RESEARCH CENTER
Rennes - Bretagne-Atlantique

FIELD

Activity Report 2019

Section Contracts and Grants with Industry

Edition: 2020-03-21

CAIRN Project-Team (section vide)

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** One of the main activities of HP Inc. is to develop and manufacture computing platforms (such as laptops, printers, etc). These platforms consist of hardware and embedded software (usually referred to as firmware). Such embedded software is typically required for the proper functioning of the hardware and relied upon by high level operating system, application or solution software. One of the research tracks of this collaboration consists in enhancing the security level of low-level software components (firmware and OS) in future computing platforms. The final objective is to provide a more resilient and trustworthy platform to the end-user. This work is carried out in the context of the PhD of Ronny Chevalier.
- **DGA (2018-2020)** Traditionally, IDSes are evaluated based on their detection ability against a labeled dataset that contains normal and abnormal network traffic. Upon inspection, it is clear that datasets publicly available are usually obsolete in the span of a couple years in both anomaly types and background, benign Internet traffic. They also suffer from a lack of volume and diversity in traffic, and ultimately, lack of representativeness and realism. In this context, the goal of this project is to come up with an evolutive platform for IDS evaluation that solves many of the issues that exist in the state of the art methods. In order to create such an evolutive platform, there is a need for dynamic infrastructure that allows continuous and automatic change. Here are a number of design principles that we followed for our platform: reproducibility (it is possible to rebuild the infrastructure of the platform or any element of it); repeatability (any action carried out on the infrastructure tested in the platform is repeatable); live evaluation (while traditional IDS evaluation is carried out using a static benchmark dataset, we propose an environment that resembles what IDS does in real life); realism (in terms of traffic generation, real world attack representativeness, and system setup. This will surely be a continuous and evolutive effort to try to approach real world conditions as best as can be); automatization (scripts allow a complete description of the system in which an IDS is tested, and of normal/malicious activity generation inside this system).

  This work is carried out in the context of the postdoc of Mouad Lemoudden.
- **DGA (2019-2021)** DGA and its industrial partners have to regularly implement filters applied to standard or proprietary protocols on communication interfaces or directly in products. In order to allow administrators to easily adapt these filters to the specific context of the various devices, filtering languages specific to the different filtering policies applicable to the different devices should be developed. Even for simple static filters, the definition of such languages is a complex task. A methodological approach that would simplify this task for higher level abstraction filtering languages (and therefore simpler to use) would be to allow the definition of higher level abstraction filtering languages by relying on a single language of lower level of abstraction. This would make it possible to define high-level abstraction and easy-to-use languages in a recursive way by progressively increasing the levels of abstraction (and specificity). In addition, this approach would improve reusability. Indeed, it would be possible to rely on a filtering language, previously developed for another project, in order to more easily develop a more specific (and easy to use) language for another project.

  This work is carried out in the context of the postdoc of Ludovic Claudepierre

7.2. Bilateral Grants with Industry

- **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.
- **Idemia: Hardware Security for Embeded 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 kind 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 developped an attack allowing to take a full control on the device. He discovered also new fault attacks never described in the litterature.
- **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 serach in a corpus of applicatons methods having the same semantics. Then in a second step, after convertir the source code into a vector he compute 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 CentraleSupelec 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 CentraleSupelec 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. 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 initiative [0].

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

[0] http://gemoc.org

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.

In 2019, the Hycomes team has been working on the use of Quantized State System (QSS) nethods for the cosimulation of aeronautics system models. The aim is to design new distributed simulation protocols, capable of simulating large, but heterogeneous system models. The investigation is on the trade-offs between pessimistic simulation techniques, where no roll-back is required, and speculative methods, where roll-back may be required. The latter method can be beneficial to the performance and scalability of the simulation, provided roll-backs do not happen too often. The models under consideration are cyberphysical systems consisting in both Modelica models (for the physics) and discrete-time models expressed in a dedicated language (for the control).

In 2019, the Hycones team has delivered one report, detailing the state-of-the-art techniques for continuous systems cosimulation.

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, Anis Peysieux, 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 study control and diagnosis issues for such systems.

Two PhD students are involved in the project. Erij Elmajed (3rd year), on the topic of Diagnosis of virtualized and reconfigurable systems supervised by Éric Fabre and Armen Aghasaryan (Nokia Bell Labs). Abdul Majith (started 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 takes part 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 Éric Fabre, Gregor Goessler (Inria Spades, Grenoble) and Sofiane Imadali (Orange Labs).

8.1.3. Alstom Transport - P22

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 P22 project between Alstom and Inria ended in 2018. However, our collaboration with Alstom Transport continues. One of the outcomes of this collaboration is the PhD defense of Karim Kecir in July 2019 [2].

8.1.4. Mitsubishi Electric Research Center Europe (MERCE)

Several researchers of SUMO are involved in a collaboration on the verification of real-time systems with the "Information and Network Systems (INS)" Team led by David Mentré of the "Communication & Information Systems (CIS)" Division of MERCE Rennes. The members of the team at MERCE work on different aspects of formal verification. Currently the SUMO team and MERCE jointly supervise a Cifre PhD student (Emily Clément) funded by MERCE since fall 2018; the thesis is about robustness of reachability in timed automata. Moreover Reiya Noguchi, a young engineer, member of MERCE, on leave of a Japanese operational division of Mitsubishi is also hosted and co-supervised by the SUMO team since the beginning of 2019, one day per week; we collaborate with him on the consistency of timed requirements.

TAMIS Project-Team

7. Bilateral Contracts and Grants with Industry

7.1. Bilateral Contracts with Industry

- CISCO (http://www.cisco.com) contract (2017–2019) to work on graph analysis of malware

7.2. 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 – Mitsubishi Electric framework program

Inria principal investigator: Jean-Pierre Talpin

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, as well as Tocata.

8.1.2. Mitsubishi Electric R&D Europe (2019-2022)

Title: A logical framework to verify requirements of hybrid system models

Inria principal investigator: Jean-Pierre Talpin, Stéphane Kastenbaum

International Partner: Mitsubishi Electric R&D Europe

Duration: 2015 - 2018

Abstract: The goal of this doctoral project is to verify and build cyber-physical systems (CPSs) with a correct-by-construction approach in order to validate system requirements against the two facets of the cyber and physical aspects of such designs. Our approach is based on components augmented with formal contracts that can be composed, abstracted or refined. It fosters the proof of system-level requirements by composing individual properties proved at component level. While semantically grounded, the tooling of this methodology should be usable by regular engineers (i.e. not proof theory specialists).

8.1.3. Mitsubishi Electric R&D Europe (2015-2019)

Title: Parallelism and modular proof in differential dynamic logic [1]

Inria principal investigator: Jean-Pierre Talpin, Simon Lunel

International Partner: Mitsubishi Electric R&D Europe

Duration: 2015 - 2018

Abstract: The primary goal of this Ph.D. 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

7. Bilateral Contracts and Grants with Industry

7.1. Bilateral Contracts with Industry

7.1.1. Collaboration with SNCF on Road circuits

Participants: Vincent Le Cam, Arthur Bouché.

The 2 objectives of the Circuit de Voie project aimed to detect the phenomenon of deshuntage are, with SNCF Innovation Research, develop criteria and models to detect, in real time, the appearance of the phenomenon, and implementing in one of several PEGASE boxes spread over several test sites these models and comparison indicators.

3 criteria have been developed and validated in simulation on real dataset: 1 criterion in residual power on the spectral band of the harmonic of rank 3, a criterion of spectral shape recognition typical in case of bad deshuntage, a statistical criterion on the RMS component of the residual signal. Future work is envisaged in 2020 to go further in comparing these models with real field data and comparison with other detection systems. Several PEGASE units have been built, deployed and implemented for one-off or long-term measurement phases, including during deshuntage tests conducted by SNCF teams.

7.1.2. Collaboration with SNCF Reseau

Participants: Vincent Le Cam, Arthur Bouché.

SNCF has commissioned 5 new DETECTEAU water level sensors adapted to the conditions of nozzles and waterways in the rail network. From a technological point of view the sensor is of small size and very weak consumption. DETECTEAU communicates according to the LORA network. From September to November 2019, one to 3 sites of LGV Paris East will probably be deployed. Scientifically a dynamic sending algorithm has been implemented, taking into account the dynamics of the watercourse (sending more information if there are phases of flood or recession). As it stands, the DETEC-TEAU project is opening the field, probably for 2020, to a more scientific follow-up of the project where the data collected will feed watershed flow models that SNCF wishes to qualify.

7.1.3. Collaboration with SNCF : Hot boxes detection

Participants: Jean Dumoulin, Thibaud Toullier.

The main strategic issue is the maintenance in operational condition of the Hot Box Detectors (DBC). The removal of the DBC from the track is part of Tech4Rail's ambition: reducing equipment to the track. The innovation aimed at in this project is to study and develop a measurement solution to be deployed at the edge of a lane out of danger zone and independent of track equipment. Among the scientific obstacles identified are the following three:

- the behavior of the measurement system in deteriorated meteorological conditions in a real site
- the design and implementation of an automated prototype for in-situ deployment (connection to an existing announcement system, hardware packaging of the system, study and design of a scalable software solution allowing pre-processing data).
- the development of automatic processing tools for the analysis of massive data generated by in-situ measurement systems

7.1.4. Contract with SIEMENS : Poof of Concept monitoring coupled with prediction model for deicing metro lane surface

Participants: Jean Dumoulin, Nicolas Le Touz, Thibaud Toullier.

This proof of concept aims at combining real site monitoring solutions with adjoint state FE thermal model approach to predict optimal heating required to preserve surface from icing in winter conditions. Furthermore, we introduced in our prediction model connection with in-line weather forecast provided by Meteo France Geoservice at different time horizon and spatial scale.

MINGUS Project-Team

7. Bilateral Contracts and Grants with Industry

7.1. Bilateral Contracts with Industry

- Contrat with RAVEL (onne year, budget 15000 euros): this is 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 fondations of artificial intelligence and in particular machine learning algorithms for data anonymized though homomorphic encryption.
  Participants: P. Chartier, M. Lemou and F. Méhats.
- Contract with Cailabs (6 months, budget 3000 euros): This collaboration aims at exploring the possibility of deriving new fiber optics devices based on neural networks architecture.
  Participants: P. Chartier, E. Faou, M. Lemou and F. Méhats.

SIMSMART Project-Team

6. Bilateral Contracts and Grants with Industry

6.1. Bilateral Contracts with Industry

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.
4. **Cooper Standard**, Machine Learning for joints design.

6.2. Bilateral Grants with Industry

1. **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 Contracts with Industry

8.1.1. SANOFI: co-supervised PhD

Participant: Emmanuelle Becker.

This collaboration project is focused on the implementation of an integrative analysis framework based on semantic web technologies and reasoning in the framework of systemic lupus erythematosus pathology [42]. **CIFRE co-supervised Grant: Ph.D. funding. 2017-2020**

8.1.2. Theranexus: co-supervised internship

Participant: Pierre Beaudier.

This collaboration project was focused on assessing public databases' relevance for predicting potential drug combinations in central nervous system's pathologies [32]. It opened the perspective of a CIFRE PhD with Insiliance (under review by ANRT) **Theranexus funding. 2019**

EMPENN Project-Team

8. Bilateral Contracts and Grants with Industry

8.1. Bilateral Contracts with Industry

8.1.1. Siemens

Participants: Elise Bannier, Christian Barillot, Emmanuel Caruyer, Olivier Commowick, Isabelle Corouge, Jean-Christophe Ferré, Jean-Yves Gauvrit.

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, Empenn 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. 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 VE11C (nearly finished).

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. Tank milk analysis

Participants: Dominique Lavenier, Jacques Nicolas.

The Seenergi company has developed a biotechnology protocol to detect cow mastitis directly by analyzing the DNA in 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, 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 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. Contract with Fourmentin-Guilbert Foundation: Macromolecule detection in 3D cellular cryo-electron tomograms

Participants: Emmanuel Moebel, Charles Kervrann.
Duration: 5 months (Dec 2019 – Apr 2020).

The objective of the project is to improve the DeepFinder software dedicated to the detection and identification of macromolecules within 3D cellular cryo-electron tomograms. In collaboration with Fourmentin-Guilbert Foundation, the goal is to build cellular atlases of several organisms from localizations of macromolecules (see Software DeepFinder in Section 6.9).

Funding: Fourmentin-Guilbert Foundation.
Collaborators: D. Larivière & E. Fourmentin (Fourmentin-Guilbert Foundation), A. Martinez & W. Baumeister (Max Planck Institute, Martinsried, Germany).

8.1.2. Contract with DGA: Motion saliency analysis in videos

Participants: Léo Maczyta, Patrick Bouthemy.
Duration: 36 months (Oct 2017 – Sep 2020).
This project funded by the DGA (Ministry of defense) and Région-Betagne 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 (see Section 7.10).

Funding: DGA (National Defense Agency) and Région-Bretagne.

8.1.3. Contract with GATACA Systems: Super-resolution microscopy and in live cell imaging

Participants: Jean Salamero, Ludovic Leconte, Charles Kervrann.
Duration: 36 months (Jan 2017 – Dec 2019).

The objective of the project is to transfer innovations for Multi-Angle TIRFM (using Azymuthal TIRFM from Ilas2) and collaborate as "β-Test site" for SIM in Nipkow disk microscopy (product: Live-SR).

Funding: GATACA Systems company.
Collaborators: C. Gueudry (GATACA Systems), J. Boulanger (MRC Laboratory of Molecular Biology, Cambridge Biomedical Campus, UK).

8.1.4. Contract with CryoCapCell SA: 3D LIVE CLEM (Correlative Light and Electron Microscopy) to decipher fates and functions of exosomes in vivo

Participant: Jean Salamero.
Duration: 24 months (Oct 2018 – Sep 2020).

The objective of the project is to link dynamic biogenesis of intracellular membrane compartments with their ultrastructures. It combines fast high resolution photonic imaging (MA-TIRFM and fast high pressure freezing for 3D cryoEM. It requires adapted registration methods in 3D, in order to navigate through the multiple scales.

Funding: DIM–ELICIT Empowering LIfe sCiences with Innovative Technologies (Région Ile de France).
Collaborators: G. Van Niel (coordinator, Institute of Psychiatry and Neuroscience of Paris), G. Raposo (CNRS-UMR 144 Institut Curie PSL Research), X. Heiligenstein (CryoCapCell SA).

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.

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/

KERDATA Project-Team (section vide)

Myriads Project-Team (section vide)

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.

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.

HYBRID Project-Team

8. Bilateral Contracts and Grants with Industry

8.1. Bilateral Contracts with Industry

8.1.1. Mensia Technologies

Participant: Anatole Lécuyer.

Mensia Technologies was an Inria start-up company created in November 2012 as a spin-off of Hybrid team. Mensia was focused on wellness and healthcare applications emerging from the BCI and Neurofeedback technologies. The Mensia startup benefited from the team's expertise and of valuable and proprietary BCI research results. Mensia was 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 contract between Hybrid and Mensia started in November 2013 and ended in August 2019 with the closing of the company. The contract supported the transfer of several softwares designed by Hybrid team (eg, OpenViBE and StateFinder) to Mensia Technologies for medical and multimedia applications of Mensia.

8.1.2. Orange Labs

Participants: Anatole Lécuyer [contact], Hakim Si-Mohammed, Ferran Argelaguet.

This four months contract between Hybrid and Orange labs (Jan - April 2019) covered the design of a proof of concept of a smart home system controlled using a brain computer interface in and augmented reality context.

8.2. Bilateral Grants with Industry

8.2.1. Orange Labs

Participants: Guillaume Bataille, Bruno Arnaldi, Valérie Gouranton [contact].

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".

In the context of this collaboration the following patent has been filled:

- "Dispositif d'affichage portatif de contenu 3D, système et procédé correspondants" (FR1914557), Guillaume Bataille, Bruno Arnaldi, Valérie Gouranton, Jérémy Lacoche. Filed in Dec. 2019.

8.2.2. InterDigital

Participants: Nicolas Olivier, Ferran Argelaguet, Anatole Lécuyer [contact].

This grant started in February 2019. It supports Nicolas's Olivier CIFRE PhD program with InterDigital company on "Avatar Stilization". This PhD is co-supervised with the MimeTIC team.

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. BARIER™ 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 developped. 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

8. Bilateral Contracts and Grants with Industry

8.1. Bilateral Contracts with Industry

8.1.1. CIFRE PhD: Incremental dynamic construction of knowledge bases from text mining

Participants: Guillaume Gravier, Cyrielle Mallart, Pascale Sébillot.

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.

8.1.2. CIFRE PhD: Embedding heterogeneous data for directory search

Participants: Vincent Claveau, Guillaume Gravier, 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.

8.1.3. CIFRE PhD: Few shot learning for object recognition in aerial images

Participants: Yannis Avrithis, Yann Lifchitz.

Duration: 3 years, started in March 2018
Partner: Safran Tech

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.

MIMETIC Project-Team

8. Bilateral Contracts and Grants with Industry

8.1. Bilateral Contracts with Industry

8.1.1. Cifre Faurecia - Monitoring of gestual efficiency at work

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 10K€ per year for the supervision and management of the PhD thesis.

8.1.2. Cifre InterDigitial - Adaptive Avatar Customization for Immersive Experiences

Participants: Franck Multon [contact], Ludovic Hoyet, Nicolas Olivier.

This Cifre contract has started in February 2019 for three years and is funding the PhD thesis of Nicolas Olivier. The aim of the project is to design stylized avatars of users in immersive environment and digital arts such as videogames or cinema.

To this end, we will design a pipeline from motion and shape capture of the user to the simulation of the 3D real-time and stylized avatar. It will take hairs, eyes, face, body shape and motion into account. The key idea is to stylized both appaearance and motion to make avatar better correspond to the style of the movie of immersive experience. We will carry-out perceptual studies to better understand the expectation of the users when controlling stylized avatars, to maximize embodiment. The Cifre contracts funds the PhD salary and 15K€ per year for the supervision and management of the PhD thesis. This contract is also in collaboration with Hybrid team.

8.2. Bilateral Grants with Industry

8.2.1. Collaboration with company SolidAnim (Bordeaux, France)

Participants: Marc Christie [contact], Xi Wang.

Thsi contract started in November 2019 for three years. Its purpose is to explore novel means of performing depth detection for augmented reality applied to the film and broadcast industries. The grant serves to fund the PhD of Xi Wang.

PANAMA Project-Team (section vide)

RAINBOW Project-Team

7. Bilateral Contracts and Grants with Industry

7.1. Bilateral Contracts with Industry

7.1.1. 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 (see Sect. 5.4.3). Each module is rent 40 days during a 3-year period in the context of the IRT B<>com NeedleWare project (see Section 7.2.3).

7.2. Bilateral Grants with Industry

7.2.1. Creative

Participants: Benoît Antoniotti, François Chaumette, Eric Marchand.

No Inria Rennes 13996, duration: 36 months.

This project funded by Creative started in March 2019. It supports Benoît Antoniotti's Ph.D. about visual exploration (see Section 6.2.9).

7.2.2. IRT JV Perform

Participant: François Chaumette.

No Inria Rennes 14049, duration: 36 months.

This project funded by IRT Jules Verne in Nantes started in January 2018. It is achieved in cooperation with Stéphane Caro from LS2N in Nantes to support Zane Zake's Ph.D. about visual servoing of cable-driven parallel robots (see Section 6.2.8).

7.2.3. IRT B<>com NeedleWare

Participants: Hadrien Gurnel, Alexandre Krupa.

No Inria Rennes 9072, duration: 36 months.

This project started in October 2016. It supports Hadrien Gurnel's Ph.D. about the study of a shared control strategy fusing haptic and visual control for assisting manual steering of needles for biopsy or therapy purposes in a synergetic way (see Section 6.4.3). This year, we published [43] [44] in the scope of this project.

SIROCCO Project-Team

8. Bilateral Contracts and Grants with Industry

8.1. Bilateral Contracts with Industry

8.1.1. CIFRE contract with InterDigital on neural networks for video compression

Participants: Xuan Hien Pham, Christine Guillemot.

- Title : Neural networks for video compression
- Partners : InterDigital (Ph. Bordes, F. Galpin), Inria-Rennes.
- Funding : InterDigital, ANRT.
- Period : Jan.2019-Oct.2021.

The goal of this Cifre contract is to first investigate novel optical flow estimation methods using deep neural networks. Based on the optical flow methods, the next step will be to design temporal prediction schemes based on convolutional neural networks (CNN) for video compression. The methods will be assessed in the context of the VVC (Versatile Video Coding) standard.

8.1.2. CIFRE contract with Orange labs. on compression of immersive content

Participants: Patrick Garus, Christine Guillemot, Thomas Maugey.

- Title : Compression of immersive content
- Research axis : 7.1.3
- Partners : Orange labs. (J. Jung), Inria-Rennes.
- Funding : InterDigital, ANRT.
- Period : Jan.2019-Dec.2021.

The goal of this Cifre contract is to develop novel compression methods for 6 DoF immersive video content. This implies investigating depth estimation and view synthesis methods that would be robust to quantization noise. This also implies developing the corresponding coding mode decisions based on rate-distortion criteria.