# Activity Report 2016

# Section Contracts and Grants with Industry

# CAIRN Project-Team  (section vide)

# CELTIQUE Project-Team  (section vide)

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

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

# 8. Bilateral Contracts and Grants with Industry

## 8.1. Bilateral Contracts with Industry

### 8.1.1. *Nano 2017 PSAIC*

**Participants:**  Arif Ali Ana-Pparakkal, Erven Rohou, Emmanuel Riou.

Nano 2017 PSAIC is a collaborative R&D program involving Inria and STMicroelectronics. The PSAIC (Performance and Size Auto-tuning through Iterative Compilation) project concerns the automation of program optimization through the combination of several tools and techniques such as: compiler optimization, profiling, trace analysis, iterative optimization and binary analysis/rewriting. For any given application, the objective is to devise through a fully automated process a compiler profile optimized for performance and code size. For this purpose, we are developing instrumentation techniques that can be focused and specialized to a specific part of the application aimed to be monitored.

The project involves the Inria teams PACAP, AriC, CAMUS and CORSE. PACAP contributes program analyses at the binary level, as well as binary transformations. We will also study the synergy between static (compiler-level) and dynamic (run-time) analyses.

## 8.2. Bilateral Grants with Industry

### 8.2.1. *Intel research grant INTEL2014-8957*

**Participants:**  André Seznec, Biswabandan Panda, Arthur Perais, Fernando Endo.

Intel is supporting the research of the PACAP project-team on "Mixing branch and value prediction to enable high sequential performance".

### 8.2.2. *Intel research grant INTEL2016-11174*

**Participants:**  André Seznec, Pierre Michaud, Kleovoulos Kalaitzidis.

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

<span style="color:red">**SUMO Project-Team**</span>

# 8. Bilateral Contracts and Grants with Industry

## 8.1. Bilateral Contracts with Industry

**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.

**Joint Nokia Bell Labs - Inria research lab:** Several members of the team are involved in the joint research lab of Nokia Bell Labs and Inria. This lab is co-directed by Éric Fabre (Inria) and Olivier Audouin (Bell Labs), and funds joint research teams over a period of 4 years. The 3rd phase of the lab is in preparation, and 6 new joint teams will be launched in the first quarter of 2017. Sumo is involved in the proposal *Softwarization of Everything* that aims at developing techniques for the programmability, the verification and the management of software-defined networks (SDN). This covers in particular the CIFRE PhD of Arij El Majed, to start in January 2017, on the topic of Root cause analysis in reconfigurable dynamic systems.

**Joint Orange Labs - Inria research lab:** Éric Fabre takes part to the joint research lab of Orange Labs and Inria. This lab funds around 5 new PhD grants every year. This covers in particular the CIFRE PhD of Sihem Cherrared on the topic of Fault management in multi-tenant programmable networks.

# 8. Bilateral Contracts and Grants with Industry

## 8.1. Bilateral Contracts with Industry

- CISCO (http://www.cisco.com)
- Thales (https://www.thalesgroup.com)
- Oberthur Technologies (http://www.oberthur.com/)

TASC Project-Team

# 8. Bilateral Contracts and Grants with Industry

## 8.1. Bilateral Contracts with Industry

### 8.1.1. *Labcom TransOp*

**Participants:** Charles Prud'Homme, Xavier Lorca.

> Title: TransOp.
>
> Duration: 2014-2016.
>
> Type: **ongoing project**.
>
> Others partners: Eurodécision.

The goal of the project is to handle robustness in the context of industrial timetabling problems with constraint programming using CHOCO. The project is managed by Xavier Lorca.

## 8.2. Bilateral Grants with Industry

### 8.2.1. *Gaspard Monge*

**Participants:** Nicolas Beldiceanu, Helmut Simonis.

> Title: Gaspard Monge 3.
>
> Duration: 2016.
>
> Type: **ongoing project**.
>
> Others partners: EDF.

Within the context of the Gaspard Monge call program for Optimisation and Operation Research, we work with EDF on the research initiative on *Optimization and Energy*. The goal of the project (continuation of last years projects) is to provide a systematic reformulation of time-series constraints in term of linear constraints that can be used in a MIP solver.

<span style="color:red">**TEA Project-Team**</span>

# 8. Bilateral Contracts and Grants with Industry

## 8.1. Bilateral Contracts with Industry

### 8.1.1. Toyota Info-Technology Centre (2014-2016)

Title: Co-Modeling of Safety-Critical Multi-threaded Embedded Software for Multi-Core Embedded Platforms

Inria principal investigator: Jean-Pierre Talpin

International Partner (Institution - Laboratory - Researcher):

Toyota Info-Technology Centre, Mountain View, California

Virginia Tech Research Laboratories, Arlington

Duration: renewed yearly since 2014

Abstract: We started a new project in April 2014 funded by Toyota ITC, California, to work with Huafeng Yu (a former post-doctorate of team ESPRESSO) and with VTRL as US partner. The main topic of our project is the semantic-based model integration of automotive architectures, virtual integration, toward formal verification and automated code synthesis. This year, Toyota ITC is sponsoring our submission for the standardization of a time annex in the SAE standard AADL.

In a second work-package, we aim at elaborating a standardized solution to virtually integrate and simulate a car based on heterogeneous models of its components. This year, it will be exemplified by the elaboration of a case study in collaboration with Virginia Tech. The second phase of the project will consist of delivering an open-source, reference implementation, of the proposed AADL standard and validate it with a real-scale model of the initial case-study.

## 8.2. Bilateral Grants with Industry

### 8.2.1. 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 plan to explore a multi-sorted algebraic framework for static analysis and formal verification starting from a simple use case extracted from Mitsubishi factory automation documentations. This will serve as a basis to more ambitious research where we intend to leverage recent advance in type theory, SMT solvers for nonlinear real arithmetic (dReal and $\delta$-decidability) and contracts theory (meta-theory of Benveniste et al., Ruchkin's contracts) to provide a general framework of reasoning about heterogeneous factory components.

# ANJA Team  (section vide)

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

# 7. Bilateral Contracts and Grants with Industry

## 7.1. Bilateral grants with industry

*See 4.1 .*

### 7.1.1. *Hybrid indoor navigation — PhD project at CEA LETI*
**Participants:**  François Le Gland, Kersane Zoubert–Ousseni.

This is a collaboration with Christophe Villien (CEA LETI, Grenoble).

The issue here is user localization, and more generally localization–based services (LBS). This problem is addressed by GPS for outdoor applications, but no such general solution has been provided so far for indoor applications. The desired solution should rely on sensors that are already available on smartphones and other tablet computers. Inertial solutions that use MEMS (microelectromechanical system, such as accelerometer, magnetometer, gyroscope and barometer) are already studied at CEA. An increase in performance should be possible, provided these data are combined with other available data: map of the building, WiFi signal, modeling of perturbations of the magnetic field, etc. To be successful, advanced data fusion techniques should be used, such as particle filtering and the like, to take into account displacement constraints due to walls in the building, to manage several possible trajectories, and to deal with rather heterogeneous information (map, radio signals, sensor signals).

The main objective of this thesis is to design and tune localization algorithms that will be tested on platforms already available at CEA. Special attention is paid to particle smoothing and particle MCMC algorithms, to exploit some very precise information available at special time instants, e.g. when the user is clearly localized near a landmark point.

In some applications, real time estimation of the trajectory is not needed, and a post processing framework may provide a better estimation of this trajectory. In [23], we present and compare three different algorithms to improve a real time trajectory estimation. Actually, two different smoothing algorithms and the Viterbi algorithm are implemented and evaluated. These methods improve the regularity of the estimated trajectory by reducing switches between hypotheses.

### 7.1.2. *Bayesian tracking from raw data — CIFRE grant with DCNS Nantes*
**Participants:**  François Le Gland, Audrey Cuillery.

This is a collaboration with Dann Laneuville (DCNS Nantes).

After the introduction of MHT (multi–hypothesis tracking) techniques in the nineties, multitarget tracking has recently seen promising developpments with the introduction of new algorithms such as the PHD (probability hypothesis density) filter  [55], [62] or the HISP (hypothesised filter for independent stochastic populations) filter  [47]. These techniques provide a unified multitarget model in a Bayesian framework  [59], which makes it possible to design recursive estimators of a *multitarget probability density*. Two main approaches can be used here: sequential Monte Carlo (SMC, also kown as particle filtering), and Gaussian mixture (GM). A third approach, based on discretizing the state–space in a possibly adaptive way, could also be considered despite its larger computational load. These methods are well studied and provide quite good results for *contact output* data, which correspond to regularly spaced measurements of targets with a large SNR (signal–to–noise ratio). Here, the data is processed (compared with a detection threshold) in each resolution cell of the sensor, so as to provide a list of detections at a given time instant. Among these methods, the HISP filter has the best performance/computational cost ratio.

However, these classical methods are unefficient for targets with a low SNR, e.g. targets in far range or small targets with a small detection probability. For such targets, preprocessing (thresholding) the data is not a good idea, and a much better idea is to feed a tracking algorithm with the raw *sensor output* data directly. These new methods  [30] require a precise modeling of the sensor physics and a direct access to the radar (or the sonar) raw data, i.e. to the signal intensity level in each azimuth/range cell. Note that these new methods seem well suited to new types of sensors such as lidar, since manufacturers do not integrate a detection module and do provide raw images of the signal intensity level in each azimuth/range cell.

The objective of the thesis is to study and design a tracking algorithm using raw data, and to implement it on radar (or sonar, or lidar) real data.

# I4S Project-Team

# 8. Bilateral Contracts and Grants with Industry

## 8.1. Bilateral Contracts with Industry

### 8.1.1. PhD project with EDF – Electrical device ageing monitoring

**Participants:** Nassif Berrabah, Qinghua Zhang.

A joint PhD project between Inria and EDF (ElectricitÈ de France) has been started since December 2014. The purpose of this study is to develop methods for the monitoring of electrical instruments in power stations, in order to prevent failures caused by ageing or accidental events. This project is funded by EDF and by the ANRT agency for three years.

### 8.1.2. Contracts with SVS

**Participants:** Laurent Mevel, Michael Doehler.

I4S is doing technology transfer towards SVS to implement I4S technologies into ARTEMIS Extractor Pro. This is done under a royalty agreement between Inria and SVS .

In 2014, the damage detection toolbox has been launched http://www.svibs.com/products/ARTeMIS_Modal_Features/Damage_Detection.aspx.

In 2015, SVS and Inria have earned an Innobooster grant to help transfer algorithms in 2016 Artemis Extractor Pro.

In 2016, uncertainty quantification for modal analysis has been launched http://www.svibs.com/newsletter/newsletter_2016_09.aspx.

### 8.1.3. Contracts with A3IP

**Participant:** Vincent Le Cam.

Since 2008, IFSTTAR has licensed the company A3IP to sell licenses of the PEGASE 1 platform (previous version of PEGASE 2 as mentioned above). A3IP sells them to to companies, laboratories or any third-party partner interested in in-situ monitoring (SHM) with smart and wireless sensors. Since 2008, about 1000 of PEGASE 1 units have been sold, plus hundreds of the following items:

- daughter boards: 3G / Ethernet communications, Analog to Digital data acquisition...
- sensors: accelerometer, strain gauges, temperature...
- specific packaging to make the PEGASE 1 solution ready to use in waterproof conditioning

For example, in 2016, A3IP has provided a complete panoply of PEGASE-1 Vibration Monitoring system with more than 30 PEGASE1 units to ensure the monitoring of the new High Speed Train line in west of France (Bretagne Pays de la Loire high speed railway).

This non exclusive license is clearly a success in terms of dissemination.

### 8.1.4. Contract with SNCF: DEMETER

**Participant:** Vincent Le Cam.

**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 Railways 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
- Axel counter monitoring
- Train detection pedal monitoring

In each case, a prototype of a specific PEGASE 2 sensor is designed, installed along in-situ railways lines under exploitation and data are transmitted wireless to the cloud supervisor at IFSTTAR for evaluation in SHM algorithms. IFSTTAR's engineers Arthur Bouche, Laurent Lemarchand and David Pallier are contributing to this project.

In particular, SNCF and IFSTTAR are able to perform the entire validation process quickly in few months: from the algorithm to the electronic design and installation. In 2016, the consortium reached 2 milestones: the PEDAL-LORA monitoring sensor has been awarded the European Railway Cluster Price in railway innovation; this system is now becoming an industrial product, directly designed by a third-party company for SNCF. In 2017, the roadmap will be extended with a specific focus on SHM algorithms implementation to help SNCF moving from big data to smart data.

### 8.1.5. *Contracts with SDEL-CC (VINCI Group)*
**Participant:** Vincent Le Cam.

In 2016, a contract has been signed with the company SDEL-CC, 100% daughter of the VINCI Group, Energy department. The project exploits the unique time stamp capacity of PEGASE 2 up to 50 nanosecond, independently of distances in the network of PEGASE2 nodes. The synchronization capacity is employed to design a sensor prototype based on PEGASE2 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. IFSTTAR's engineers Arthur Bouche and Laurent Lemarchand have contributed to this project.

During 2016, we have improved its embedded algorithms on PEGASE 2 platform to:

- take into account some specific GPS frames that output from its GPS receiver and give practical information on time drift
- take into account the temperature effect
- auto compute the real quartz period on each specific PEGASE 2 board

Two PEGASE 2 platforms are now able to time stamp an event with an accuracy of less that 10 nanoseconds. This leads to a precision of around 3 m for Lightning localization.

In 2017 in situ validation will be achieved on a real operated electric line.

### 8.1.6. *Collaboration with SIEMENS : CityVal Rennes*
**Participant:** Jean Dumoulin.

A first Winter season measurements campaign on the 100m metro structure mock-up built at IFSTTAR test track facilities in Nantes was carried out in 2016. It was completed by in situ instrumentation including coupling of infrared thermography with other measurements techniques for long term monitoring during several months. A new campaign is under preparation and will be launched in 2017. This collaboration is also connected with the new automated metro line B under construction in Rennes.

# IPSO Project-Team  (section vide)

# DYLISS Project-Team  (section vide)

## FLUMINANCE Project-Team

# 7. Bilateral Contracts and Grants with Industry

## 7.1. Bilateral Contracts with Industry

### 7.1.1. Contract CERSAT/IFREMER

**Participants:** Etienne Mémin, Valentin Resseguier.

*duration 36 months.* This partnership between Inria and Ifremer funds the PhD of Valentin Resseguier, which aims at studying image based data assimilation strategies for oceanic models incorporating random uncertainty terms. The goal targeted will consist in deriving appropriate stochastic version of oceanic model and on top of them to devise estimation procedures from noisy data to calibrate the associated subgrid models.

### 7.1.2. Contract inter Carno IFREMER Inria

**Participants:** Etienne Mémin, Thibaut Tronchin.

*duration 36 months.* This contract aims at proposing image-based tools for the analysis of the hydraulic load of an immerged body. This project takes place within an inter Carnot cooperation between Ifremer and Inria.

### 7.1.3. 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 CIFRE PhD is to design new image-based flow measurement methods for the study of industrial fluid flows. Those techniques will used in particular to calibrate industrial fume hood.

### 7.1.4. ANDRA project

**Participants:** Yvan Crenner, Benjamin Delfino, Jean-Raynald de Dreuzy, Jocelyne Erhel.

Contract with ANDRA (National Agency for Nuclear Waste)
Duration: three years from November 2015.
Title: reactive transport in fractured porous media
Coordination: Jocelyne Erhel.
Partners: Geosciences Rennes.
Abstract: Even in small numbers, fractures must be carefully considered for the geological disposal of radioactive waste. They critically enhance diffusivity, speed up solute transport, extend mixing fronts and, in turn, modify the physicochemical conditions of reactivity around possible storage sites. Numerous studies in various fields have shown that fractures cannot be simply integrated within an equivalent porous medium with a simple enhancement of its petro-physical properties (porosity and permeability). We propose a combined numerical and experimental approach to determine the influence on reactivity of typical fracture patterns found in some radioactive waste applications.

### 7.1.5. IFPEN project

**Participants:** Bastien Hamlat, Jocelyne Erhel.

Contract with IFPEN (Institut Français du Pétrole et Energies Nouvelles)
Duration: three years from October 2016.
Title: Fully implicit Formulations for the Simulation of Multiphase Flow and Reactive Transport
Coordination: Jocelyne Erhel.

Abstract: Modeling multiphase flow in porous media coupled with fluid-rock chemical reactions is essential in order to understand the origin of sub-surface natural resources and optimize their extraction. This project aims to determine optimal strategies to solve the coupled transport and chemical reaction equations describing the physical processes at work in reactive multiphase flow in porous media. Three different formulations show great potential to accurately solve these equations. Two are fully implicit ("Reactive Coats" and "Semi-smooth Newton)" and one is an operator splitting approach. These formulations are still incomplete at the moment. The work will focus on extending the existing formulations to more complex physical phenomena, study their stability, convergence and theoretical equivalence. Another objective is to provide practical solutions to efficiently solve the resulting non-linear systems.

<span style="color:red">**GENSCALE Project-Team**</span>

# 8. Bilateral Contracts and Grants with Industry

## 8.1. Bilateral Contracts with Industry

### 8.1.1. *Empowerd 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 (see section New Results).

## 8.2. Bilateral Grants with Industry

### 8.2.1. *EnginesOn start-up project*
**Participant:**  Jennifer Del Giudice.

EnginesOn is a start-up project based on life science digital data analysis (http://engineson.fr/). The origin of the project comes from a simple field observation: NGS technology is involved in numerous scientific studies. Deciphering the heterogeneous and voluminous data generated is a real challenge. People with the skills to analyze this type of data are scarce. EnginesOn focuses its first effort on health market with cancer diagnosis and personalized medecine. The start-up provides to physicians a virtual research laboratory with analysis workflows, compute infrastructure and data management that will lead to a simple, fast, reproducible diagnosis in a transparent fashion. EnginesOn also addresses the issue of big data management and storage. The project is entitled to the Fasttrack program since october 2016. Inria funds a 6-month technology transfer engineer in order to study the valorization and promote the GATB toolbox.

### 8.2.2. *Rapsodyn project*
**Participants:**  Dominique Lavenier, Claire Lemaitre, Sebastien Letort, Pierre Peterlongo.

RAPSODYN is a long term project funded by the IA 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.

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

# 8. Bilateral Contracts and Grants with Industry

## 8.1. Bilateral Contracts with Industry

### 8.1.1. Contract with Innopsys: Tissue microarrays (TMA) image analysis

**Participants:** Hoai Nam Nguyen, Charles Kervrann.

**Collaborators:** Vincent Paveau and Cyril Cauchois (Innopys company).

A three-year contract has been established with Innopsys in 2013 to support Hoai Nam Nguyen's PhD thesis. The objective is to investigate and develop methods and algorithms dedicated to fluorescence images acquired by the scanners and devices designed by the company. In this project, we focus on i/ localization and segmentation fluorescence tissue microarrays (TMA) cores in very large 2D images; ii/ de-arraying of digital images and correction of grid deformation adapted to devices; iii/ correction of scanning artifacts to improve image reconstruction; iv/ deconvolution, denoising and superresolution of fluorescence TMA images corrupted by Poisson noise. The algorithms will be integrated into the plateforms and devices designed by Innopsys.

### 8.1.2. Contract (CIFRE) with Technicolor: Semantically meaningful motion descriptors for video understanding

**Participants:** Juan Manuel Perez Rua, Patrick Bouthemy.

**Collaborators:** Tomas Crivelli and Patrick Pérez (Technicolor).

A three-year contract has been established with Technicolor on January 2015 for a CIFRE grant supporting Juan Manuel Perez Rua's PhD thesis. The purpose is to investigate new methods for extracting meaningful mid-level motion-related descriptors that may help for the semantic discovery of the scene. In 2015, we started with the occlusion detection problem. We have proposed a novel approach where occlusion in the next frame or not is formulated in terms of visual reconstruction. Our approach outperforms state-of-the-art occlusion detection methods on the challenging MPI Sintel dataset. In 2016, we have developed two hierarchical motion segmentation methods involving a compositional motion representation. The first one follows a frame-based labeling approach which amounts to the minimization of a global energy function. The second one is trajectory-based and relies on tree-structured learning and sparse coding.

### 8.1.3. Contract with OBSYS: microscope set-up control and inverse problems in microscopy

**Participants:** Giovanni Petrazzuoli, Charles Kervrann.

**Collaborators:** Charles Gudeudry (OBSYS).

A three-year contract has been established with OBSYS in 2016. The objective is to investigate and develop methods and algorithms dedicated to the control of a microscope set-up and to the analysis of fluorescence images. Fast and robust algorithms will be especially developed to improve image reconstruction of 3D-TIRF microscope images. The algorithms will be integrated into the plateforms and devices designed by OBSYS.

## 8.2. Bilateral grants with industry

### 8.2.1. Fourmentin-Guilbert Foundation: Macromolecule detection in cryo electron tomograms

**Participants:** Emmanuel Moebel, Charles Kervrann.

**Collaborator:** Damien Larivière (Fourmentin-Guilbert Foundation).

The Fourmentin-Guilbert Foundation 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 Fourmentin-Guilbert Foundation 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 and evaluate novel methods from the field of 3D shape retrieval for identifying, localizing and counting macromolecules (e.g., 70S ribosome) within a tomogram. This project is also supported by "Region Bretagne".

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

# 8. Bilateral Contracts and Grants with Industry

## 8.1. Bilateral Contracts with Industry

### 8.1.1. Siemens

*duration: 5 years from 2011/10/26, extended until end of 2017.*
In the context of the Neurinfo imaging platform, a partnership between Siemens SAS - Healthcare and University of Rennes 1 was signed in October 2011 for 5 years. This contract defines the terms of the collaboration between Siemens and the Neurinfo platform. The Neurinfo platform 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. This is a major advance in the collaboration since it will enable the development of MRI sequences on site.

## 8.2. Bilateral Grants with Industry

### 8.2.1. MEDday

As part of its activities, MEDday led the final testing phase on patients diagnosed from Multiple Sclerosis in order to find treatment of progressive multiple sclerosis. This is done in partnership with several hospitals in France. The goal is to achieve an effective treatment for this disease. The role of the team in this industrial grant is to develop new algorithms to perform the processing and the analysis of the images from this study.

<span style="color:red">**ASAP Project-Team**</span>

# 7. Bilateral Contracts and Grants with Industry

## 7.1. Contract with Technicolor

**Participants:** Fabien Andre, Anne-Marie Kermarrec.

We had a contract with Technicolor for collaboration on large-scale infrastructure for recommendation systems. In this context, Anne-Marie Kermarrec was the PhD advisor of Fabien Andre until Nov 2016. In his Phd, Fabien Andre worked on efficient algorithms for heterogeneous data on large-scale platforms.

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

# 8. Bilateral Contracts and Grants with Industry

## 8.1. Cooperation with SIGMA group

**Participants:** Thomas Ledoux [correspondent], Simon Dupont.

In 2012, we have started a cooperation with Sigma Group (http://www.sigma.fr), a software editor and consulting enterprise. The cooperation consists in a joint (a so-called Cifre) PhD on eco-elasticity of software for the Cloud and the sponsorship of several engineering students at the MSc-level.

As a direct consequence of the increasing popularity of Cloud computing solutions, data centers are rapidly growing in number and size and have to urgently face with energy consumption issues. The aim of Simon Dupont's PhD, started in November 2012, is to explore the *software elasticity* capability in Software-as-a-Service (SaaS) development to promote the management of SaaS applications that are more flexible, more reactive to environment changes and therefore self-adaptive for a wider range of contexts. As a result, SaaS applications become more elastic and by transitivity more susceptible to energy constraints and optimization issues.

In 2016, Simon Dupont defended his PhD on "Cross-layer elasticity management for Cloud: towards an efficient usage of Cloud resources and services" [12]. Besides, we focused on ElaScript, a domain-specific language that offers Cloud administrators a simple and concise way to define complex elasticity-based reconfiguration plans [23].

<p align="center"><span style="color:red">**CIDRE Project-Team**</span></p>

# 8. Bilateral Contracts and Grants with Industry

## 8.1. Bilateral Contracts with Industry

- **HP (2013-2016): 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. Being under NDA, details about this research program cannot be provided.

## 8.2. Bilateral Grants with Industry

- **Orange Labs: Privacy-preserving location-based services**

  Solenn Brunet has started her PhD thesis in September 2014 within the context of a CIFRE contract with Orange Labs Caen. Her PhD subject concerns the development of privacy-preserving location-based services that are able to personalize the service provided to the user according to his current position while preserving his location privacy. In particular, Solenn Brunet adapts existing cryptographic primitives (private information retrieval, secure multiparty computation, secure set intersection, ...) or design novel ones to use them as building blocks for the construction of these privacy-preserving location-based services.

- **DGA: BGP-like Inter Domain routing protocol for tactical mobile ad hoc networks: feasibility, performances and quality of service**

  Florian Grandhomme has started his PhD thesis in October 2014 in cooperation with DGA-MI. The subject of the PhD is to propose new secure and efficient algorithms and protocols to provide inter-domain routing in the context of tactical mobile ad hoc network. The protocol proposed will have to handle context modification due to the mobility of MANET, that is to say split of a MANET, merge of two or more MANET, and also handle heterogeneity of technology and infrastructure. The solution will have to be independent from the underlying intra-domain routing protocol and from the infrastructure: wired or wireles, fixed or mobile.

- **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 monitors 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 will focus on the construction of behavioral models (during a learning phase) and their use to detect intrusions during an execution of the modelled distributed application.

- **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.

- **B-Com: Privacy Protection for JPEG Content on Image-Sharing Platforms**

  Kun He was hired as a PhD in September 2013 by the IRT B-Com. The subject of the PhD was the protection of users' privacy while publishing images on image-sharing platforms. The proposed solution is an image encryption algorithm that preserve the image format after encryption, and the experimentation have shown that the proposed encryption algorithm can be used on several widely used image-sharing platforms such as Flickr, Pinterest, Google+, Facebook and Twitter.

- **Thalès: Privacy and Secure Multi-party Computation**

  Aurélien Dupin has started his PhD thesis in January 2016 within the context of a CIFRE contract with Thalès. His PhD subject concerns the development of privacy-preserving location-based services based on secure multi-party computation. As part of his Master of Science from the ETS (Ecole de Technologie Supérieure) in Montreal, co-supervised by Prof. Jean-Marc ROBERT (ETS) and Prof. Christophe BIDAN (CentraleSupélec), Mr Aurélien DUPIN has already addressed the issue and proposed multi-party computation protocols to provide evidence of geolocations while ensuring the secrecy of the geographical location of participants protocols. The thesis is an opportunity to continue the work initiated during the Master of Science.

- **Thalès: 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.

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

# 8. Bilateral Contracts and Grants with Industry

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

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

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

Dionysos 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 risk 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.

## 8.2. Bilateral Contract with Industry: Participation in a CRE with Orange

**Participant:** Bruno Tuffin.

We are participating to a CRE (managed by Telecom Bretagne) with Orange on the strategies of Content Delivery Networks (CDNs) and their impact on the overall Internet economy and regulation. In this study, we focus on the CDN as an economic actor. The goals are 1) to analyze CDNs' caching strategies from an economic point of view, 2) to study the strategies of an integrated CDN actor, and 3) to study the impact of CDNs in the net neutrality debate.

## 8.3. 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.

## 8.4. Cifre contract on SDN for 5G mobile networks

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

This is a Cifre contract (2015-2018) including a PhD thesis supervision (PhD of Imad Alawe), done with TDF, on cooperation in SDN use for the 5th generation of mobile networks. The objective of the thesis is to study and devise appropriate solutions to introduce SDN in the current LTE architecture.

## 8.5. Camion

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

We are working in the 2-year (October 2014 to October 2016) Eurostars European Project Camion, which aims at offering cost-efficient, QoE-optimized content delivery, allowing for faster content access, as well as offline operation, while improving wireless network capacity and coverage. Camion is leaded by JCP-Connect, and the partners are a SME (FON) and our team. The project is extended until June 2017.

## 8.6. DVD2C

**Participants:**  Yassine Hadjadj-Aoul, Adlen Ksentini, Pantelis Frangoudis.

We are working in the 3-year (September 2014 – September 2017) FUI Project DVD2C, which aims to virtualize CDN through the Cloud and Network Function Virtualization concept. DVD2C is leaded by Orange labs., and the partners are two SMEs (Viotech and Resonate) and two academics (our team and Télécom Paris Sud).

# DIVERSE Project-Team  (section vide)

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

# 8. Bilateral Contracts and Grants with Industry

## 8.1. Bilateral Contracts with Industry

Microsoft: Z-CloudFlow (2013–2016).   In the framework of the Joint Inria-Microsoft Research Center, this project is a follow-up to the A-Brain project. The goal of this new project is to propose a framework for the efficient processing of scientific workflows in clouds. This approach will leverage the cloud infrastructure capabilities for handling and processing large data volumes.

In order to support data-intensive workflows, the cloud-based solution will: adapt the workflows to the cloud environment and exploit its capabilities; optimize data transfers to provide reasonable times; manage data and tasks so that they can be efficiently placed and accessed during execution.

The validation will be performed using real-life applications, first on the Grid5000 platform, then on the Azure cloud environment, access being granted by Microsoft through a *Azure for Research Award* received by G. Antoniu. The project also provides funding for the PhD thesis of Luis Pineda-Morales, started in 2014.

**Collaboration.** *The project is being conducted in collaboration with the Zenith team from Montpellier, led by Patrick Valduriez.*

Huawei: HIRP Low-Latency Storage for Stream Data (2016–2017).   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 plan to investigate the main requirements and challenges, evaluate the different design choices (e.g., a standalone component vs. an extension of an existing Big Data solution like HDFS) and then propose an architectural overview.

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

# 8. Bilateral Contracts and Grants with Industry

## 8.1. Bilateral Contracts with Industry

### 8.1.1. Technicolor (2016-2017)

**Participant:**  Guillaume Pierre.

Our collaboration with Technicolor focuses on the design of a scalable and elastic virtual vistumer premises equipment based on Network Function Virtualization, Software-Defined Networking and Cloud technologies. In 2016 we completed the system design and an engineer from Technicolor started implementing the system. We expect to conduct further experiments and write a joint publication on this topic in 2017.

## 8.2. Bilateral Grants with Industry

### 8.2.1. 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.

### 8.2.2. Nokia (2015-2018)

**Participant:**  Christine Morin.

Together with CIDRE Inria project-team we are involved in a collaboration with Nokia on security policy adaptation driven by risk evaluation in modern communication infrastructures. To address the need for efficient security supervision mechanisms, approaches such as attack graphs generation, coupled to a risk-based assessment have been used to provide an insight into a system's threat exposure. In comparison to static infrastructures, clouds exhibit a dynamic nature and are exposed to new attack scenarios due to virtualization. The goal of this collaboration is thus to revisit existing methods in the context of clouds. This contract funds Pernelle Mensah's PhD grant. Pernelle is a member of CIDRE project-team.

<span style="color:red">**TACOMA Team**</span>

# 7. Bilateral Contracts and Grants with Industry

## 7.1. SIMHet

Partner: YoGoKo

Starting: Nov 2015; ending: Oct 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, this smart mechanism will give competitive advantage for YoGoKo over its competitors.

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

# 8. Bilateral Contracts and Grants with Industry

## 8.1. Bilateral Contracts with Industry

### 8.1.1. *Mensia Technologies*

**Participants:**  Anatole Lécuyer, Jussi Tapio Lindgren.

<span style="color:red">Mensia Technologies</span> 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 should 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 together with CEO Jean-Yves Quentel.

The on-going contract between Hybrid and Mensia started in November 2013 and supports the transfer of several softwares designed by Hybrid team ("OpenViBE", "StateFinder") related to our BCI activity to Mensia Technologies for multimedia or medical 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 supports 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 supports 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 supports Anne-Solene Dris-Kerdreux's CIFRE PhD program with Vinci company on "Training in VR for construction applications".

<span style="color:red">**LACODAM Team**</span>

# 8. Bilateral Contracts and Grants with Industry

## 8.1. Bilateral Contracts with Industry

### 8.1.1. *SocTrace: analysis of SOC traces*

**Participant:** Alexandre Termier.

SoCTrace is a FUI project led by STMicroelectronics, with the companies ProbaYes and Magilem, University Grenoble Alps and Inria Rhône-Alpes. Its goal is to provide an integrated environment for storing and analyzing execution traces. In this project, we are working on data mining techniques for analyzing the traces, and on the use of ontologies to enable querying traces with a higher level of abstraction.

### 8.1.2. *ITRAMI: Interactive Trace Mining*

**Participant:** Alexandre Termier.

ITRAMI is a Nano2017 project. Such projects are designed to support joint research efforts between STMicrolectronics and academic partners in the domain of embedded systems. Alexandre Termier is the PI of this project whose goal is to design novel data mining methods for interactive analysis of execution traces. Such methods aim at considerably reducing the time that STMicroelectronics developers spend at understanding, debugging and profiling applications running on STMicrolectronics chips. The project work is done at University Grenoble Alps, in collaboration with Lacodam researchers. Two contractual staff are working on the project in Grenoble: Willy Ugarte as a postdoc, and Soumaya Ben Alouane as an engineer.

## 8.2. Bilateral Grants with Industry

Maël Guillemé has obtained a CIFRE PhD grant with the Energiency startup, supervised by V. Masson and L. Rozé. The goal of Maël Guillemé's thesis is to propose new approaches for improving industrial energy performance and aims at integrating both numerical and symbolic attributes. A master 2 internship explored in 2016 a first approach based on an algorithm proposed by Shokoohi and al, but with several improvements: avoid data normalisation, detect patterns as fast as possible, enhance functions like distance and score.

Another CIFRE PhD has started, this time with the Amossys company, specialized in cyber-security. This is the PhD of Alban Siffer, located in the EMSec team of IRISA and co-supervised between EMSec (P.A. Fouque) and Lacodam (A. Termier, C. Largouët). The goal of this PhD is to propose new methods for intrusion detection in networks. The originality is to only consider IP flow as input (metadata of packets and not packet contents), requiring to detect intrusion via unusual traffic patterns.

<span style="color:red">**LAGADIC Project-Team**</span>

# 8. Bilateral Contracts and Grants with Industry

## 8.1. Bilateral Grants with Industry

### 8.1.1. *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 <span style="color:red">7.1.7</span> ).

### 8.1.2. *Realyz*

**Participant:**  Eric Marchand.

*no Inria Rennes 10822, duration: 36 months.*

This project funded by Realiz started in October 2015. It is realized in cooperation with Anatole Lecuyer, Hybrid group at Irisa and Inria Rennes-Bretagne Atlantique to support Guillaume Cortes Ph.D. about motion capture.

### 8.1.3. *Pôle Saint Hélier*

**Participants:**  Louise Devigne, Marie Babel.

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

This project started in November 2015. It addresses the following two issues. First, the idea is to design a low-cost indoor / outdoor efficient obstacle avoidance system that respects the user intention, and does not alter user perception. This involves embedding innovative sensors to tackle the outdoor wheelchair navigation problem. 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.

### 8.1.4. *Axyn*

**Participants:**  Dayana Hassan, Paolo Salaris, Patrick Rives.

*no Inria Sophia 10874-1, duration: 36 months.*

The objective of this project that started in November 2016 is to explore new methodologies for the interaction between humans and robots, autonomous navigation and mapping and to transfer the results obtained on the robotic platform developed by AXYN for assisting disabled/elderly people at home or in hospital structures. Cost limits, good accessibility to aged people, robustness and safety related to the applications are at the heart of the project. This contract (ANRT-CIFRE) support Dayana Hassan's Ph.D.

# 8. Bilateral Contracts and Grants with Industry

## 8.1. Bilateral Contracts with Industry

Teddy Furon spent 20 % of his time during 6 months to transfer research result to IRT B-com

Ph. D. contract with Alcatel-Lucent Bell Labs (Raghavendran Balu) in the framework of the joint Inria-Alcatel Lucent lab.

<div align="center">**MIMETIC Project-Team**</div>

# 8. Bilateral Contracts and Grants with Industry

## 8.1. Cifre Faurecia

**Participants:** Franck Multon [contact], Pierre Plantard.

This contract aims at developing new ergonomics assessments based on inaccurate Kinect measurements in real manufacturing conditions. The main challenges are:

- being able to improve the Microsoft Kinect measurement in order to extract accurate poses from depth images while occlusions may occur,
- developing new inverse dynamics methods based on such inaccurate kinematic data in order to estimate the joint torques required to perform the observed task,
- and proposing a new assessment tool to translate joint torques and poses into potential musculoskeletal disorders risks.

Faurecia has developed its own assessment tool but it requires tedious and subjective tasks for the user, at specific times in the work cycle. By using Kinect information we aim at providing more objective data over the whole cycle not only for specific times. We also wish to make the user focus on the interpretation and understanding of the operator's tasks instead of taking time estimating joint angles in images.

This work is performed in close collaboration with an ergonomist in Faurecia together with the software development service of the company to design the new version of their assessment tool. This tool will be first evaluated on a selection of manufacturing sites and will then be spread worldwide among the 300 Faurecia sites in 33 countries.

This contract enabled us to hire Pierre Plantard as a PhD student to carry-out this work in MimeTIC and M2S Lab. He started in January 2013, finished at the beginning of 2016, and defended his PhD in July 2016. This contract was the opportunity to demonstrate the impact of MimeTIC's work about in-site motion capture on ergonomic assessment, as a decision-support system for ergonomists. The software Kimea is one of the results of this collaboration. It is currently spread in the factories of Faurecia around the world, which demonstrates the maturity of this work for industrial transfer. The method has been published with ergonomic validation in the famous journal Applied Ergonomics (see Highlight section).

<span style="color:red">**PANAMA Project-Team**</span>

# 8. Bilateral Contracts and Grants with Industry

## 8.1. Bilateral Contracts with Industry

### 8.1.1. *Licensing agreement contract with Cedar Audio Limited*
**Participants:**  Nancy Bertin, Srdan Kitic, Rémi Gribonval.

This contract aimed at licensing an audio desaturation (declipping) software developed in the team.

## 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:* <span style="color:red">*3.1.2*</span>

*Partners: Technicolor R&I France, Inria-Rennes*

*Funding: Technicolor R&I France, ANRT*

The grand goal of this thesis is 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.

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

# 8. Bilateral Contracts and Grants with Industry

## 8.1. Bilateral Grants with Industry

### 8.1.1. Consulting contract with Enensys technologies
**Participant:**  Aline Roumy.

- Title : Matrix inversion for video streaming.
- Research axis : REF AT 7.4. Distributed processing and robust communication
- Partners : Enensys, Inria-Rennes.
- Funding : Enensys.
- Period : Apr. 2016 - May 2016.

This contract with Enensys technologies aimed at studying solutions for reducing the complexity of matrix inversion used for encoding data in the context of video streaming. First a bibliographical study has been carried out related to the problem of matrix inversion in a finite field, then a novel solution has been proposed together with some recommendations regarding the algorithmic implementation.

### 8.1.2. Google faculty research award
**Participants:**  Christine Guillemot, Xiaoran Jiang, Mikael Le Pendu.

- Title  : Light fields low rank and sparse approximation
- Research axis : 7.3.2
- Partners : Inria-Rennes.
- Funding : Google.
- Period : Oct.2015-Sept.2016.

The goal of the project was to study low-rank and sparse approximation models for light fields compression. A homography-based low-rank approximation has been developed showing significant PSNR-rate gains compared to a direct encoding of light field views with HEVC-inter coding.

### 8.1.3. CIFRE contract with Envivio/ Ericsson on LDR compatible HDR video coding
**Participants:**  Christine Guillemot, David Gommelet, Aline Roumy.

- Title  : LDR-compatible coding of HDR video signals.
- Research axis : § 7.3.5 .
- Partners : Envivio.
- Funding : Cifre Envivio.
- Period : Oct.2014-Sept.2017.

The goal of this Cifre contract is to design solutions for LDR-compatible coding of HDR videos. This involves the study of rate-distortion optimized tone mapping operators taking into account constraints of temporal coherency to avoid the temporal flickering which results from a direct frame-by-frame application of classical tone mapping operators. The goal is also to design a coding architecture which will build upon these operators, integrating coding tools tailored to the statistics of the HDR refinement signals.

### 8.1.4. CIFRE contract with Harmonic on image analysis for HDR video compression

**Participants:**  Maxime Rousselot, Olivier Le Meur.

- Title : image and video analysis for HDR video compression
- Partners : Harmonic, Univ. Rennes 1
- Funding: Harmonic, ANRT
- Period: April 2016-April 2019

This project (in collaboration with Rémi Cozot, FRVSense) aims to investigate two main axes. First, we want to assess whether the representation of High Dynamic Range signal has an impact on the coding efficiency. We will focus mainly on the Hybrid Log-Gamma (HLG) and Perceptual Quantizer (PQ) OETF (Opto-Electronic Transfer Function)approaches. The former defines a nonlinear transfer function which is display-independent and able to produce high quality images without compromising the director's artistic intent. The latter approach is based on Just Noticeable Difference curve. If it turns out that this representation has an impact, the coding strategy should be adjusted with respect to the representation. In addition, specific preprocessing tools will be defined to deal with the limitations of PQ and HLG approaches.

### 8.1.5. CIFRE contract with Technicolor on image collection analysis

**Participants:**  Dmitry Kuzovkin, Olivier Le Meur.

- Title : Spatiotemporal retargeting and recomposition based on artistic rules
- Partners : Technicolor, Univ. Rennes 1
- Funding: Technicolor, ANRT
- Period: Nov. 2015 – Nov. 2018

The goal of the project (in collaboration with Rémi Cozot, FRVSense) is to take advantage of the huge quantities of image and video data currently available - captured by both amateur and professional users - as well as the multiple copies of each scene that users often capture, to improve the aesthetic appeal of content. Additionally, given Technicolor's unique position, we propose to take advantage of insights as well as content from professional artists and colorists to learn how different content types can be enhanced.

### 8.1.6. CIFRE contract with Technicolor on light fields editing

**Participants:**  Christine Guillemot, Matthieu Hog.

- Title  : Light fields editing
- Research axis : 7.1.2
- Partners : Technicolor, Inria-Rennes.
- Funding : Technicolor, ANRT.
- Period : Oct.2015-Sept.2018.

Editing is quite common with classical imaging. Now, if we want light-fields 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 is to develop methods for light-field editing, and the work in 2016 has focused on the design of fast semi-supervised segmentation algorithms with coherence constraints across sub-aperture images (see 7.1.2 ).

### 8.1.7. CIFRE contract with Technicolor on light fields compressed representation

**Participants:**  Christine Guillemot, Fatma Hawary.

- Title  : Light fields compressed representation
- Partners : Technicolor, Inria-Rennes.
- Funding : Technicolor, ANRT.
- Period : Feb.2016-Jan.2019.

The goal of this PhD is to study reconstruction algorithms from compressed measurements based on the assumption of sparsity in the Fourier domain. The goal is to apply these algorithms to scalable compression of light fields.

### 8.1.8. CIFRE contract with Technicolor on cloud-based image compression

**Participants:** Jean Begaint, Christine Guillemot.

- Title  : Cloud-based image compression
- Research axis : 7.3.6
- Partners : Technicolor, 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. The objective will therefore be to develop rate-distortion optimized affine or homographic estimation and compensation methods which will allow us to construct prediction schemes and learn adapted bases from most similar images retrieved by image descriptors. One issue to be addressed is the rate-distortion trade-off induced by the need for transmitting image descriptors.