



RESEARCH CENTER
Rennes - Bretagne-Atlantique

FIELD

Activity Report 2018

Section Contracts and Grants with Industry

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CAIRN Project-Team

8. Bilateral Contracts and Grants with Industry

8.1. Bilateral Contracts with Industry

Collaboration with Huawei Technologies, Sophia Antipolis: In the context of Image Signal Processing (ISP), the project aims at building a proof of concept of an environment able to automatically optimize the precision of every operator (fixed-point or floating-point arithmetic) in a complex, multi-kernel algorithm and find the best tradeoff between cost/power and image quality.

CELTIQUE Project-Team (section vide)

CIDRE Project-Team

7. Bilateral Contracts and Grants with Industry

7.1. Bilateral Contracts with Industry

- **HP (2013-2019): Embedded Systems Security** We aim at researching and prototyping low-level intrusion detection mechanisms in embedded system software. This involves mechanisms in continuation of previous work realized by our team as well as investigating new techniques more directly tied to specific HP device architectures. Our main objective is to monitor low-level software (firmware, OS kernels, hypervisors) thanks to a dedicated external co-processor. Ronny Chevalier is doing his PhD in the context of this project. Being under NDA, details about this research program cannot be provided.

7.2. Bilateral Grants with Industry

- **ANSSI: Security of Low-level Components** Thomas Letan has started his PhD thesis in the context of a contract between CentraleSupélec and the French National Computer Security Agency (ANSSI). His work consists in using formal methods to specify hardware/software security mechanisms and to verify that they correctly enforce some security policies.
- **DGA: Visualization for security events monitoring** Damien Crémilleux has started his PhD thesis in October 2015 in the context of a cooperation with DGA-MI. The subject of the PhD is to define relevant representations to allow front-line security operators to monitor systems from a security perspective. A first proposal was made that led to a tool, VEGAS, that allows to monitor large quantities of alerts in real time and to dispatch these alerts in a relevant way to security analysts.
- **DGA: Intrusion Detection in Distributed Applications** David Lanoé has started his PhD thesis in October 2016 in the context of a cooperation with DGA-MI. His work is focussing on the construction of behavioral models (during a learning phase) and their use to detect intrusions during an execution of the modelled distributed application.
- **DGA: Protection against fuzzing attack** Aurelien Palisse has started his PhD in October 2015 in the context of a cooperation with DGA-MI. The subject of the PhD is to propose a detection mechanism and a mitigation procedure to counter ransomware attacks. He designed a low cost Windows driver that uses a Markov chain as a model for an anomaly detection system. The technology has been patented by both Inria and DGA.
- **Idemia: Hardware Security for Embedded Devices** Kevin Bukasa has started his PhD in January 2016 in a bilateral contract between Inria and Idemia. He explored fault injection attacks using EM probes on two different kinds of devices: microcontroller (representing IoT) and SoC (representing Smart phone). He demonstrated the vulnerability of both architectures on this kind of attack. On IoT device he has developed an attack allowing to take a full control on the device. He discovered also new fault attacks never described in the literature.
- **Idemia: Protection against fuzzing attack** Leopold Ouairy has started his PhD in October 2017 in a bilateral contract between Inria and Idemia. The context is related with security testing of Java applications to avoid fuzzing attack. The approach is based on AI to design automatically a model use for the oracle. He used machine learning to search in a corpus of applications methods having the same semantics. Then in a second step, after converting the source code into a vector he computes a similarity value which is related with absence of conditions evaluation.

- **Ministry of Defence: Visualisation for the characterization of security events** Laetitia Leichtnam has started his PhD thesis in November 2016 in the context of a contract between CentraleSupélec and the French Ministry of Defence. His work consists in presenting events appearing in heterogeneous logs as a dependency graph between the lines of logs. This permits to the administrator to investigate easily the logs to discover the different steps that has performed an attack in the supervised system.
- **Ministry of Defence: Characterization of an attacker** Aïmad Berady has started his PhD thesis in November 2018 in the context of a contract between CentraleSupélec and the French Ministry of Defence. His work is to highlight the characteristics of an attacker performing a targeted and long-term attack on an information system.
- **Nokia: Risk-aware security policies adaptation in modern communication infrastructures** Pernelle Mensah was hired in January 2016 on this CIFRE funding in order to work on unexplored aspects of information security, and in particular response strategies to complex attacks, in the context of cloud computing architectures. The use case proposed by our industrial partner is a multi-tenant cloud computing platform involving software-defined networking in order to provide further flexibility and responsiveness in architecture management. The topic of the thesis is to adapt and improve the current risk-aware reactive response tools, based on attack graphs and adaptive security policies, to this specific environment, taking into account the heterogeneity of actors, platforms, policies and remediation options.
- **Orange LAB's: Storage and query in a massive distributed graph for the web of things** Cyprien Gottstein has started his PhD thesis in October 2018 in the context of a collaboration between Inria and Orange (I/O Lab). In this thesis, we consider storage and query problems that arise when massive distributed graphs are used to represent the web of things. In particular, access to the data and partitioning of the graph are studied to propose efficient geographical services.
- **Thales: Privacy and Secure Multi-party Computation** Aurélien Dupin has started his PhD thesis in January 2016 within the context of a CIFRE contract with Thales. His PhD subject concerns secure multi-party computation. Secure two-party computation provides a way for two parties to compute a function, that depends on the two parties' inputs, while keeping them private. Known since the 1980s, Yao's garbled circuits appear to be a general solution to this problem, in the semi-honest model. Decades of optimizations have made this tool a very practical solution. However, it is well known that a malicious adversary could modify a garbled circuit before submitting it. Many protocols, mostly based on cut-&-choose, have been proposed to secure Yao's garbled circuits in the presence of malicious adversaries. Nevertheless, how much an adversary can modify a circuit and make it still executable have not been studied. In the context of his PhD, Aurélien Dupin is interested by such a question.
- **Thales: Combining Attack Specification and Dynamic Learning from traces for correlation rule generation** Charles Xosanavongsa has started his PhD thesis in December 2016 in the context of a CIFRE with Thales. His work will focus on the construction of correlation rules. In previous work on correlation rule generation, the usual approach is static. It always relies on the description of the supervised system using a knowledge base of the system. The use of correlation trees is an appealing solution because it allows to have a precise description of the attacks and can handle any kind of IDS. But in practice, the behavior of each IDS is quite difficult to predict, in particular for anomaly based IDS. To manage automatically the correlation rules (and adapt them if necessary), we plan to analyze synthetic traces containing both anomaly based and misused based IDS alerts resulting from an attack.

GALLINETTE Project-Team (section vide)

HYCOMES Project-Team

7. Bilateral Contracts and Grants with Industry

7.1. Bilateral Contracts with Industry

7.1.1. *Glose: Globalisation for Systems Engineering*

Participants: Benoît Caillaud, Benoît Vernay.

Glose is a bilateral collaboration between Inria and Safran Tech., the corporate research entity of Safran Group. It started late 2017 for a duration of 44 months. Three Inria teams are involved in this collaboration: Diverse (Inria Rennes), Hycomes and Kairos (Inria Sophia-Antipolis). The scope of the collaboration is systems engineering and co-simulation.

The simulation of system-level models requires synchronizing, at simulation-time, physical models with software models. These models are developed and maintained by different stakeholders: physics engineers, control engineers and software engineers. Models designed by physics engineers are either detailed 3D finite-elements models, with partial differential equations (PDEs), or finite-dimension 0D models (obtained by model reduction techniques, or by empirical knowledge) expressed in modeling languages such as Simulink (with ordinary differential equations, or ODEs), Modelica (with differential algebraic equations, or DAEs), or directly as a C code embedding both the differential equations and its discretization scheme. Coupling together heterogeneous models and programs, so that they can be co-simulated, is not only a technological challenge, but more importantly raises several deep and difficult questions: Can we trust simulations? What about their reproducibility? Will it be possible to simulate large systems with hundreds to thousands of component models?

Co-simulation requires that models are provided with interfaces, specifying static and dynamic properties about the model and its expected environments. Interfaces are required to define how each model may synchronize and communicate, and how the model should be used. For instance, an interface should define (i) which variables are inputs, which are outputs, (ii) their data types, physical units, and sampling periods, but also (iii) the environmental assumptions under which the model is valid, and (iv) the causal dependencies between input and output variables and for continuous-time models, (v) the stiffness of the model, often expressed as a time-varying Jacobian matrix.

Formally, an interface is an abstraction of a model's behavior. A typical example of interface formalism for 0D continuous-time models is the FMI standard. Co-simulation also requires that a model of the system architecture is provided. This architectural model specifies how components are interconnected, how they communicate and how computations are scheduled. This is not limited to the topology of the architecture, and should also specify how components interact. For instance, variables in continuous-time models may have different data-types and physical units. Conversion may be required when continuous-time models are plugged together. Another fine example is the coupling of a 3D finite-element model to a 0D model: effort and flow fields computed in the 3D model must be averaged in a scalar value, before it can be sent to the 0D model, and conversely, scalar values computed by the 0D model must be distributed as a (vector) field along a boundary manifold of the 3D model. For discrete-time models (eg., software), components may communicate in many ways (shared variables, message passing, ...), and computations can be time- or event-triggered. All these features are captured as data-/behavior-coordination patterns, as exemplified by the GEMOC initiative⁰.

⁰<http://gemoc.org>

In the Glose project, we propose to formalize the behavioral semantics of several 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 co-simulation of a system-level architecture consists in an orchestration of hundreds to thousands of components. This orchestration is achieved by a master algorithm, in charge of triggering the communication and computation steps of each component. It takes into account the components' interfaces, and the data-/behavior-coordination patterns found in the system architecture model. Because simulation scalability is a major issue, the scheduling policy computed by the master algorithm should be optimal. Parallel or distributed simulations may even be required. This implies that the master algorithm should be hierarchical and possibly distributed.

PACAP Project-Team

8. Bilateral Contracts and Grants with Industry

8.1. Bilateral Grants with Industry

8.1.1. Intel research grant INTEL2016-11174

Participants: Niloofar Charmchi, Kleovoulos Kalaitzidis, Pierre Michaud, André Seznec.

Intel is supporting the research of the PACAP project-team on “Design tradeoffs for extreme cores”.

SUMO Project-Team

8. Bilateral Contracts and Grants with Industry

8.1. Bilateral Contracts with Industry

8.1.1. Nokia Bell Labs - ADR SAPIENS

Several researchers of SUMO are involved in the joint research lab of Nokia Bell Labs France and Inria. We participate in the common research team SAPIENS (Smart Automated and Programmable Infrastructures for End-to-end Networks and Services), previously named “Softwarization of Everything.” This team involves several other Inria teams : Convecs, Diverse and Spades. SUMO focuses on the management of reconfigurable systems, both at the edge (IoT based applications) and in the core (e.g. virtualized IMS systems). In particular, we focus on control and diagnosis issues for such systems. Two PhD students are involved in the project. Erij Elmajed (2nd year), on the topic of Diagnosis of virtualized and reconfigurable systems supervised by Éric Fabre and Armen Aghasaryan (Nokia Bell Labs). Abdul Majith (to start in January 2019) on Controller Synthesis of Adaptive Systems, supervised by Hervé Marchand, Ocan Sankur, and Dinh Thai Bui (Nokia Bell Labs).

8.1.2. Orange Labs

SUMO is participating in IOLab, the common lab of Orange Labs and Inria, dedicated to the design and management of Software Defined Networks. Our activities concern the diagnosis of malfunctions in virtualized multi-tenant networks. This collaboration supports one Cifre PhD student, Sihem Cherrared (2nd year), supervised by Eric Fabre, Gregor Goessler (Inria team Spades in Grenoble) and Sofiane Imadali (Orange Labs).

8.1.3. Alstom Transport - P22

Joint Alstom-Inria research lab: Several researchers of SUMO are involved in the joint research lab of Alstom and Inria, in a common research team called P22. On Alstom side, this joint research team involves researchers of the ATS division (Automatic Train Supervision). The objective of this joint team is to evaluate regulation policies of urban train systems, to assess their robustness to perturbations and failures, to design more efficient regulation policies and finally to provide decision support for human regulators. The project started in march 2014. A second phase of the project started in 2016, for a duration of three years. This covers in particular the CIFRE PhD of Karim Kecir.

8.1.4. Mitsubishi Electric Research Center Europe (MERCE)

Several researchers of SUMO are involved in a collaboration with the formal verification team of MERCE on model checking of real-time systems. The members of the formal verification team at MERCE work on different aspects of formal verification and participate to academic collaborations.

The SUMO team and MERCE have jointly supervised an M1 internship (Ludovic Landuré), and are supervising a Cifre PhD student (Emily Clement) funded by MERCE, started this fall. Reiya Noguchi, a member of MERCE will be hosted by the SUMO team in 2019.

TAMIS Project-Team

8. Bilateral Contracts and Grants with Industry

8.1. Bilateral Contracts with Industry

- CISCO (<http://www.cisco.com>) contract (2017–2022) to work on graph analysis of malware

8.2. Bilateral Grants with Industry

- CISCO (<http://www.cisco.com>) one grant (2016–2019) to work on semantical analysis of malware
- Thales (<https://www.thalesgroup.com>) one CIFRE (2016–2019) to work on verification of communication protocols, one grant (2018–2019) to work on learning algorithms
- Oberthur Technologies (<http://www.oberthur.com/>) one grant (2016–2020) to work on fuzzing and fault injection

TEA Project-Team

8. Bilateral Contracts and Grants with Industry

8.1. Bilateral Contracts with Industry

8.1.1. *Inria – Mitsubishi Electric framework program (2018+)*

Title:

Inria principal investigator: Jean-Pierre Talpin, Simon Lunel

International Partner: Mitsubishi Electric R&D Europe (MERCE)

Duration: 2018

Abstract: Following up the fruitful collaboration of TEA with the formal methods group at MERCE, Inria and Mitsubishi Electric signed a center-wide collaboration agreement, which currently hosts projects with project-teams Sumo and Tea.

8.1.2. *Mitsubishi Electric R&D Europe (2015-2018)*

Title: Analysis and verification for correct by construction orchestration in automated factories

Inria principal investigator: Jean-Pierre Talpin, Simon Lunel

International Partner: Mitsubishi Electric R&D Europe

Duration: 2015 - 2018

Abstract: The primary goal of our project is to ensure correctness-by-design in cyber-physical systems, i.e., systems that mix software and hardware in a physical environment, e.g., Mitsubishi factory automation lines. We develop a component-based approach in Differential Dynamic Logic allowing to reason about a wide variety of heterogeneous cyber-physical systems. Our work provides tools and methodology to design and prove a system modularly.

I4S Project-Team

6. Bilateral Contracts and Grants with Industry

6.1. Bilateral Contracts with Industry

6.1.1. Contract with SNCF: DEMETER

Participants: Vincent Le Cam, Quentin Bossard, Mathieu Le Pen.

IFSTTAR's engineers Arthur Bouche and Laurent Lemarchand are contributing to this project.

DEMETER is one of the major projects for I4S in terms of strategy, scientific and technological impact.

DEMETER is a meta project whose global objective is the validation of the contribution of the Internet of Things (IOT) applied to the health monitoring of railway items. SNCF and IFSTTAR have signed a roadmap for safety relevant items, where wireless monitoring and smart algorithms could bring strong improvements to SNCF in terms of real-time maintenance or predictive maintenance. Those items are, amongst others:

- Crossing engine motor monitoring
- Needle motor monitoring
- Axle counter monitoring
- Train detection pedal monitoring

In each case, a prototype of a specific wireless and smart sensor is designed (that may or may not use PEGASE 2 platform), installed along railway lines in service and data are transmitted wirelessly to the cloud supervisor at IFSTTAR for evaluation in SHM algorithms.

In particular, during 2017 SNCF and IFSTTAR have performed the following common projects:

- finalization of the TRAIN PEDAL DETECTION instrumentation with smart sensors using new wireless and industrial IOT protocols: LoRa and Sigfox. A specific pedal is now subject of in situ test led by SNCF
- axle counter monitoring has been the major R&D subject of 2017: 2 entire and specific smart sensors have been designed, programmed and installed at Chevilly specific SNCF testbench (e.g. with real train passages). Specific algorithms (such as PID and Pattern Recognition) have been modeled and programmed into PEGASE2 platform for these new sensors.

For the future, new projects related to

- water-level monitoring around railways has been setup
- ballast vibration monitoring of railways has been setup
- "unshunting of electrical lines at train passage" detection around railways

have been initiated with SNCF R&D department.

6.1.2. Contracts with SDEL-CC (VINCI Group)

Participants: Vincent Le Cam, Mathieu Le Pen.

This work was done in collaboration with Laurent Lemarchand, and Arthur Bouche at IFSTTAR, SII, Nantes. Following a 2016 contract, a new contract was signed in 2017 until end 2018, with the company SDEL-CC, a 100% affiliate of the VINCI Group, Energy department. The project exploits the unique time stamp capacity of the PEGASE 2 platform up to 50 nanoseconds, independently of distances in the network of PEGASE2 nodes. The synchronization capacity is employed to design a sensor prototype based on PEGASE 2 to time-stamp the current wave after a lightning impact on a high-voltage line. By knowing the exact time, the wave can be seen at each extremity of the electrical line to localize accurately the lightning impact point.

During 2017, a real high-voltage electrical line has been instrumented: at each end of the line, 2 sensors have been set up and data are sent in real time to a cloud platform. Furthermore, the software of the platform was optimized: at the embedded level (i.e. on PEGASE 2 wireless system) with new algorithms to correct time synchronization up to some 10 nanoseconds, at the cloud level with a specific QT C++ Interface to display results (i.e. lightning localization on electrical line) and to transform raw data into ComTrade standard representation.

Discussions are ongoing with SDEL-CC to transform the prototype into a future product.

MINGUS Project-Team

8. Bilateral Contracts and Grants with Industry

8.1. Bilateral Contracts with Industry

Contract with RAVEL (01/09/2018-31/08/2019, budget 15000 euros) : P. Chartier, M. Lemou and F. Méhats initiated a collaboration with the startup RAVEL on a one-year basis (with possible renewal at the end of the year). The objective is to study the mathematical foundations of artificial intelligence and in particular machine learning algorithms for data anonymized through homomorphic encryption.

Contract with CaiLabs (20/12/2018-20/06/2019, budget 8774 euros) : E. Faou initiated a collaboration with the startup CaiLabs on a six-months basis (with possible renewal at the end of the contract). The collaboration between CaiLabs and MINGUS aims at modelling optical devices allowing the recognition of simple objects. The structure of the devices combines quantum propagation phenomena, reflection mirrors and frequency absorbers and possesses a deep neural networks structure.

SIMSMART Team

7. Bilateral Contracts and Grants with Industry

7.1. Bilateral Contracts or Grants with Industry (Private Sector)

1. **Scalian Alyotech**, through the CIFRE PhD project of Gabriel Jouan, dedicated to weather forecast corrections.
2. **Naval Group Research**, through the CIFRE PhD project of Audrey Cuillery dedicated to Bayesian tracking.
3. **Eau du Ponant**, through the R&D project MEDISA (<https://www.eauduponant.fr/fr/actualite/lancement-du-projet-de-rd-medisa>) on water industry.

7.2. Bilateral Contracts or Grants with Industry (Public Sector)

1. **CEA LETI** on indoor navigation (particle filtering) through the CEA PhD grant of Kersane Zoubert–Ousseni.
2. **EURAMED** (a Euro-Mediterranean Cooperation Initiative, which aims to develop an Internet-based, multi-parametric electronic platform for optimum design of desalination plants, supplied by Renewable Energy Sources (RES). PI: E. Koutroulis (GREECE).

DYLISS Project-Team

8. Bilateral Contracts and Grants with Industry

8.1. Bilateral Grants with Industry

8.1.1. *SANOFI: co-supervised PhD*

Participants: Emmanuelle Becker, Olivier Dameron, Anne Siegel, Méline Wery.

This collaboration project is focused on the implementation of an integrative analysis framework based on semantic web technologies and reasoning in the framework of scleroderma pathology. **CIFRE co-supervised Grant: Ph.D. funding. 2017-2020**

FLUMINANCE Project-Team

7. Bilateral Contracts and Grants with Industry

7.1. Bilateral Contracts with Industry

7.1.1. Contract ITGA

Participants: Dominique Heitz, Etienne Mémin.

duration 36 months. This partnership between Inria, Irstea and ITGA funds the PhD of Romain Schuster. The goal of this PhD is to design new image-based flow measurement methods for the study of industrial fluid flows. Those techniques will be used in particular to calibrate industrial fume hood.

7.1.2. Contract CSTB

Participants: Mohamed Yacine Ben Ali, Dominique Heitz, Etienne Mémin.

duration 36 months. This partnership between Inria, Irstea and CSTB funds the PhD of Yacine Ben Ali. This PhD aims to design new data assimilation scheme for Reynolds Average Simulation (RANS) of flows involved in wind engineering and buildings construction. The goal pursued here consists to couple RANS models and surface pressure data in order to define data driven models with accurate turbulent parameterization.

GENSCALE Project-Team

8. Bilateral Contracts and Grants with Industry

8.1. Bilateral Contracts with Industry

8.1.1. Processing in memory

Participants: Charles Deltel, Dominique Lavenier.

The UPMEM company is currently developing new memory devices with embedded computing power (<http://www.upmem.com/>). GenScale investigates how bioinformatics algorithms can benefit from these new types of memory. In 2018 we parallelized the detection of short variants (see new results section).

8.1.2. Tank milk analysis

Participants: Dominique Lavenier, Jacques Nicolas.

The Seenergi company has developed a biotechnology protocol to detect cow mastitis directly by analyzing the milk of the tanks. Cows are first genotyped. Since cows with mastitis produce a high level of lymphocytes, a DNA milk analysis can point out infested cows. Currently, DNA chips are used to support this analysis. We are currently investigating the possibility to use sequencing technologies in order to both reduce cost analysis and to extend the detection to larger herds.

8.2. Bilateral Grants with Industry

8.2.1. Rapsodyn project

Participants: Dominique Lavenier, Claire Lemaitre, Sebastien Letort, Pierre Peterlongo, Gwendal Virlet.

RAPSODYN is a long term project funded by the IA ANR French program (Investissement d'Avenir) and several field seed companies, such as Biogemma, Limagrain and Euralis (<http://www.rapsodyn.fr/>). The objective is the optimization of the rapeseed oil content and yield under low nitrogen input. GenScale is involved in the bioinformatics work package, in collaboration with Biogemma's bioinformatics team, to elaborate advanced tools dedicated to polymorphism detection and analysis.

SERPICO Project-Team

8. Bilateral Contracts and Grants with Industry

8.1. Bilateral grants with industry

8.1.1. *Fourmentin-Guilbert Foundation: Macromolecule detection in cryo-electron tomograms*

Participants: Emmanuel Moebel, Charles Kervrann.

Collaborators: Damien Larivière (Fourmentin-Guilbert Foundation).

A three-year contract was established with Fondation Fourmentin-Guilbert to partly support the PhD thesis of Emmanuel Moebel. The Fondation Fourmentin-Guilbert strives for building a virtual *E. coli* bacteria. Information about the position of macromolecules within the cell is necessary to achieve such a 3D molecularly-detailed model. The Fondation Fourmentin-Guilbert supports cutting-edge *in-situ* cryo-electron tomography combined with image processing at the Max-Planck Institute of Biochemistry to map the spatial distribution of the ribosomes, and obtain structural information on the complexes they form *in-situ* with cofactors and other ribosomes. The objective of the project is to explore novel methods from the field of 3D shape retrieval for identifying and counting macromolecules within a tomogram. This project is also supported by Région Bretagne.

8.1.2. *DGA contract on motion saliency analysis*

Participants: Léo Maczyta, Patrick Bouthemey

Funding: DGA (National Defense Agency) (Oct 2017 - Sept 2020)

Collaborators:

This project funded by the DGA (Ministry of defense) concerns the PhD thesis (co-funding) carried out by Léo Maczyta. The goal is to develop motion saliency methods along three axes: temporal motion saliency detection, saliency map estimation, trajectory-based saliency detection.

VISAGES Project-Team

8. Bilateral Contracts and Grants with Industry

8.1. Bilateral Contracts with Industry

8.1.1. Siemens

In the context of the Neurinfo imaging platform, a master research agreement between Siemens SAS - Healthcare and University of Rennes 1 defines the terms of the collaboration between Siemens, Visages and the Neurinfo platform. Relying on this research agreement contract, Neurinfo has received work in progress (WIP) sequences from Siemens in the form of object code for evaluation in the context of clinical research. The Neurinfo platform has also received source code of selected MRI sequences. As an example, the diffusion sequence code was modified to load arbitrary diffusion gradient waveforms for the FastMicroDiff project led by E. Caruyer. This is crucial in the collaboration since it enables the development of MRI sequences on site. Siemens currently provides research resources through the funding of a PhD student (Cédric Meurée: CIFRE Inria / Siemens grant). The MR Diffusion pulse sequence source code was modified in collaboration with our Siemens clinical scientist as part of our Master Research Agreement, Marc Lapert, in order to play arbitrary gradient waveforms. This was done on the Syngo VB17 software version and again on VE11C (nearly finished).

The PhD of Cédric Meurée is funded by Siemens Healthineers under a CIFRE grant.

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 Illyne 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 led 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.

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: OKWind⁰ 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-supervised with Tayeb Lemlouma (IRISA OCIF team).

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.

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.

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 Research 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 particular 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 ecosystem.

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.

HYBRID Project-Team

8. Bilateral Contracts and Grants with Industry

8.1. Bilateral Contracts with Industry

8.1.1. Mensia Technologies

Participants: Anatole Lécuyer, Jussi Tapio Lindgren.

Mensia Technologies is an Inria start-up company created in November 2012 as a spin-off of Hybrid team. Mensia is focused on wellness and healthcare applications emerging from the BCI and Neurofeedback technologies. The Mensia startup benefit from the team's expertise and of valuable and proprietary BCI research results. Mensia is based in Rennes and Paris. Anatole Lécuyer and Yann Renard (former Inria expert engineer who designed the OpenViBE software architecture and was involved in team projects for 5 years) are co-founders of Mensia Technologies.

The on-going contract between Hybrid and Mensia started in November 2013 and supports the transfer of several softwares designed by Hybrid team (eg, OpenViBE and StateFinder) related to our BCI activity to Mensia Technologies for medical and multimedia applications of Mensia.

8.2. Bilateral Grants with Industry

8.2.1. Technicolor

Participants: Antoine Costes, Anatole Lécuyer, Ferran Argelaguet.

This grant started in December 2015. It supported Antoine Costes's CIFRE PhD program with Technicolor company on "Haptic Texturing".

8.2.2. Realyz

Participants: Guillaume Cortes, Anatole Lécuyer.

This grant started in December 2015. It supported Guillaume Cortes's CIFRE PhD program with Realyz company on "Improving tracking in VR".

8.2.3. VINCI Construction

Participants: Anne-Solène Dris-Kerdreux, Bruno Arnaldi, Valérie Gouranton.

This grant started in November 2015. It supported Anne-Solene Dris-Kerdreux's CIFRE PhD program with Vinci company on "Training in VR for construction applications".

8.2.4. Orange Labs

Participants: Guillaume Bataille, Bruno Arnaldi, Valérie Gouranton.

This grant started in October 2017. It supports Guillaume Bataille's PhD program with Orange Labs company on "Natural Interactions with IoT using VR/AR".

LACODAM Project-Team

8. Bilateral Contracts and Grants with Industry

8.1. Bilateral Contracts with Industry

- **AdvisorSLA 2018 - Inria**

Participants: E. Bourrand, L. Galárraga, E. Fromont, A. Termier

Contract amount: 7,5k€

Context. AdvisorSLA is a French company headquartered in Cesson-Sévigné, a city located in the outskirts of Rennes in Brittany. The company is specialized in software solutions for network monitoring. For this purpose, the company relies on techniques of network metrology. AdvisorSLA's customers are carriers and telecommunications/data service providers that require to monitor the performance of their communication infrastructure as well as their QoE (quality of service). Network monitoring is of tremendous value for service providers because it is their primary tool for proper network maintenance. By continuously measuring the state of the network, monitoring solutions detect events (e.g., an overloaded router) that may degrade the network's operation and the quality of the services running on top of it (e.g., video transmission could become choppy). When a monitoring solution detects a potentially problematic sequence of events, it triggers an alarm so that the network manager can take actions. Those actions can be preventive or corrective. Some statistics gathered by the company show that only 40% of the triggered alarms are conclusive, that is, they manage to signal a well-understood problem that requires an action from the network manager. This means that the remaining 60% are presumably false alarms. While false alarms do not hinder network operation, they do incur an important cost in terms of human resources.

Objective. We propose to characterize conclusive and false alarms. This will be achieved by designing automatic methods to “learn” the conditions that most likely precede the fire of each type of alarm, and therefore predict whether the alarm will be conclusive or not. This can help adjust existing monitoring solutions in order to improve their accuracy. Besides, it can help network managers automatically trace the causes of a problem in the network. The aforementioned problem has an inherent temporal nature: we need to learn which events occur before an alarm and in which order. Moreover, metrology models take into account the measurements of different components and variables of the network such as latency and packet loss. For these two reasons, we resort to the field of multivariate time sequences and time series. The fact that we know the “symptoms” of an alarm and whether it is conclusive or not, allows for the application of supervised machine learning and pattern mining methods.

Additional remarks. This is a pre-doctoral contract signed with AdvisorSLA to start the work for the PhD of E. Bourrand (Thèse CIFRE) while the corresponding administrative formalities are completed.

- **ATERMES 2018-2021 - Univ Rennes 1**

Participants: H. Zhang, E. Fromont

Contract amount: 45k€

Context. ATERMES is an international mid-sized company, based in Montigny-le-Bretonneux with a strong expertise in high technology and system integration from the upstream design to the long-life maintenance cycle. It has recently developed a new product, called BARIERTM (“Beacon Autonomous Reconnaissance Identification and Evaluation Response”), which provides operational and tactical solutions for mastering borders and areas. Once in place, the system allows for a continuous night and day surveillance mission with a small crew in the most unexpected rugged terrain. BARIERTM is expected to find ready application for temporary strategic site protection or ill-defined border regions in mountainous or remote terrain where fixed surveillance modes are impracticable or overly expensive to deploy.

Objective. The project aims at providing a deep learning architecture and algorithms able to detect anomalies (mainly the presence of people or animals) from multimodal data. The data are considered “multimodal” because information about the same phenomenon can be acquired from different types of detectors, at different conditions, in multiple experiments, etc. Among possible sources of data available, ATERMES provides Doppler Radar, active-pixel sensor data (CMOS), different kind of infra-red data, the border context etc. The problem can be either supervised (if label of objects to detect are provided) or unsupervised (if only times series coming from the different sensors are available). Both the multimodal aspect and the anomaly detection one are difficult but interesting topics for which there exist few available works (that take both into account) in deep learning.

- **PSA - Inria**

Participants: E. Fromont, A. Termier, L. Rozé, G. Martin

Contract amount: 15k€

Context. Peugeot-Citroën (PSA) group aims at improving the management of its car sharing service. To optimize its fleet and the availability of the cars throughout the city, PSA needs to analyze the trajectory of its cars.

Objective. The aim of the internship is (1) to survey the existing methods to tackle the aforementioned need faced by PSA and (2) to also investigate how the techniques developed in LACODAM (e.g., emerging pattern mining) could be serve this purpose. A framework, consisting of three main modules, has been developed. We describe the modules in the following.

- A town modelisation module with clustering. Similar towns are clustered in order to reuse information from one town in other towns.
- A travel prediction module with basic statistics.
- A reallocation strategy module (choices on how to relocate cars so that the most requested areas are always served). The aim of this module is to be able to test different strategies.

Additional remarks. This is a pre-doctoral contract to start the work for the PhD of G. Martin (Thèse CIFRE) while the corresponding administrative formalities are completed.

LINKMEDIA Project-Team

7. Bilateral Contracts and Grants with Industry

7.1. Bilateral Contracts with Industry

7.1.1. *Few shot learning for object recognition in aerial images (CIFRE PhD)*

Participants: Yannis Avrithis, Yann Lifchitz.

Duration: 3 years, started in March 2018

Partner: Safran

This is a CIFRE PhD thesis project aiming to study architectures and learning techniques most suitable for object recognition from few samples and to validate these approaches on multiple recognition tasks and use-cases related to aerial images.

7.1.2. *Incremental dynamic construction of knowledge bases from text mining (CIFRE PhD)*

Participants: Guillaume Gravier, Pascale Sébillot, Cyrielle Mallart.

Duration: 3 years, started in Dec. 2018

Partner: Ouest France

In the context of a newspaper, the thesis explores the combination of text mining and knowledge representation techniques to assist the extraction, interpretation and validation of valuable pieces of information from the journal's content so as to incrementally build a full-scale knowledge base. This thesis is in close relation with the iCODA Inria Project Lab, with direct contribution to the project's results.

7.1.3. *Embedding heterogeneous data for directory search (CIFRE PhD)*

Participants: Guillaume Gravier, Vincent Claveau, François Torregrossa.

Duration: 3 years, started in Dec. 2018

Partner: SoLocal

The thesis aims at learning how to jointly exploit heterogeneous sources of information (e.g., names, activity sector, user profiles, queries, etc.) in the design of neural network embeddings for information retrieval and language understanding. Applications cover natural language query analysis and personalized information retrieval in Pagesjaunes' directory.

7.1.4. *Active learning on adaptive representations for object detection in high-resolution imaging (CIFRE PhD)*

Participants: Ewa Kijak, Mathieu Laroze.

Duration: 3 years, started in Jun. 2016

Partner: Wipsea

Wipsea is a Rennaise startup, created in 2013 whose core business is image analysis for ecology. WIPSEA helps biologists, Unmanned Aerial Vehicle (UAV) companies and environmental consultants to automatically process automatically captured pictures by proposing image-processing algorithms that detect and characterize all kinds of animals such as dugongs, whales, elephants, and orangutans... The main objective of the thesis is to develop a detection method to optimize the interaction between the expert and the system in order to converge as quickly as possible to an object detection solution adapted to a given task.

MIMETIC Project-Team

8. Bilateral Contracts and Grants with Industry

8.1. Bilateral Contracts with Industry

8.1.1. BPI-PCR Robo-KII

Participant: Armel Crétual [contact].

This contract has started in February 2017 and ended in October 2018. In M2S, it involved two permanent members of MimeTic team, Armel Crétual and Franck Multon, and two engineers, Antoine Marin (18 months grant) and Brice Bouvier (10 months grant).

This project was a collaboration between BA Healthcare and M2S lab. It aimed at developing a robotics platform to allow physicians to start gait rehabilitation as soon as possible, even before patients are able to maintain upright posture alone. The usual way to perform such rehab sessions is to make the patient walk on a treadmill benefiting from a harness to prevent patient from falling. The two main limits of this approach are that:

- only straightforward at constant speed gaits are feasible whereas falling risks are much higher when modifying speed or turning
- walking on a treadmill when motor abilities are very affected can be challenging and can generate strong apprehension.

In a previous project, Robo-K, ended in september 2016, BA Healthcare has developed a first prototype of a mobile robot which strongly modified the approach: the harness is mobile and follows the patient displacement. In this way, the patient walks on the ground at his/her desired speed and the physician can include curved trajectories in the rehab process.

The main novelty of Robo-KII project was to implement a biofeedback system onto the robotics platform to reinforce rehab sessions. Closely working with physicians from two PMR services, CHU Rennes and Kerpape center, we tested several parameters of the feedback to be given to the patients. In particular, in a clinical pre-test, we focused on the temporal aspect, i.e. providing the feedback at each gait cycle or only after one rehab exercise (up to 20 steps) to avoid dual tasks situation as patients in this early stage after stroke usually also suffer from cognitive issues.

8.1.2. Unity - Cinecast

Participants: Marc Christie [contact], Quentin Galvane.

Cinecast is a research collaboration between Unity and Inria Rennes. The collaboration is focused on automated cinematography and automated editing technologies for creating video casts of 3D game sessions. The project has started in July 2018 for one year, and with a budget of 45k€. The challenge consists in specializing the general editing techniques proposed in our Automated Editing paper (AAAI 2015), reducing the knowledge of the editing algorithm from the full sequence to only 3 seconds. A first demonstration of the results was presented at the Unite 2018 event in Los Angeles.

8.1.3. SolidAnim - Solidtrack

Participants: Marc Christie [contact], Xi Wang.

In the scope of the ANR project LabCom, the purpose of this research collaboration is to develop SLAM technologies which are robust to changes in the lighting conditions. The collaboration started in October 2018, with a budget of 180k€ for a duration of three years. The budget is mostly dedicated to hiring PhD student Xi Wang. The work is a co-supervision with Eric Marchand (from Rainbow team).

8.1.4. Cifre Faurecia - Monitoring de l'efficience gestuelle d'opérateurs sur postes de travail

Participants: Franck Multon [contact], Georges Dumont, Charles Pontonnier, Olfa Haj Mahmoud.

This Cifre contract has started in September 2018 for three years and is funding the PhD thesis of Olfa Haj Mamhoud. It consists in designing new methods based on depth cameras to monitor the activity of workers in production lines, compute the potential risk of musculoskeletal disorders, and efficiency compared to reference workers. It raises several fundamental questions, such as adapting previous methods to assess the risk of musculoskeletal disorders, as they generally rely on static poses whereas the worker is performing motion. Based on previous works in the team (previous Cifre PhD thesis of Pierre Plantard) we will provide 30Hz motion capture of the worker, that will enable us to evaluate various time-dependent assessment methods.

We will also explore how to estimate joint forces based and torques on such noisy and low-sampling motion data. We will then define a new assessment method based on these forces and torques.

The Cifre contracts funds the PhD salary and 30K€ per year for the supervision and management of the PhD thesis.

8.2. Bilateral Grants with Industry

8.2.1. Bilateral contract with Technicolor

Participant: Marc Christie.

Bilateral contract with Technicolor on empowering drones with cinematographics knowledge. Participants: Philippe Guillotel, Julien Fleureau, Quentin Galvane. Amount 25k€. Duration 24 months.

PANAMA Project-Team

8. Bilateral Contracts and Grants with Industry

8.1. Bilateral Contracts with Industry

8.1.1. Contract with 5th dimension on "dynamic separation of localized sound sources"

A first phase of this contract, in collaboration with InriaTech, involved porting in C++ a subset of our source localization library Multichannel BSS Locate. A second phase will involve further investigations on the interplay between localization and separation, using the FASST library, with support from LABEX AMIES.

8.1.2. Contract with Honda on "multichannel speech and audio processing"

This is a follow-up contract, which targets collaborative research on multichannel speech and audio processing and eventual software licensing in order to enable voice-based communication in challenging noisy and reverberant conditions in which current hands-free voice-based interfaces perform poorly.

8.2. Bilateral Grants with Industry

8.2.1. CIFRE contract with Technicolor R&I France on Very large scale visual comparison

Participants: Rémi Gribonval, Himalaya Jain.

Duration: 3 years (2015-2018)

Research axis: [3.1.2](#)

Partners: Technicolor R&I France; Inria-Rennes

Funding: Technicolor R&I France; ANRT

The grand goal of this thesis was to design, analyze and test new tools to allow large-scale comparison of high-dimensional visual signatures. Leveraging state of the art visual descriptors, the objective is to obtain new compact codes for visual representations, exploiting sparsity and learning, so that they can be stored and compared in an efficient, yet meaningful, way.

8.2.2. CIFRE contract with Facebook Artificial Intelligence Research, Paris on Deep neural networks for large scale learning

Participants: Rémi Gribonval, Pierre Stock.

Duration: 3 years (2018-2021)

Research axis: [3.1.2](#)

Partners: Facebook Artificial Intelligence Research, Paris; Inria-Rennes

Funding: Facebook Artificial Intelligence Research, Paris; ANRT

The overall objective of this thesis is to design, analyze and test large scale machine learning algorithms with applications to computer vision and natural language processing. A major challenge is to design compression techniques able to replace complex and deep neural networks with much more compact ones while preserving the capacity of the initial network to achieve the targeted task. An avenue primarily envisioned to achieve this goal is to rely on structured linear layers.

RAINBOW Project-Team

8. Bilateral Contracts and Grants with Industry

8.1. Bilateral Contracts with Industry

8.1.1. Robocortex

Participants: Fabien Spindler, François Chaumette.

no Inria Rennes 11369, duration: 20 months.

This contract with the Inria Robocortex start up in Sophia-Antipolis ended in May 2018. It is devoted to provide our expertise in visual tracking for an application specified by Dassault Aviation.

8.1.2. ABB

Participants: Souriya Trinh, Fabien Spindler, François Chaumette.

no Inria Rennes 12597, duration: 8 months.

This contract with ABB in Barcelona started in September 2017. It is devoted to provide our expertise in visual tracking and visual servoing for an industrial application.

8.1.3. IRT b<>com

Participants: Hadrien Gurnel, Fabien Spindler, Alexandre Krupa.

no Inria Rennes 11774, duration: 36 months.

This contract started in October 2016 and concerns the leasing to IRT b<>com of two modules of the Rainbow medical robotic platform. Each module is rent 40 days during a 3-year period in the context of the IRT b<>com NeedleWare project (see Section 9.1.6).

8.2. Bilateral Grants with Industry

8.2.1. Pôle Saint Hélier

Participants: Louise Devigne, Marie Babel.

no Insa Rennes 2015/0890, duration: 36 months.

This project started in November 2015 and supports Louise Devigne PhD about wheelchair navigation assistance. The idea is first to design a low-cost indoor / outdoor efficient obstacle avoidance system that respects the user intention, and does not alter user perception. The second objective is to take advantage of the proposed assistive tool to enhance the user Quality of Experience by means of biofeedback as well as the understanding of the evolution of the pathology.

8.2.2. Technicolor

Participants: Salma Jiddi, Eric Marchand.

no Univ. Rennes 1 15CC310-02D, duration: 36 months.

This project funded by Technicolor started in October 2015. It supports Salma Jiddi's Ph.D. about augmented reality (see Section 7.1.4).

8.2.3. Realyz

Participant: Eric Marchand.

no Inria Rennes 10822, duration: 36 months.

This project funded by Realyz started in October 2015. It is achieved in cooperation with Anatole Lécuyer from Hybrid group at Irisa and Inria Rennes-Bretagne Atlantique to support Guillaume Cortes Ph.D. about motion tracking in virtual reality.

SIROCCO Project-Team

8. Bilateral Contracts and Grants with Industry

8.1. Bilateral Contracts with Industry

8.1.1. CIFRE contract with Technicolor on light fields editing

Participants: Christine Guillemot, Matthieu Hog.

- Title : Light fields editing
- Research axis : [7.1.1](#)
- Partners : Technicolor (N. Sabater), Inria-Rennes.
- Funding : Technicolor, ANRT.
- Period : Oct.2015-Sept.2018.

Editing is quite common with classical imaging. Now, if we want light-field cameras to be in the future as common as traditional cameras, this functionality should also be enabled with light-fields. The goal of the PhD thesis is to develop methods for light-field editing, and in 2018 we have extended our concept of super-rays initially introduced for static light fields to video light fields (see Section [7.1.1](#)). Super-rays group rays within and across views, emitted by the same set of 3D points in the space. A method for dynamic tracking of super-rays with scene flow estimation has been developed. We have further explored a novel way, using recurrent neural networks and in particular long short term memory (LSTM) networks, to solve the problem of view synthesis (see Section [7.3.1](#)).

8.1.2. CIFRE contract with Technicolor on light fields compressed representation

Participants: Christine Guillemot, Fatma Hawary.

- Title : Light fields compressed representation
- Research axis : [7.2.2](#)
- Partners : Technicolor (G. Boisson), Inria-Rennes.
- Funding : Technicolor, ANRT.
- Period : Feb.2016-Jan.2019.

The goal of this PhD thesis is to study reconstruction algorithms from compressed measurements. The goal is to apply these algorithms to scalable compression of light fields. Methods of sparse light field recovery have been developed, based on the assumption of sparsity in the Fourier domain, and using orthogonality constraint in the Fourier transform domain. The method has been further improved by introducing a refinement of the basis functions with non integer frequencies.

8.1.3. CIFRE contract with Technicolor on cloud-based image compression

Participants: Jean Begaint, Christine Guillemot.

- Title : Cloud-based image compression
- Research axis : [7.2.6](#)
- Partners : Technicolor (Ph. Guillotel, F. Galpin), Inria-Rennes.
- Funding : Technicolor, ANRT.
- Period : Nov.2015-Oct.2018.

The goal of this Cifre contract is to develop a novel image compression scheme exploiting similarity between images in a cloud. A region-based geometric and photometric alignment algorithm has been developed and validated for still image compression with an inter-coding set-up using similar images in the cloud as reference frames. This model has been further validated in the context of temporal prediction in a video compression scheme (see Section 7.2.6). Neural network based frame interpolation techniques have also been investigated, showing promising performance gains compared to the state of the art.

8.1.4. DGA contract on deep learning for image compression

Participants: Thierry Dumas, Christine Guillemot, Aline Roumy.

- Title : Deep learning for image compression
- Research axis : 7.2.5
- *Partners:* Inria-Rennes (Sirocco team)
- *Funding:* DGA/Ministry of defense
- Period : Oct.2015-Sept.2018.

This project funded by the DGA/Ministry of Defense concerns the PhD thesis of T. Dumas. The goal was to study deep learning architectures for image compression. Autoencoders have been studied to jointly learn transforms and quantizers with rate-distortion optimization criteria. A set of neural network architectures called Prediction Neural Networks Set (PNNS), based on both fully-connected and convolutional neural networks, has also been developed for intra image prediction (see Section 7.2.5).