameters to allow the involvement of self-decision elements into the network. To achieve this, classification techniques based on machine learning approaches are used to analyze the behavior of PON users and specify their upstream data transmission tendency. A dynamic adjustment of some SLA parameters is then performed to maximize the overall customers' satisfaction with the network. The proposed architecture comes with two major contributions. First, it can be directly and easily integrated in the PON management system without a need to modify the resources allocation mechanism itself in the equipment. Second, as it focuses only on manageable parameters, the proposed approach gives us the opportunity to apply the autonomic and cognitive paradigm in order to enrich the network with self-decision capabilities that leave the task of the dynamic reconfiguration of the SLA parameters to the network itself with the minimum of direct human intervention. This contract funds Nejm Frigui's PhD grant, co-supersized with Tayeb Lemlouma (IRISA OCIF team).

# FOCUS Project-Team (section vide)

**INDES Project-Team**

# 6. Bilateral Contracts and Grants with Industry

## 6.1. Bilateral Grants with Industry

The ANSWER project (Advanced aNd Secured Web Experience and seaRch) is lead by the QWANT search engine and the Inria Sophia Antipolis Méditerranée research center. This proposal is the winner of the "Grand Challenges du Numérique" (BPI) and aims to develop the new version of the search engine http://www.qwant.com with radical innovations in terms of search criteria, indexed content and privacy of users. The project started on January 1, 2018. In the context of this project, we got

- with Arnaud Legout from the DIANA project-team a funding for a 3 years Ph.D. student to work on Web tracking technologies and privacy protection. Imane Fouad was hired to work on this project.
- a funding for 18 months Postdoc to work on Web application security. Yoonseok Ko was hired to work on this project as a postdoc.

## PHOENIX-POST Team (section vide)

RMOD Project-Team

# 8. Bilateral Contracts and Grants with Industry

## 8.1. Bilateral Contracts with Industry

### *8.1.1. BlockChain*

Participants: Henrique Rocha, Marcus Denker, Stéphane Ducasse
From 2016, ongoing.

We started a new collaboration with a local startup (UTOCAT) about tools and languages in the context of Blockchain systems. The collaboration started with a 2 month exploration phase involving an engineer at Inria Tech. A postdoc started in 2017.

### *8.1.2. Pharo Consortium*

Participants: Esteban Lorenzano, Clément Béra, Marcus Denker, Stéphane Ducasse
From 2012, ongoing.

The Pharo Consortium was founded in 2012 and is growing constantly. By the end 2018, it has 32 company members, 17 academic partners. Inria supports the consortium with one full time engineer starting in 2011. In 2018, the Pharo Consortium joined InriaSoft.

More at http://consortium.pharo.org.

## 8.2. Bilateral Grants with Industry

### *8.2.1. Thales CIFRE*

Participants: Brice Govin, Anne Etien, Nicolas Anquetil, Stéphane Ducasse
From 2015, ongoing.

We are working on large industrial project rearchitecturization. PhD in progress: Brice Govin, *Support to implement a rejuvenated software architecture in legacy software*. CIFRE Thales started Jan 2015.

### *8.2.2. Remodularization of Architecture*

Participants: Nicolas Anquetil, Santiago Bragagnolo Stéphane Ducasse, Anne Etien, Benoît Verhaeghe
From 2017, ongoing.

We started a new collaboration with the software editor Berger Levrault about software architecture remodularization. The collaboration started with an end study project exploring the architecture used in the company in order to later migrate from GWT to Angular JS since GWT will not be backward supported anymore in the next versions. An internship and a PhD CIFRE thesis will start in 2018.

**STACK Team**

# 8. Bilateral Contracts and Grants with Industry

## 8.1. Bilateral Contracts with Industry

**Participants:** Adrien Lebre [Contact point], Ronan-Alexandre Cherrueau, Marie Delavergne, Alexandre Van Kempen.

During 2017, we agreed with Orange Labs (Lannion) to conduct a dedicated study on the evaluation of AMQP message bus alternatives within the OpenStack ecosystem. This bilateral contract ("Contrat de Recherche Externalisé") officially started in Sept 2017 for one year. With the allocated budget ( 100K), we hired a new research engineer, Alexandre Van Kempen. Alexandre Van Kempen works with Ronan-Alexandre Cherrueau (Temporary Resarch Engineer, hired in the context of the MERCURY InriHub) and Matthieu Simonin (Permanent Research Engineer from the Rennes Bretagne Atlantique Center) on conducting this analysis. In addition to extending the EnOS framework previously presented, they are performing several experiments with the support of the OpenStack open-source community (in particulat RedHat). The goal of the study is to identify major drawbacks of the default RabbitMQ solution with respect to the Fog/Edge requirements and evaluate whether some alternatives are available in the open-source ecosytem.

**AGORA Project-Team**

# 8. Bilateral Contracts and Grants with Industry

## 8.1. Bilateral Contracts with Industry

- We have contracted a first bilateral contract with Total (2018-2019) where we work with the laboratory LQA of Total on the design and the test of autonomous low cost air quality sensors. The Lora-based developed platform is currently deployed et evaluated by LQA.
- We have contracted bilateral cooperation with Rtone, an SME focusing on the connected objects area. This collaboration is associated with the CIFRE PhD grant for Alexis Duque, on the subject of Visible Light Communication.
- We have contracted bilateral cooperation with industrial and academic partners in the context of the PSPC Fed4PMR project (2015-2019). In this context, we are working on the design of new professional mobile radio solutions, compatible with 4G and 5G standards. This collaboration funds the PhD thesis of Jad Oueis, the PhD thesis of Romain Pujol, and a part of the PhD thesis of Abderrahman Ben Khalifa.

## 8.2. Bilateral Grants with Industry

- Common Laboratory Inria/Nokia Bell Labs - ADR Network Information Theory.
  Agora is part of the ADR Network Information Theory of the common laboratory Inria/Nokia Bell Labs.
- Spie - INSA Lyon IoT Chaire.
  Agora is involved in the SPIE INSA Lyon IoT Chaire, launched in November 2016. The IoT Chaire partially funds the PhD thesis of Abderrahman Ben Khalifa. The PhD thesis work of Alexis Duque and Amjed Belkhiri are also contributing in this structure.
- Volvo - INSA Lyon Chaire.
  Agora is involved in the Volvo Chaire at INSA Lyon, on the area of autonomous electrical distribution vehicle in urban environments. Razvan Stanica is a member in the steering committee of this structure.

# COATI Project-Team (section vide)

**DANTE Project-Team**

# 8. Bilateral Contracts and Grants with Industry

## 8.1. GranData

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

Founded in 2012, Grandata is a Palo Alto-based company that leverages advanced research in Human Dynamics (the application of « big data » to social relationships and human behaviour) to identify market trends and predict customer actions. Leading telecom and financial services firms are using Grandata's Social Universe product to transform « big data » into impressive business results.

The DANTE team and Grandata started to collaborate in 2014 on the analysis of large datasets provided by the company. The aim of the collaboration is to gain better understanding about the dynamical patterns of human interactions, mobility, and the socio-economic structure of the society. This collaboration was very successful over the years, leading to several publications within the PhD thesis of Yannick Leo. Currently the collaboration is supported by the MOTIF Stic-AmSud project (2018-2020) (coordinated by Márton Karsai) which allows to meet frequently with the company. Recent projects within this collaboration are focusing on socioeconomic inference using remote sensing techniques.

**DIANA Project-Team**

# 7. Bilateral Contracts and Grants with Industry

## 7.1. Bilateral Contracts with Industry

### *7.1.1. SAFRAN*

**Participants:** Damien Saucez.

We have a bilateral contract covering 2017 and 2018 with Safran Electrical and Power in order to build a network simulator specialised for aeronautical networks.

## 7.2. Bilateral Grants with Industry

### *7.2.1. QWANT*

**Participants:** Arnaud Legout.

The PIA ANSWER project is led by the QWANT search engine and the Inria Sophia Antipolis Méditerranée research center. This proposal is the winner of the "Grand Challenges du Numérique" (BPI) and aims to develop the new version of the search engine http://www.qwant.com with radical innovations in terms of search criteria, indexed content and privacy of users. In the context of this project, we got with Nataliia Bielova from the INDES project-team a funding for a 3 years Ph.D. working on Web tracking technologies and privacy protection.

**DIONYSOS Project-Team**

# 8. Bilateral Contracts and Grants with Industry

## 8.1. Cifre contract on Personalization for Cognitive Autonomic Networks in 5G

**Participant:** César Viho.

This is a Cifre contract (2017-2019) including a PhD thesis supervision (PhD of Illyyne Saffar), done with Nokia, on the proposition to use machine learning and data analytics to transform user and network data into actionable knowledge which in turn can be automatically exploited by Autonomic Networking approaches for cognitive self management of the 5G network.

## 8.2. Cifre contract on Device-Assisted Distributed Machine-Learning on Many Cores

**Participants:** Corentin Hardy, Bruno Sericola.

This is a Cifre contract including a PhD thesis supervision (PhD of Corentin Hardy), done with Technicolor. The starting point of this thesis is to consider the possibility to deploy machine-learning algorithms over many cores, but out of the datacenter, on the devices (home-gateways) deployed by Technicolor in users' homes. In this device-assisted view, an initial processing step in the device may significantly reduce the burden on the datacenter back-end. Problems are numerous (power consumption, CPU power, network bandwidth and latency), but costs for the operator can be lowered and scale may bring some new level in data processing.

## 8.3. Cifre contract on Throughput Prediction in Mobile Networks

**Participant:** Yann Busnel.

This is a Cifre contract (2015-2018) including a PhD thesis supervision (PhD of Alassane Samba), done with Orange, on cooperation in statistical approaches for the prediction of throughput without history. Throughput has a strong impact on user experience in cellular networks. The ability to predict the throughput of a connection, before it starts, bring new possibilities, particularly to the Internet service providers. They could adapt contents to the quality of service really reachable by users, in order to enhance their experience.

## 8.4. Cifre contract on Mobile SDN architecture

**Participants:** Yassine Hadjadj-Aoul, César Viho.

This is a Cifre contract (2015-2018) including a PhD thesis supervision (PhD of Imad Alawe), done with TDF, on the proposition of a scalable SDN-based mobile network architectures for the future 5G network.

## 8.5. Bilateral Contract with Industry: ALSTOM-Inria Common Lab

**Participants:** Bruno Tuffin, Gerardo Rubino.

Bruno Tuffin is the co-director of ALSTOM-Inria common Lab.

The group currently manages a project with ALSTOM on system availability simulation taking into account logistic constraints. Current ALSTOM Transport and Power contracts, especially service-level agreements, impose stringent system availability objectives. Non-adherence to the required performance levels often leads to penalties, and it is therefore critical to assess the corresponding risks already at a tender stage. The challenge is to achieve accurate results in a reasonable amount of time. Monte Carlo simulation provides estimates of the quantities it is desired to predict (e.g., availability). Since we deal with rare events, variance reduction techniques, specifically Importance Sampling (IS) here, is used. The goal of the project is to establish the feasibility of IS for solving problems relevant to ALSTOM and to develop the corresponding mathematical tools.

## 8.6. DVD2C

**Participant:** Yassine Hadjadj-Aoul.

We participated to the 3-year (January 2015 – June 2018) FUI Project DVD2C, which aims to virtualize CDN through the Cloud and Network Function Virtualization concept. DVD2C is leaded by Orange labs., and the partners are two SMEs (Viotech and Resonate) and two academics (our team and Télécom Paris Sud).

## 8.7. Bilateral Contract with Industry: Nokia Bell Labs

**Participants:** Yassine Hadjadj-Aoul, Gerardo Rubino.

Gerardo Rubino is the coordinator of the research action “Analytics and machine learning”, with Nokia Bell Labs. The objective is to carry out common research on an integrated framework for 5G, programmable networks, IoT and clouds that aims at statically and dynamically managing and optimizing the 5G infrastructure using, in particular, machine learning techniques.

**DYOGENE Project-Team**

# 7. Bilateral Contracts and Grants with Industry

## 7.1. CRE with Huawei

18-month contract titled “Mathematical Modeling of 5G Ultra Dense Wireless Networks” between Inria represented by B. Blaszczyszyn (PI) and F. Baccelli, and Huawei comes to an end in December 2018. It aimed at investigating obstacle-based shadowing fields in the spatial models of cellular networks and efficient scheduling policies. Paul Keeler was hired by Inria as a research engineer thanks to this contract. The publication [39] is one of the deliverable of this contract.

## 7.2. CIFRE with Nokia

Contract with Nokia started in 2015 for the co-advising by B. Blaszczyszyn of a PhD student of Nokia, Dalia-Georgiana Herculea came to an end in December 2018. Dalia-Georgiana Herculea has successfully defended her PhD Thesis in November 2018.

## 7.3. CIFRE with Orange

Contract with Orange started in 2017 and continued in 2018 for the co-advising by B. Blaszczyszyn of a PhD student of Orange, Quentin Le Gall.

**EVA Project-Team**

# 8. Bilateral Contracts and Grants with Industry

## 8.1. Bilateral Contracts with Industry

**Participants:** Pascale Minet, Ines Khoufi, Zied Soua.

In the framework of the CNES Launchers Research and Technology program, Inria and CNEs co-funded a study dealing with wireless sensor networks in a spatial environment. More precisely, this study deals with the improvement and performance evaluation of a solution of wireless sensor networksbased on the IEEE 802.15.4e standard of TSCH (Time Slotted Channel Hopping), operating in a spatial environment.

In space launch vehicles, a NASA study shows that the mass per channel of 0.45 kg for a wiring approach can be reduced to 0.09 kg for a wireless approach.8 A question arises: which wireless technology is able to meet the requirements of space launch vehicles in terms of latency, throughput and robustness. The IEEE 802.15.4e amendment has been designed to meet such requirements. More specifically, the Time Slotted Channel Hopping (TSCH) mode of the IEEE 802.15.4e standard that has been designed for industrial automation, process control and equipment monitoring, appears very promising for space launch vehicles. More precisely, the study for CNES deals with:

- Building an IEEE 802.15.4e TSCH network: see [11] the Acta Astronautica 2018 publication.
- Scheduling transmissions in an IEEE 802.15.4e TSCH network.
- Adapting the schedule to traffic or topology changes.

This study ended in July 2018 with very satisfying results.

## 8.2. Bilateral Grants with Industry

**Participants:** Thomas Watteyne, Felipe Moran.

Felipe Moran was awarded a 6-month EDF fellowship to conduct a 6-month internship around low-power wireless networking in extrement industrial environments. Details are confidential.

**FUN Project-Team**

# 8. Bilateral Contracts and Grants with Industry

## 8.1. Bilateral Contracts with Industry

- Sencrop
  **Participants:** Brandon Foubert, Nathalie Mitton [correspondant].

  This collaboration aims to develop a complete multi-technology bilateral wireless communication stack for agriculture sensor networks.
- Enedis and NooliTic
  **Participants:** Ibrahim Amadou, Nathalie Mitton [correspondant].

  This collaboration aims to investigate a novel localization approach based on wireless propagations. It is a tri-partite contract between our Inria team, the SME NooliTic and Enedis.

**GANG Project-Team**

# 8. Bilateral Contracts and Grants with Industry

## 8.1. Bilateral Contracts with Industry

### *8.1.1. Collaboration with Nokia Bell Labs*

Gang has a strong collaboration with Bell Labs (Nokia). We notably collaborate with Fabien Mathieu who is a former member of GANG and Élie de Panafieu. An ADR (joint research action) is dedicated to distributed learning.

This collaboration is developed inside the Alcatel-Lucent and Inria joint research lab.

**INFINE-POST Team**

# 6. Bilateral Contracts and Grants with Industry

## 6.1. Bilateral Contracts with Industry

### *6.1.1. Fujitsu (RunMyProcess):*

**Participants:** Emmanuel Baccelli, Francisco Acosta.

In 2018 we have worked with Fujitsu RIOT enhancements to demonstrate dynamic application software loading and execution on top of RIOT running on Arduino-like hardware, managed remotely from Fujitsu's RMP Cloud component. The results of this work were published in several conferences in 2018, and a prototype was demonstrated.

### *6.1.2. Thalès:*

**Participant:** Cedric Adjih.

In 2018, studies were made with Thalès (TRT) on IoT systems.

### *6.1.3. GranData:*

**Participants:** Guangshuo Chen, Adriano Di Luzio, Aline Carneiro Viana.

Since June 2014, we have a collaboration with GranData (http://grandata.com/), Buenos Aires, Argentina on traffic vs mobility modeling of smartphone users. GranData is a small company that integrates first-party and telco partner data to understand key market trends, to predict customer behavior, and to deliver business results. For the time being, the collaboration with Grandata has generated knowledge transfer. From both directions, (1) from myself to GranData, I have being transferring my knowledge in modeling and analysing human behavior in terms of mobility, encounters, and content demand, (2) from them to myself, they have advising me on issues related to machine learning and statistical methods to be used. It describes **an industrial partner's collaboration having the outcomes of our works impacting their products** (e.g., GranData data mining algorithms can be improved based on the better understanding on mobility and content consumption of mobile users) **or research/business decisions** (e.g., proved strong correlations between mobility and data traffic consumption can open new perspectives of services to telecom operators, i.e., clients of GranData).

Part of the thesis of Guangshuo Chen (endend April 2018) and of Eduardo Mucelli (ended in 2015) on data traffic analysis used telco traces provided by GranData.

**Neo Project-Team**

# 8. Bilateral Contracts and Grants with Industry

## 8.1. Bilateral Contracts with Industry

NEO members are involved in the

- Inria-Nokia Bell Labs joint laboratory: the joint laboratory consists of five ADRs (Action de Recherche/Research Action) in its third phase (starting October 2017). NEO members participate in one ADR "Distributed Learning and Control for Network Analysis" (see §8.1.1 ).
- Inria-QWANT joint laboratory "Smart search is privacy" (see §8.1.2 );
- Inria-Orange Labs joint laboratory (see §8.1.3 ).

### *8.1.1. ADR Nokia on the topic "Distributed Learning and Control for Network Analysis" (October 2017 – September 2021)*

**Participants:** Eitan Altman, Konstantin Avrachenkov, Mandar Datar, Maximilien Dreveton, Alain Jean-Marie.

- Contractor: Nokia Bell Labs (http://www.bell-labs.com)
- Collaborator: Gérard Burnside

Over the last few years, research in computer science has shifted focus to machine learning methods for the analysis of increasingly large amounts of user data. As the research community has sought to optimize the methods for sparse data and high-dimensional data, more recently new problems have emerged, particularly from a networking perspective that had remained in the periphery.

The technical program of this ADR consists of three parts: Distributed machine learning, Multiobjective optimisation as a lexicographic problem, and Use cases / Applications. We address the challenges related to the first part by developing distributed optimization tools that reduce communication overhead, improve the rate of convergence and are scalable. Graph-theoretic tools including spectral analysis, graph partitioning and clustering will be developed. Further, stochastic approximation methods and D-iterations or their combinations will be applied in designing fast online unsupervised, supervised and semi-supervised learning methods.

### *8.1.2. Qwant contract on "Asynchronous on-line computation of centrality measures" (15 December 2017 – 14 May 2020)*

**Participants:** Nicolas Allegra, Konstantin Avrachenkov.

- Contractor: Qwant
- Collaborator: Sylvain Peyronnet

We shall study asynchronously distributed methods for network centrality computation. The asynchronous distributed methods are very useful because they allow efficient and flexible use of computational resources on the one hand (e.g., using a cluster or a cloud) and on the other hand they allow quick local update of centrality measures without the need to recompute them from scratch.

### *8.1.3. Orange CIFRE on the topic "Self-organizing features in the virtual 5G radio access network" (November 2017 – October 2020)*

**Participants:** Eitan Altman, Marie Masson.

- Contractor: Orange Labs (https://orange.jobs/site/en-innovation-rd/)
- Collaborator: Zwi Altman

The considerable extent of the complexity of 5G networks and their operation is in contrast with the increasing demands in terms of simplicity and efficiency. This antagonism highlights the critical importance of network management. Self-Organizing Networks (SON), which cover self-configuration, self-optimization and self-repair, play a central role for 5G Radio Access Network (RAN).

This CIFRE thesis aims at innovating in the field of managing 5G RAN, with a special focus on the features of the SON-5G. Three objectives are identified: a) develop self-organizing features (SON in 5G-RAN), b) develop cognitive managing mechanisms for the SON-5G features developed, and c) demonstrate how do the self-organizing mechanisms fit in the virtual RAN (vRAN).

### *8.1.4. Huawei CIFRE on the topic "Scalable Online Algorithms for SDN controllers" (June 2016 – May 2019)*

**Participants:** Zaid Allybokus, Konstantin Avrachenkov.

- Contractor: Huawei Technologies (http://www.huawei.com/en/about-huawei/research-development)
- Collaborators: Jérémie Leguay

Software-Defined Networking (SDN) technologies have radically transformed network architectures. They provide programmable data planes that can be configured from a remote controller platform.

The objective of this CIFRE thesis is to provide fundamental answers on how powerful SDN controller platforms could solve large online flow problems to optimize networks in real-time and in a distributed or semi-distributed fashion. We use methods from both optimization and dynamic programming.

**POEMS-POST Team**

# 8. Bilateral Contracts and Grants with Industry

## 8.1. Bilateral Contracts with Industry

- Contract and CIFRE PhD with EDF on *the FEM-BEM coupling for soil-structure interactions*
  Participants: M. Bonnet, S. Chaillat, Z. Adnani
  Start: 11/2014. End: 02/2018. Administrator: CNRS
- Contract and CIFRE PhD with Airbus on *time-harmonic acoustic scattering in a vortical flow*
  Participants: P. Joly, J.-F. Mercier, A. Bensalah
  Start: 10/2014, End: 04/2018. Administrator: ENSTA
- Contract and CIFRE PhD with Naval Group on *modelling the fluid-structure coupling caused by a far-field underwater explosion*
  Participants: M. Bonnet, S. Chaillat, D. Mavaleix-Marchessoux
  Start: 11/2017. End: 10/2020. Administrator: CNRS
- Contract and CIFRE PhD with Naval Group on *flow noise prediction*
  Participants: J-F Mercier, S. Cotté, N. Trafny
  Start: 04/2018. End: 03/2021. Administrator: ENSTA

**RESIST Team**

# 8. Bilateral Contracts and Grants with Industry

## 8.1. Bilateral Contracts with Industry

- RED ALERT LABS (Paris, France)
  - Verification of the security requirements of an IoT device (a connected doorbell) using the SCUBA tool suite.
  - An extension of SCUBA (see 6.6 ) is developed to verify the security requirements provided in Common Criteria format by the industrial partner. The verification uses the information of the Security Knowledge Bases (SKB) built by the SCUBA tool suite.

## 8.2. Bilateral Grants with Industry

- Thales (Palaiseau, France):
  - CIFRE PhD (Pierre-Olivier Brissaud, supervised by Isabelle Chrisment and Jérôme François)
  - Anomaly detection in encrypted network traffic
- Orange Labs (Issy-Les-Moulineaux, France):
  - CIFRE PhD (Maxime Compastie, supervised by Olivier Festor and Rémi Badonnel)
  - Software-Defined Security for Distributed Cloud Infrastructures
- Orange Labs (Issy-Les-Moulineaux, France):
  - CIFRE PhD (Paul Chaignon, supervised by Olivier Festor and Jérôme François)
  - Monitoring of Software-Defined Networks
- Xilopix then Qwant (Épinal, France):
  - CIFRE PhD (Abdulqawi Saif, supervised by Ye-Qiong Song and Lucas Nussbaum)
  - Open Science for the scalability of a new generation search technology
- Numeryx Technologies (Paris, France):
  - CIFRE PhD (Ahmad Abboud, supervised by Michael Rusinowitch, Abdelkader Lahmadi and Adel Bouhoula)
  - Compressed and Verifiable Filtering Rules in Software-defined Networking

**SOCRATE Project-Team**

# 7. Bilateral Contracts and Grants with Industry

## 7.1. Bilateral Grants with Industry

### *7.1.1. Research Contract with Atlantic 2016-2018*

Socrate (Guillaume Villemaud, Florin Hutu, Guillaume Salagnac and Tanguy Risset) are collborating with Atlantic to prototype guided wireless communications in ventilation ducts with low energy consumption. The project will lead to a shift to wireless communications in HVAC ducts.

### *7.1.2. Research Contract with SigFox 2015-2018*

Socrate explored the performance of UNB networks with an emphasis on robust signal processing techniques (PhD defended on Dec 2018).

### *7.1.3. Research Contract with Orange 2016-2018*

Socrate explored in this partnership the theoretical limits of IoT access networks by combining information theory and stochastic geometry.

### *7.1.4. Research Contract with Nokia 2017-2021*

Socrate contributes to two research actions in the Nokia Bell Labs - Inria common lab. The first ADR is on Network Information Theory devoted to to the modeling of IoT networks, and which relies on our academic work in the ANR Arburst. We collaborate with Agora, Infine and Eva teams.

The second ADR is on machine learning for wireless networks. Our contribution is on designing new PHY layer protocols with machine learning, with an experimental assessment of these techniques on FIT/CorteXlab.

### *7.1.5. Research Contract with Bosch 2018*

In collaboration with Aric, Socrate worked with Bosch on the impementation of some elementary functions in an embedded context.