RESEARCH CENTER

FIELD
Networks, Systems and Services, Distributed Computing

Activity Report 2019

Section Contracts and Grants with Industry

Edition: 2020-03-21

COAST Project-Team

8. Bilateral Contracts and Grants with Industry

8.1. Bilateral Contracts with Industry

8.1.1. Open Group

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

Company: Open Group

Dates: 2017-2020

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

8. Bilateral Contracts and Grants with Industry

8.1. Bilateral Grants with Industry

8.1.1. Orange

We have a cooperation with Orange labs, around a CIFRE PhD grant, on the topic of autonomic device management (see Section 7.2.4.1). This activity is part of the Inria/Orange joint laboratory.

8.1.2. Nokia / Bell labs

We have 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 Autonomic management in Software Defined Networks. This activity is part of the Inria/ Nokia / Bell labs joint laboratory.

DELYS Project-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 three 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.
- José Alves Esteves Jurandir is advised by Pierre Sens. He works on network slice placement stategies.

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 2018-2019.

Myriads Project-Team (section vide)

SPIRALS Project-Team

8. Bilateral Contracts and Grants with Industry

8.1. ip-label

Participant: Romain Rouvoy [contact person].

A software exploitation license (2014–ongoing) 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. Davidson

Participants: Mohammed Chakib Belgaid, Romain Rouvoy [contact person], 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.

8.3. Orange #1

Participants: Philippe Merle [contact person], Lionel Seinturier.

This collaboration (2017–19) aims at defining a computational model for software infrastructures layered on top of virtualized and interconnected cloud resources. This computational model provides application programming and management facilities to distributed applications and services [39], [44]. This computational model defines a pivot model that enables the interoperability of various existing and future standards for cloud systems such as OCCI and TOSCA. This pivot model is defined with the Alloy specification language [62]. This collaboration takes advantage of the expertise that we are developing since several years on reconfigurable component-based software systems [75], on cloud systems [69], and on the Alloy specification language [67].

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

8.4. Orange #2

Participants: Zakaria Ournani, Romain Rouvoy [contact person], 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.

8.5. Amaris (now Mantu)

Participants: Sacha Brisset, Romain Rouvoy [contact person], 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.

STACK Project-Team

8. Bilateral Contracts and Grants with Industry

8.1. Bilateral Contracts with Industry

Participants: Ronan-Alexandre Cherrueau, Marie Delavergne, Adrien Lebre [Contact point], Javier Rojas Balderrama, Matthieu Simonin.

Following the ENOS bilateral contract ("Contrat de Recherche Externalisé") between Orange and Inria (Sept 2017-Oct 2018), we agreed with Orange Labs to pursue this collaboration around a second contrat. This new contrat, which is going to last 18 months for a budget of 150K€, targets the following objectives:

- Strengthen the Enos framework and the resulting EnosLib solution (see Section 6.4 and Section 6.5).
- Define an experimental protocol allowing the automatozed and reproducible evaluation of an OpenStack instance in a WANWide context.
- Develop a DSL to reify location aspects at the CLI level in order to create new resources (image, VM, etc.) through a set of OpenStack instances while guaranteeing a notion of master copy.

WHISPER Project-Team

8. Bilateral Contracts and Grants with Industry

8.1. Bilateral Contracts with Industry

- Orange Labs, 2019-2021, 30 000 euros. The purpose of this contract is to design application-specific proxies so as to speed up network services. The PhD of Yoann Ghigoff is supported by a CIFRE fellowship as part of this contract.
- Thales Research, 2016-2019, 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.
- DGA-Inria, 2019-2021, 60 000 euros. The purpose of this PhD grant is to develop a high-performance, certified packet processing system. The PhD of Pierre Nigron is supported by this grant.

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.

As part of this project, we have already identified frequency scaling and the “fork/wait” paradigm as a source of inefficiency in modern multicore machines. These first results were published in the PLOS workshop that is held together with SOSP. The diagnosis of the problem was possible thanks to the *SchedLog and* SchedDisplay tools that we developed as part of this project.

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)

Participants: Loïck Bonniot, 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.

ALPINES Project-Team

8. Bilateral Contracts and Grants with Industry

8.1. Bilateral Contracts with Industry

- 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.

AVALON Project-Team

7. Bilateral Contracts and Grants with Industry

7.1. Bilateral Contracts with Industry

7.1.1. 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.

7.1.2. MUMPS Technologies

AVALON has a collaboration with MUMPS Technologies. The funding is dedicated for Marie Durand during few months to make experimental validation of the interest of using XKBLAS library to let MUMPS software to gain in performance on multi-GPUs server.

7.2. Bilateral Grants with Industry

7.2.1. 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

8. Bilateral Contracts and Grants with Industry

8.1. Bilateral Contracts with Industry

- **EDF R&D (2019)**. Integration of Melissa and OpenTurn.
- **TOTAL SA (2019)**. Proof of Concept for performing large scale sensibility analysis with Melissa on Total use-case.

8.2. Bilateral Grants with Industry

- **ATOS-BULL (2016-2019)**. Two PhD grants (Michael Mercier and Adrien Faure). Job and resource management algorithms.
- **Qarnot Computing (2019-2022)**. PhD grant (Angan Mitra).

HIEPACS Project-Team (section vide)

KERDATA Project-Team (section vide)

POLARIS Project-Team

8. Bilateral Contracts and Grants with Industry

8.1. Bilateral Grants with Industry

Nicolas Gast obtained funding Enedis for a study on the PLC-G3 protocol (≈50k euros).

ROMA Project-Team

8. Bilateral Contracts and Grants with Industry

8.1. Bilateral Contracts with Industry

In the context of a consortium (http://mumps-consortium.org) of users of the MUMPS library (http://mumps-solver.org), we had partnership contracts with EDF, ALTAIR, FFT-MSC Software, Michelin, LSTC, Siemens, ESI Group, Total, Safran, LBNL, Airbus, and SHELL. Following the creation of the start-up Mumps Technologies in January 2019, these contracts (scientific exchanges, support, organization of point-to-point and plenary meetings, releases in advance, ...) have been transferred to Mumps Technologies.

STORM Project-Team

8. Bilateral Contracts and Grants with Industry

8.1. Bilateral Contracts with Industry

- Contract with ATOS/Bull for the PhD CIFRE of Tassadit Célia Ait Kaci (2019-2021),
- Contract with Airbus for 1 year, renewable, on StarPU in Flusepa code (2019-), for the engineer contract of Alexis Juven,
- Contract with CEA for the PhD of Arthur Loussert (2017-2019), for the PhD of Van Man Nguyen (2019-2021) and other short contracts.

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. EDF

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

8.1.3. CEA

CEA/DAM granted the CIFRE PhD thesis of Florian Reynier 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 a chaos engineering principles to IoT Services frameworks to improve the robustness of the software-defined network services using this approach and to explore the concept of equivalence for software-defined network services and propose an approach to constantly evolve the attack surface of the network services.

7.1.2. BCOM

- Coordinator: UR1
- Dates: 2018-2024
- Abstract: The aim 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 at working 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. GLOSE Demonstrator

- Partners: Inria/Safran
- Dates: 2019-2020
- Abstract: Demonstrator illustrating the technologies involved in the WP5 off the GLOSE project. The use case chosen for the demonstrator is the high-level description of a remote control drone system, whose the main objective is to illustrate the design and simulation of the main functional chains, the possible interactivity with the model in order to raise the level of understanding over the models built, and possibly the exploration of the design space.

7.1.5. 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 5 points 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.

7.1.6. Kereval

- Partners: INSA Rennes/Kereval
- Dates: 2019-2022
- Abstract: Front-ends testing in a DevOps context, Romain Lebouc's PhD Cifre project.

7.1.7. Obeo

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

7.1.8. OKWind

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

7.1.9. Orange

- Partners: UR1/Orange
- Dates: 2016-2019
- Abstract: Modelling and evaluating security of authentication paths, Youssou Ndiaye's PhD Cifre project.

7.1.10. 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.

7.1.11. FaberNovel

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

EASE Project-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: April 2020

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

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. This contract funds Nejm Frigui's PhD grant, co-supersized with Tayeb Lemlouma (IRISA OCIF team).

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

FOCUS Project-Team

8. Bilateral Contracts and Grants with Industry

8.1. Bilateral Contracts with Industry

In 2019 we have started the Innovation Lab on Blockchain and New Technologies (https://site.unibo.it/blockchain-and-newtechnologies/en). The Lab is a new joint laboratory of the Computer Science and Engineering Department of the University of Bologna and KPMG Advisory S.p.A. that is committed to scientific research and technology transfer of systems based on blockchain and new technologies. The laboratory joins the efforts of several researchers of the Department and uses the experience in technology transfer of KPMG Advisory S.p.A.

The Lab has received a grant of 10KE from KPMG and a grant of 10KE from CIRFOOD, one of the biggest Italian companies in organised commercial and collective catering.

INDES Project-Team

7. Bilateral Contracts and Grants with Industry

7.1. 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. Nataliia Bielova, Manuel Serrano and Tamara Rezk are involved in this project. 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. Yoon Seok Ko has worked on this project as a postdoc.

RMOD Project-Team

8. Bilateral Contracts and Grants with Industry

8.1. Bilateral Contracts with Industry

8.1.1. Pharo Consortium

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

The Pharo Consortium was founded in 2012 and is growing constantly. By the end 2019, it has 25 company members, 19 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. Berger-Levrault: 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 since GWT will not be backward supported anymore in the next versions. A PhD CIFRE thesis started in 2019: Benoît Verhaeghe, *Support à l'automatisation de la migration d'interface d'applications Web : le cas de GWT vers Angular*.

8.2.2. Arolla: Machine Learning-Based Recommenders to Support Software Evolution

Participants: Nicolas Anquetil, Stéphane Ducasse, Anne Etien, Oleksandr Zaitsev

We started a new collaboration with the council company, Arolla, about software evolution. Arolla has daily problems with identifying architecture, design, and deviations from those artifacts. The goal of the thesis is to experiment which learning techniques can help with semi-automatically extracting design and architectural aspects and their violations. A PhD CIFRE has started in 2019: Oleksandr Zaitsev, *Machine Learning-Based Tools to Support Software Evolution*.

A second CIFRE around legacy system cartography will start in 2020.

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 (2018-2021) 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 and evaluated by LQA.
- 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.
- 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

8. Bilateral Contracts and Grants with Industry

8.1. Bilateral Contracts with Industry

8.1.1. Oui!Greens, 2019

Participant: Joanna Moulierac.

Duration: January 2019 - February 2019

Coordinator: Joanna Moulierac

Other partners: Dorian Mazauric from EP ABS

Abstract: Supervision of an InriaTech engineer for the development of the algorithm proposed in a previous collaboration with Oui!Greens.

The aim of the algorithm is to propose to clients the adequate products (fruits or vegetables) that are almost out-of-date with the objective of maximizing the satisfaction of the clients, and the diminution of the wastage. During one month, this algorithm has been implemented into the mobile application pepino, owned by Oui!Greens.

8.1.2. MillionRoads, 2019-2020

Participants: David Coudert, Frédéric Giroire, Luc Hogie, Nicolas Nisse, Michel Syska.

Duration: October 2019 - April 2020

Project title: HumanRoads

Coordinator: Nicolas Nisse

Other partners: SME MillionRoads; EP Zenith (Didier Parigot)

Abstract: HumanRoads uses a graph database, in the Neo4j environment, to store and structure its data. This database is already large and is regularly enriched with new data. However, to date, response times to queries are not satisfactory. This Project aims at identifying the limiting factors and to propose alternatives. More precisely, we will work on analyzing the data structure in the graph database to optimize queries, in the Neo4j environment, and on graph algorithms to speed up queries.

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. 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. Collaboration with Safran

Participant: Damien Saucez.
The research collaboration with Safran on Constrained Software Defined Networks has evolved into a new stage: Damien Saucez took a one year secondment from Inria to join Safran and further develop this activity from "inside".

7.1.2. Collaboration with Ekinops

Participant: Thierry Turletti, Walid Dabbous.
We have started a collaboration with EKINOPS on the topic of Multi-access Edge Computing. The activity started with a CIFRE thesis. The PhD student Mamoutou Diarra started his PhD on this topic on November 2019.

7.1.3. Collaboration with Orange

Participant: Thierry Turletti, Damien Saucez.
We have a collaboration with Orange on the topic of Network Function Virtualization. The activity includes the CIFRE PhD thesis of Giuseppe Di Lena that started his PhD on resilient NFV/SDN environments on April 2018.

7.2. Bilateral Grants with Industry

7.2.1. QWANT

Participant: 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 Device-Assisted Distributed Machine-Learning on Many Cores

Participants: Corentin Hardy, Bruno Sericola.

This is a Cifre contract (2016-2019) including a PhD thesis supervision (PhD of Corentin Hardy), done with Technicolor. The starting point of this thesis was 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. The thesis has been defended in April 2019.

8.2. 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.

8.3. Cifre contract on Resiliency as a Service for 5G networks using Machine Learning

Participants: Sofiene Jelassi, Gerardo Rubino.

The is a Cifre contract including a PhD thesis supervision (PhD of Soumaya Kaada), done with Nokia (Paris). It concerns providing on demand and evolving resiliency schemes over 5G network using advanced machine learning algorithms. It relies on a highly flexible network infrastructure supporting both wired and wireless programmable data planes through a highly-efficient distributed network operating system.

8.4. Bilateral Contract with Industry: Nokia Bell Labs

Participants: Yassine Hadjadj-Aoul, Quang Pham Tran Anh, Anouar Rkhami, 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

8. Bilateral Contracts and Grants with Industry

8.1. Bilateral Contracts with Industry

8.1.1. CRE with Orange

Two year contract titled *Taking into account the "massive MIMO" in the assessment of QoS and the dimensioning of 5G cellular networks* between Inria and Orange Labs started 2018. It is a part of a long-term collaboration between TREC/DYOGENE, represented by B. Błaszczyszyn and Orange Labs, represented by M. K. Karray on the development of analytic tools and methods allowing one to capture macroscopic relation between antennas roll-out, frequency allocation, volume of traffic carried on the network and quality of service parameters such as the average and the variation of bandwidth available to end users. This work addresses crucial technical and economical issues related to the operator core business, particularly related to the current evolution of the cellular network technology (4G⇒5G). The developed solutions are implemented by Orange Labs in the internal toolbox *CapRadio* (see 6.1.1) and used by the Direction of Regulatory Affairs of Orange.

8.1.2. Contract with EDF

Collaborative research in the area of demand dispatch of flexible loads. PI : A. Busic.

8.1.3. CIFRE with Orange

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

EVA Project-Team

8. Bilateral Contracts and Grants with Industry

8.1. Bilateral Grants with Industry

Participants: Razanne Abu Aisheh, Mina Rady, Thomas Watteyne.

Razanne Abu Aisheh is doing her PhD under a CIFRE agreement between Inria and Nokia Bell Labs. Mina Rady is doing his PhD under a CIFRE agreement between Inria and Orange Labs.

FUN Project-Team

7. Bilateral Contracts and Grants with Industry

7.1. Bilateral Contracts with Industry

- Sencrop
  Participants: Brandon Foubert, Nathalie Mitton [contact person].

  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 [contact person].

  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.
- Expleo
  Participants: Ibrahim Amadou, Nathalie Mitton [contact person].

  This collaboration aims to transfer self-deployment protocols to Expleo.

GANG Project-Team (section vide)

GANG Project-Team (section vide)

MARACAS Team

8. Bilateral Contracts and Grants with Industry

8.1. Bilateral Contracts with Industry

We have currently the following partnerships

1. Inria-Nokia Bell Labs common lab (600k€) : we are involved in two research actions (Analytics, and Network Information Theory), with the funding of two PhDs and 1 postdoc (to be hired) for Maracas.
2. SPIE-ICS (1Meuros, 2017-2021) : The Insa-Spie IoT Chair http://www.citi-lab.fr/chairs/iot-chair/ relies on the expertise of the CITI Lab. The skills developed within the different teams of the lab integrate the study, modelling, conception and evaluation of technologies for communicating objects and dedicated network architectures. It deals with network, telecom and software matters as well as societal issues such as privacy. The chair will also lean on the skills developed at INSA Lyon or in IMU LabEx. The SPIE-ICS / Insa Lyon chaire on IoT has been setup in 2017 by JM Gorce for the benefit of the CITIlab. JM Gorce was the head of this chair from 2016 to 2019 and is now vice-head (Frédéric Le Mouel is heading the chair since sept 2019). The remaining budget for Maracas corresponds to one postdoc to be hired nad overhead costs.
3. Sigfox : we are collaborating with Sigfox for several years. Maracas explored the performance of UNB networks with an emphasis on robust signal processing techniques (PhD defended on Dec 2018) and a new contract is in preparation for a PhD grant to be started in September, 2020.
4. Orange Labs : our research contract ended in 2018 and we are preparing a new contract.

8.2. Bilateral Grants with Industry

1. PhD grant of Mathieu Goutay (with Nokia Bell Labs, 2019-2022).

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 two ADRs: "Distributed Learning and Control for Network Analysis" (see §8.1.1) and "Rethinking the network: virtualizing network functions, from middleboxes to application" (see §8.1.2).
- Inria-QWANT joint laboratory "Smart search is privacy" (see §8.1.3);
- Inria-Orange Labs joint laboratory (see §8.1.4).

NEO has contracts with Accenture (see §8.1.5), Azursoft (see §8.1.6), MyDataModels (see §8.1.7), Huawei (see §8.1.8), and Payback Network (see §8.1.9).

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.

- 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. ADR Nokia on the topic "Rethinking the network: virtualizing network functions, from middleboxes to application" (October 2017 – September 2021)

Participants: Sara Alouf, Giovanni Neglia.

- Contractor: Nokia Bell Labs (http://www.bell-labs.com)
- Collaborators: Fabio Pianese, Massimo Gallo

A growing number of network infrastructures are being presently considered for a software-based replacement: these range from fixed and wireless access functions to carrier-grade middle boxes and server functionalities. On the one hand, performance requirements of such applications call for an increased level of software optimization and hardware acceleration. On the other hand, customization and modularity at all layers of the protocol stack are required to support such a wide range of functions. In this scope the ADR focuses on two specific research axes: (1) the design, implementation and evaluation of a modular NFV architecture, and (2) the modelling and management of applications as virtualized network functions. Our interest is in low-latency machine learning prediction services and in particular how the quality of the predictions can be traded off with latency.

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

Participants: Nicolas Allegra, Konstantin Avrachenkov, Patrick Brown.

- Contractor: Qwant
- Collaborators: Sylvain Peyronnet, Thomas Aynaud

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.

8.1.4. 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://www.orange.com/en/Infographics/Orange-and-Research/Orange-and-Research)
- 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.

8.1.5. Accenture contract on the topic "Distributed Machine Learning for IoT applications" (Dec 2019 – May 2020)

Participant: Giovanni Neglia.

- Contractor: Accenture Labs (https://www.accenture.com/fr-fr/accenture-lab-sophia-antipolis)
- Collaborators: Laetitia Kameni, Richard Vidal

IoT applications will become one of the main sources to train data-greedy machine learning models. Until now, IoT applications were mostly about collecting data from the physical world and sending them to the Cloud. Google's federated learning already enables mobile phones, or other devices with limited computing capabilities, to collaboratively learn a machine learning model while keeping all training data locally, decoupling the ability to do machine learning from the need to store the data in the cloud. While Google envisions only users' devices, it is possible that part of the computation is executed at other intermediate elements in the network. This new paradigm is sometimes referred to as Edge Computing or Fog Computing. Model training as well as serving (provide machine learning predictions) are going to be distributed between IoT devices, cloud services, and other intermediate computing elements like servers close to base stations as envisaged by the Multi-Access Edge Computing framework. The goal of this project is to propose distributed learning schemes for the IoT scenario, taking into account in particular its communication constraints. This 6-month contract prepares a CIFRE.

8.1.6. AzurSoft contract on the topic "Proof of concept on automatic detection of false alarms" (May 2019 – April 2020)

Participants: Konstantin Avrachenkov, Andrei Bobu.

- Contractor: AzurSoft (https://www.azursoft.com/)
- Collaborators: Marc Vaillant, Beatrice Escuyer

Intrusion detection or telesurveillance systems generates signals from sensors that allow to raise alarm and start a checking procedure for a potential intrusion or anomaly. Typically, one telesurveillance system surveys many sites and is challenged by a stream of false alarms. In this project, we aim to reduce the rate of false alarms by using various supervised and semi-supervised learning methods.

8.1.7. MyDataModels contract on the topic "Semi supervised variational autoencoders for versatile data" (June 2019 – May 2022)

Participants: Konstantin Avrachenkov, Mikhail Kamalov.

- Contractor: MyDataModels (https://www.mydatamodels.com/)
- Collaborators: Denis Bastiment, Carlo Fanara

Variational autoencoders are highly flexible machine learning techniques for learning latent dimension representation. This model is applicable for denoising data as well as for classification purposes. In this thesis we plan to add semi-supervision component to the variational autoencoder techniques. We plan to develop methods which are universally applicable to versatile data such as categorical data, images, texts, etc. Initially starting from static data we aim to extend the methods to time-varying data such as audio, video, time-series, etc. The proposed algorithms can be integrated into the internal engine of MyDataModels company and tested on use cases of MyDataModels.

8.1.8. 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 was 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.

8.1.9. Consulting contract with Payback Network (November 2019 - January 2020)

Participant: Giovanni Neglia.

- Contractor: Payback Network
- Collaborators: Tanguy Racinet, Anne Legencre

Consulting with the startup Payback Network on differential privacy techniques.

RESIST Team

8. Bilateral Contracts and Grants with Industry

8.1. Bilateral Grants with Industry

- Thales (Palaiseau, France):
  - CIFRE PhD (Pierre-Olivier Brissaud, supervised by Isabelle Chrisment and Jérôme François)
  - Encrypted network traffic analysis (HTTP2 over TLS)
- Orange Labs (Issy-Les-Moulineaux, France):
  - CIFRE PhD (Paul Chaignon, supervised by Olivier Festor and Jérôme François)
  - Software Datapaths for Multi-Tenant Packet Processing
- Orange Labs (Issy-Les-Moulineaux, France):
  - CIFRE PhD (Matthews Jose, supervised by Olivier Festor and Jérôme François)
  - Complex arithmetic operation for in-network computing using hardware dataplanes
- 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

6. Bilateral Contracts and Grants with Industry

6.1. Bilateral Contracts with Industry

6.1.1. Research Contract with Bosch 2019

In collaboration with Aric, Socrate worked with Bosch on the impementation of the Power function in an embedded context.

TRIBE Project-Team

7. Bilateral Contracts and Grants with Industry

7.1. Bilateral Contracts with Industry

7.1.1. GranData:

Participants: Douglas Do Couto Teixiera, Licia Amichi, Lucas Santos de Oliveira [EMBRACE], 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.

7.2. Bilateral Grants with Industry

7.2.1. Nokia (ADR):

Participants: Cedric Adjih, Iman Hmedoush.

Through the common Inria-Nokia laboratory, the team is involved in the action "Network Information Theory" (ADR, "Action De Recherche"). In collaboration with Nokia, and Inria EPI MARACAS, and EPI EVA, we are working on the subject of optimization and evaluating communications for IoT networks. This includes 5G and beyond, medium-access level/random access techniques protocols and applying machine learning techniques to wireless communications.