Activity Report 2014

Section Partnerships and Cooperations

<p style="text-align:center">**ASAP Project-Team**</p>

8. Partnerships and Cooperations

8.1. National initiatives

8.1.1. LABEX CominLabs

Participants: Anne-Marie Kermarrec, Davide Frey, Michel Raynal, François Taïani.

ASAP participates in the CominLabs initiative sponsored by the "Laboratoires d'Excellence" program. The initiative federates the best teams from Bretagne and Nantes regions in the broad area of telecommunications, from electronic devices to wide area distributed applications "over the top." These include, among the others, the Inria teams: ACES, ALF, ASAP, CELTIQUE, CIDRE, DISTRIBCOM, MYRIADS, TEMICS, TEXMEX, and Visages. The scope of CominLabs covers research, education, and innovation. While being hosted by academic institutions, CominLabs builds on a strong industrial ecosystem made of large companies and competitive SMEs. In this context, ASAP received funding for DeSeNt (a collaborative project with the Univ. Nantes / LINA).

8.1.2. ANR project SocioPlug

Participants: Davide Frey, Anne-Marie Kermarrec, Pierre-Louis Roman, François Taïani.

SocioPlug is a collaborative ANR project involving Inria (ASAP team), the Univ. Nantes, and LIRIS (INSA Lyon and Univ. Claude Bernard Lyon). The project emerges from the observation that the features offered by the Web 2.0 or by social media do not come for free. Rather they bring the implicit cost of privacy. Users are more of less consciously selling personal data for services. SocioPlug aims to provide an alternative for this model by proposing a novel architecture for large-scale, user centric applications. Instead of concentrating information of cloud platforms owned by a few economic players, we envision services made possible by cheap low-end plug computers available in every home or workplace. This will make it possible to provide a high amount of transparency to users, who will be able to decide their own optimal balance between data sharing and privacy.

8.1.3. DeSceNt CominLabs

Participants: Resmi Ariyattu Chandrasekharannair, Davide Frey, Michel Raynal, François Taïani.

The DeSceNt project aims to ease the writing of distributed programs on a federation of plug computers. Plug computers are a new generation of low-cost computers, such as Raspberry pi (25$), VIA- APC (49$), and ZERO Devices Z802 (75$), which offer a cheap and readily available infrastructure to deploy domestic on-line software. Plug computers open the opportunity for everyone to create cheap nano-clusters of domestic servers, host data and services and federate these resources with their friends, colleagues, and families based on social links. More particularly we will seek in this project to develop novel decentralized protocols than can encapsulate the notion of privacy-preserving federation in plug-based infrastructures. The vision is to use these protocols to provide a programming toolkit that can support the convergent data types being developed by our partner GDD (Gestion de Données Distribuées) at Univ. Nantes.

8.1.4. ANR Blanc project Displexity

Participants: George Giakkoupis, Anne-Marie Kermarrec, Michel Raynal.

The Displexity project started in Oct 2011. The aim of this ANR project that also involves researchers from Paris and Bordeaux is to establish the scientific foundations for building up a consistent theory of computability and complexity for distributed computing. One difficulty to be faced by DISPLEXITY is to reconcile two non necessarily disjoint sub-communities, one focusing on the impact of temporal issues, while the other focusing on the impact of spatial issues on distributed algorithms.

8.2. European initiatives

8.2.1. FP7 & H2020 projects

8.2.1.1. TOWARD THE ALLYOURS START-UP

Title: TOWARD THE ALLYOURS START-UP

Type: EIT-ICT Labs

Instrument: ACLD Computing in the Cloud

Duration: Jan - Dec 2014.

Coordinator: Inria (France)

Partners: Trento Rise, BDP EIT-ICT

See also: http://www.gossple.fr

Abstract: The goal of the Activity proposal is to turn the inventions from the ERC Starting Grant Project GOSSPLE to innovation by setting up a start-up (AllYours) targeting both Internet users as well as small to medium companies (SME) offering full-fledged personalization in notification systems. In this second year, the AllYours activity focused on the peer-to-peer and on the corporate version of AllYours through a collaborative initiative that involves the ASAP team, TrentoRise (Italy), and the Eindhoven EIT/ICT nodes. Our work consisted on refining and testing our implementations. For the p2p version, we ran a test with real users coordinated by TrentoRise from Sep to Nov 2014.

8.2.2. Collaborations with major European organizations

Ecole Polytechnique Federale de Lausanne EPFL Switzerland; collaboration on the Google Focused Award Web-Alter-Egos.

8.3. International Initiatives

8.3.1. Inria associate teams

8.3.1.1. RADCON

Title: Randomized Algorithms for Distributed Computing and Networks

International Partner (Institution - Laboratory - Researcher):

Univ. of Calgary (CANADA)

Duration: 2013 - 2015

See also: http://www.irisa.fr/asap/radcon

Over recent years, computing systems have seen a massive increase in parallelism and interconnectivity. Peer-to-peer systems, ad-hoc networks, sensor networks, or the "cloud" are based on highly connected and volatile networks. Individual nodes such as cell phones, desktop computers or high performance computing systems rely on parallel processing power achieved through multiple processing units. To exploit the power of massive networks or multiple processors, algorithms must cope with the scale and asynchrony of these systems, and their inherent instability, e.g., due to node, link, or processor failures. In this research project we explore randomized algorithms for large-scale networks of distributed systems, and for shared memory multi-processor systems.

For large-scale networks, decentralized gossip protocols have emerged as a standard approach to achieving fault-tolerant communication between nodes with simple and scalable algorithms. We will devise new gossip protocols for various complex distributed tasks, and we will explore the power and limits of gossip protocols in various settings.

For shared memory systems, randomized algorithms have proved extremely useful to deal with asynchrony and failures. Sometimes probabilistic algorithms provide the only solution to a problem; sometimes they are more efficient; sometimes they are simply easier to implement. We will devise efficient algorithms for some of the fundamental problems of shared memory computing, such as mutual exclusion, renaming, and consensus.

8.3.2. Inria international partners

Univ. of Calgary

Univ. Nacional Autonoma de Mexico

Univ. of Glasgow

8.4. International Research Visitors

8.4.1. Visits of international scientists

Yahya Benkaouz, ENSIAS Rabat, Morocco, from Dec 1 2013 to Feb 28 2014

Maryam Helmi Khomeirani, Univ. of Calgary, Canada, from Aug 15 to Oct 14 2014

Frederik Mallmann-Trenn, Simon Fraser Univ., Canada, from Jan 15 to Apr 20 and from Jun 16 to Jul 22 2014

Diogo Saraiva Lima, Univ. of Lisbon, Portugal, from Jul 1 to Aug 29 2014

8.4.2. Internships

Naman Goel; from Feb 1 to Apr 25 2014. *User profiles segmentation for efficient personalized recommendations*. Supervised by Anne-Marie Kermarrec and François Taiani.

Frederik Mallmann-Trenn; until Jul 31 2014. *Bounds on the Voting Time in Terms of Conductance.* Supervised by George Giakkoupis (and Petra Berenbrink of Simon Frazer Univ., Canada).

Mathieu Pasquet; from Feb 1 to Jun 30 2014. *Content-based orientation in decentralized recommenders*. Supervised by Davide Frey.

Martin Sansoucy; from May 15 to Aug 31 2014. *Caractérisation d'un protocole décentralisé de construction de topologies informatiques réparties à mémoire de forme*. Supervised by François Taiani.

8.4.3. Visits to international teams

George Giakkoupis, Univ. of Calgary, Canada, Mar 23 to Apr 10, and Oct 22 to Nov 9 2014.

Anne-Marie Kermarrec was a part-time visiting professor at EPFL, Switzerland, from Jan to Jul 2014.

Anne-Marie Kermarrec, Univ. of Sydney and NICTA, Australia, two weeks in Jan 2014.

Anne-Marie Kermarrec, Yandex, Moscow, Russia, one week in Jun 2014.

Antoine Rault, EPFL, Switzerland, Sep 1 to Nov 29 Nov 2014

<div align="center" style="color:red;">**ATLANMOD Project-Team**</div>

7. Partnerships and Cooperations

7.1. Regional Initiatives

Program: **Pole Images et Reseaux - Appel Projets PME 2011**

Project title: StreamMaster

Duration: 2012 - 2014

Coordinator: Data Syscom

Other partners: Research and University (University of Nantes, Ecole de Design Nantes Atlantique, ESC Rennes) and Vendors and service providers (IMINFO)

Abstract: The purpose of the StreamMaster project is creating a universal software solution for the smart management of document streams, providing an added value over all the chain. StreamMaster will provide: an hybrid (local and remote) technological platform to allow user access, the possibility of connection to every information system and every input and output stream, the management of all the parameters of the document stream (cost, speed, delay, quality, environmental impact), security and reinforced document authentication mechanisms, non-falsifiable documents by means of invisible document tatooing, an innovative and multimodal HMI.

Program: **Pays de la Loire regional funding. Call: Creation of new teams**

Project title: AtlanMod New Team Creation

Duration: 2011 - 2014

Coordinator: AtlanMod

Other partners: None

Abstract: AtlanMod has been funded by the Pays de la Loire Regional Council new research teams program. This funding will mainly cover a PhD Student and two years of a postdoc to work on the quality of models research line.

7.2. National Initiatives

7.2.1. FUI

Program: FUI - AAP 15

Project acronym: MoNoGe

Project title: Atelier de Modélisation de Nouvelle Génération

Duration: 2013 - 2016

Coordinator: Softeam

Other partners: Industry (DCNS), Research and University (ARMINES AtlanMod, LIP6) and Vendors and service providers (Softeam, Soft-Maint, Mia-Software)

Abstract: There is currently in companies a wide diversity of models and modeling tools according to the application domains, services or contexts which are concerned. This implies different problems forbidding their plain exploitation: traceability, global coherence, continuity between works, knowledge management, etc. All are largely penalized by this situation that harms the mastering of the complexity of the related systems and software. The MoNoGe project has for objective to bring innovative solutions allowing to ensure the agility of the models and modeling tools. The term agility is here referring to the properties of interoperability, extensibility and evolution of models. The dynamic extension mechanism to be developed in MoNoGe, potentially inspiring from the OMG MEF

standard currently under definition, is intended to preserve the original metamodel which can be conserved, partially hidden or extended. Thus, the legacy data and models can stay operational with the extended metamodel. The user does not have to deal with heavy migration or conversion operations, and can this way focus on its modeling activities while continuously exploiting past models. Our focus within the project is on defining conceptually such a (meta)model extension solution and proposing an implementing prototype based on Eclipse/EMF. To this intent, we are already studying the potential reuse (and improvement) of our EMF Views prototype in this given context.

Program: FUI - AAP 13

Project acronym: TEAP

Project title: TOGAF Entreprise Architecture Platform

Duration: 2012 - 2014

Coordinator: Obeo

Other partners: Industry (DCNS), Research and University (Inria AtlanMod) and Vendors and service providers (Obeo, Capgemini)

Abstract: The fast evolution of technologies (SOA, Cloud, mobile environments), the systems complexity and the growing need for agility require to be able to represent information systems as a whole. The high-level approach promoted by Enterprise Architecture (EA) is a key element in this context and intends to address all the systems dimensions: software components, associated physical resources, relationships with the companies requirements and business processes, implied actors/roles/structures, etc. The objective of the TEAP project was to specify and implement an EA platform based on the Open Group international standard named TOGAF and on the SmartEA technical solution. In addition to its base modeling capabilities, this platform now allows data federation from different existing sources (e.g. for reverse engineering purposes such as retro-cartography) as well as the definition of possible transformation chains (for governance and modernization). As part of this project, we have been notably using in practice (and improving accordingly) some of our works and corresponding prototypes such as EMF Views, ATL or some MoDisco components.

Program: FUI - AAP 13

Project acronym: ITM Factory

Project title: Information Technology Modernisation Factory

Duration: 04/2012 - 10/2014

Coordinator: Soft-Maint (Groupe SODIFRANCE)

Other partners: Mia-Software (Groupe SODIFRANCE), ACAPNOS, MMA and Inria AtlanMod.

Abstract: Application maintenance represents about 80 per cent of the computer market (at the French and global level). The challenge of software maintenance is to keep running applications with technologies that are no longer required to be maintained and with changing development teams and whose skills are not always validated on ancient languages. The main goal of the ITM Factory is to propose a software modernization framework, based on the ModDisco project and including: (i) an integrated workbench for software modernization engineers and (ii) a set of ready to use modernization cartirdges, i.e., a solution brick that meets a business challenge level, as opposed to a technical bricks that provides technical solutions that are integrated into a business solution.

7.3. European Initiatives

7.3.1. FP7 & H2020 Projects

7.3.1.1. ARTIST

Type: COOPERATION

Defi: Cloud Computing, Internet of Services and Advanced Software engineering

Instrument: Integrated Project

Duration: October 2012 - September 2015

Coordinator: Clara Pezuela (ATOS Spain)

Partner: ATOS and TECNALIA (Spain), Inria AtlanMod (France), Fraunhofer (Germany), TU Wien and Sparks (Austria), ENGINEERING (Italy), Spikes (Belgium), ATC and ICCS (Greece)

Inria contact: Hugo Bruneliere

Abstract: Nowadays Cloud Computing is considered as the ideal environment for engineering, hosting and provisioning applications. A continuously increasing set of cloud-based solutions is available to application owners and developers to tailor their applications exploiting the advanced features of this paradigm for elasticity, high availability and performance. Even though these offerings provide many benefits to new applications, they often incorporate constrains to the modernization and migration of legacy applications by obliging the use of specific development technologies and explicit architectural design approaches. The modernization and adaptation of legacy applications to cloud environments is a great challenge for all involved stakeholders, not only from the technical perspective, but also in business level with the need to adapt the business processes and models of the modernized application that will be offered from now on, as a service. The purpose of the ARTIST project is to propose and develop a novel model-driven approach for the migration of legacy applications in modern cloud environments which covers all aspects and phases of the migration process, as well as an integrated framework that supports all migration process.

7.3.1.2. MONDO

Title: Scalable Modelling and Model Management on the Cloud

Type: COOPERATION (ICT)

Defi: Cloud Computing, Internet of Services and Advanced Software engineering

Instrument: Small or medium-scale focused research project (STREP)

Duration: November 2013 - May 2016

Coordinator: The Open Group - X/Open Company

Partners: The Open Group - X/Open Company (United Kingdom), University of York (United Kingdom), Universidad Autonoma de Madrid (Spain), Budapest University of Technology and Economics (Hungary), IKERLAN (Spain), MIA Software (France), Cassidian (Germany)

Inria contact: Massimo Tisi

Abstract: As Model Driven Engineering (MDE) is increasingly applied to larger and more complex systems, the current generation of modelling and model management technologies are being pushed to their limits in terms of capacity and efficiency, and as such, additional research is imperative in order to enable MDE to remain relevant with industrial practice and continue delivering its widely recognised productivity, quality, and maintainability benefits. The aim of MONDO is to tackle the increasingly important challenge of scalability in MDE in a comprehensive manner. Achieving scalability in modelling and MDE involves being able to construct large models and domain specific languages in a systematic manner, enabling teams of modellers to construct and refine large models in a collaborative manner, advancing the state-of-the-art in model querying and transformations tools so that they can cope with large models (of the scale of millions of model elements), and providing an infrastructure for efficient storage, indexing and retrieval of large models. To address these challenges, MONDO brings together partners with a long track record in performing internationally-leading research on software modelling and MDE, and delivering research results in the form of robust, widely-used and sustainable open-source software, with industrial partners active in the fields of reverse engineering and systems integration, and a global consortium including more than 400 organisations from all sectors of IT.

7.3.1.3. Automobile

Title: Automated Mobile App Development

Type: Research For SMEs

Duration: November 2013 - October 2015

Coordinator: WebRatio s.r.l.

Partners: WebRatio, Politecnico di Milano (ITaly), AtlanMod-Armines, Moon Submarine (UK), ForwardSoftware (Rumania).

Inria contact: Jordi Cabot

Abstract:The AutoMobile project aims at designing and bringing to the market innovative methodologies, software tools, and vertical applications for the cost-effective implementation of cross-platform, multi-device mobile applications, i.e. business applications that can be accessed by users on a variety of devices and operating systems, including PC, cellular / smart phones and tablets.

Cross-platform and multi-device design, implementation and deployment is a barrier for today's IT solution providers, especially SME providers, due to the high cost and technical complexity of targeting development to a wide spectrum of devices, which differ in format, interaction paradigm, and software architecture.

AutoMobile will exploit the modern paradigm of Model-Driven Engineering and code generation to dramatically simplify multi-device development, reducing substantially cost and development times, so as to increase the profit of SME solution providers and at the same time reduce the price and total cost of ownership for end-customers.

AutoMobile will rely on modeling languages such as IFML (Interaction Flow Modeling Languages) and on tools like WebRatio.

7.3.2. Collaborations in European Programs, except FP7 & H2020

Program: CORE Multi-annual thematic research programme. Fonds National de la Recherche Luxembourg.

Project acronym: TOOM

Project title: Testing Orders of Magnitude

Duration: September 2013 - August 2015

Coordinator: SnT/University of Luxembourg

Other partners: the iTrust company, EBRC, Inria Rennes/University of Nantes and the UFPR (Brazil).

Abstract: Over the last decade, large-scale systems drew much attention due to scalability and resiliency features. Many popular large-scale data-oriented systems (i.e., BigData), including, Peer-to-peer (P2P) and MapReduce, reached millions of users and processed petabytes of data, such as: Hadoop, Skype, Bittorrent, and Gnutella. The main reason is due to a decentralized manner to remove potential performance bottlenecks and centralized points of failure. Recently, cloud computing is gathering all these BigData systems underneath its layers (e.g. Paas, Saas, Iaas) to free developers from large-scale issues, such as: deployment, distribution, resiliency, security, and performance. Several companies around the globe rely on cloud computing to build robust and reliable services for their business operations (e.g. eBay, Amazon, Skype) mainly to handle heavy load conditions (e.g. seasonal sales, Internet-scale malicious attacks). Testing robustness and reliability of cloud computing services is a hard activity, the state of the art shows that the existing testing techniques suffer to handle aspects, such as: the scale of the cloud, the dynamism of the nodes, and the amount of data and load. In general, these testing techniques rely on a combination of unit tests with some mocking approach that may hide the cloud aspects and may not be suited for large-scale testing. The TOOM project is planned to present a solution for testing robustness of cloud computing services built on top of P2P technology to address scalability and dynamism aspects. The main contributions lie on two main steps. The first one is to validate the overall resilience

and reliability of cloud services. The second one is to reproduce large-scale stress loads, such as Distributed Denial of Service (DDoS) and peak loads, either gathered from the real load traces or synthetically generated. We plan to leverage data warehouse technology to house real load traces and use them during testing. To generate synthetic loads, we plan to use known load patterns or adapt them to new load trends. To assess the effectiveness of the TOOM outcomes, we will reproduce stress loads submitted by P2P technology across the cloud infrastructure on top of step-stress testing methodologies. In this manner, we can progressively increase the load in orders of magnitude up to a peak load. Then, we will measure the effectiveness either by code coverage whether the SUT is open-source, by the quality of service (QoS) of the SUT, or by the coverage of network and computing components used by the cloud computing services.

7.4. International Initiatives

7.4.1. Inria International Partners

7.4.1.1. Informal International Partners

The four main research partners of the team are:

- Politecnico di Milano (Italy) - DB Group, specially with Marco Brambilla
- TU Wien (Austria) - BiG Group, specially Manuel Wimmer
- Politecnica de Catalunya (Spain) - GESSI Group, specially Xavier Franch
- Universitat Poliècnica de València (Spain) - ISSI Group, specially José H. Canós

7.5. International Research Visitors

7.5.1. Visits of International Scientists

Javier Criado (University of Almeria, Spain), June-July

7.5.1.1. Internships

Rolandi, María Belén

Subject: Democracy in Open Source projects

Date: from May 2014 until Oct 2014

Institution: Universidad Nacional del Centro de la Provincia de Buenos Aires (Argentina)

7.5.2. Visits to International Teams

7.5.2.1. Research stays abroad

In March, M. Tisi visited the National Institute of Informatics (NII) of Tokyo, Japan, for one month, in the frame of a collaboration on bidirectionalization of model-transformation languages.

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

8. Partnerships and Cooperations

8.1. Regional Initiatives

- **Région Bretagne ARED grant:** the PhD of Regina Marin on privacy protection in distributed social networks is supported by a grant from the Région Bretagne.

- **Labex COMINLAB contract (2012-2015): "POSEIDON" -** http://www.poseidon.cominlabs.ueb.eu/fr/

  POSEIDON deals with the protection of data in outsourced or shared systems such as cloud computing and peer-to-peer networks. While these approaches are very promising solutions to outsource storage space, contents, data and services, they also raise serious security and privacy issues since users lose their sovereignty on their own data, services and systems. Instead of trying to prevent the bad effects of the cloud and of peer-to-peer systems, the main objective of the POSEIDON project is to turn benefit from their main characteristics (distribution, decentralization, multiple authorities, etc.) to improve the security and the privacy of the users' data, contents and services.

  This project is conducted in cooperation with Télécom Bretagne and Université de Rennes I. The PhD of Julien Lolive (co-supervised by Sébastien Gambs and Caroline Fontaine), which deals with the entwining of identification and privacy mechanisms, is funded by the POSEIDON project. The postdoctoral researcher of Wei Pan (co-supervised by Gouenou Coatrieux and Nicolas Prigent) that deals with a distributed system to ensure patients' privacy in the context of medical imaging is also funded by this project.

- **Labex COMINLAB contract (2012-2015): "SecCloud" -** http://www.seccloud.cominlabs.ueb.eu

  Nowadays attacks targeting the end-user and especially its web browser constitute a major threat. Indeed web browsers complexity has been continuously increasing leading to a very large attack surface. Among all possible threats, we tackle in the context of the SecCloud project those induced by client-side code execution (for example javascript, flash or html5).

  Existing security mechanisms such as os-level access control often only rely on users identity to enforce the security policy. Such mechanisms are not sufficient to prevent client-side browser attacks as the web browser is granted the same privileges as the user. Consequently, a malicious code can perform every actions that are allowed to the user. For instance, it can read and leak user private data (credit cart numbers, registered passwords, email contacts, etc.) or download and install malware.

  One possible approach to deal with such threats is to monitor information flows within the web browser in order to enforce a security information flow policy. Such a policy should allow to define fine-grained information flow rules between user data and distant web sites. This implies to propose an approach and to design and implement a mechanism that can handle both OS-level and browser-level information flows.

  Dynamically monitoring information flow at the web browser level may dramatically impact runtime performances of executed codes. Consequently, an important aspect of this work will be to benefit as far as possible from static analysis of application code. This static-dynamic hydride approach should reduce the number of verifications performed at run time.

  This study is conducted in cooperation with other Inria Teams (Ascola and Celtique). Deepak Subramanian is doing his PhD in the context of this project.

- **Labex COMINLAB contract (2013-2016): "DeSceNt" - http://www.descent.cominlabs.ueb.eu**

    In DeSceNt, we propose to investigate how decentralized home-based networks of plug computers can support personal clouds according to sound architectural principles, mechanisms, and programming abstractions. To fulfill this vision we see three core scientific challenges, which we think must be overcome. The first challenge, decentralized churn-poor design, arises from the nature of plug federations, which show much lower levels of churn than traditional peer-to-peer environments. The second challenge, quasi-causal consistency, is caused by the simultaneous needs to produce a highly scalable environment (potentially numbering millions of users), that also offers collaborative editing capabilities of mutable data-structures (to offer rich social interactions). The third and final challenge, intuitive data structures for plug programming, arises from the need by programmers for intuitive and readily reusable data-structures to rapidly construct rich and robust decentralized personal cloud applications.

    This study is conducted in cooperation with other teams (GDD Team (University of Nantes), Inria team ASAP)

- **Labex COMINLAB contract (2014-2017): "Kharon-Security" - http://www.securite.cominlabs.ueb.eu/**

    Google Play offers more than 800'000 applications (apps), and this number increases every day. Google play users have performed more than 25 billion app downloads. These applications vary from games to music, video, books, tools, etc. Unfortunately, each of these application is an attack vector on Android. The number of malicious applications (pieces of malware) discovered during the first six months of 2013 exceeds the number of pieces of malware discovered during the 2010 to 2012 period, more than 700 thousand malicious and risky applications were found in the wild. In this context, we propose the Security project to stem the progression of Android pieces of malware. We propose to combine status and dynamic monitoring to compute a behavioral signature of Android malware. Behavioral signatures are helpful to understand how malware infect the devices and how they spread information in the Android operating system. Static analysis is essential to understand which particular event or callback triggers malware payload.

    In the project we aim to imagine and develop a malware scanning service that will permit users to analyze their own applications. This service will be available on a online platform that will also deliver previously computed signatures of known malware.

    Project members are from Celtique and Cidre Inria teams.

8.2. National Initiatives

8.2.1. ANR

- **ANR INS Project: AMORES (2011-2015) - http://amores-project.org/**

    Situated in the mobiquitous context characterized by a high mobility of individuals, most of them wearing devices capable of geolocation (smartphones or GPS-equipped cars), the AMORES project is built around three use-cases related to mobility, namely (1) dynamic carpooling, (2) real-time computation of multi-modal transportation itineraries and (3) mobile social networking. For these three use cases, the main objective of the AMORES project is to define and develop geo-communication primitives at the middleware level that can offer the required geo-located services, while at the same time preserving the privacy of users, in particular with respect to their location (notion of geo-privacy). Within this context, we study in particular the problem of anonymous routing and the design of a key generation protocol tied to a particular geographical location. Each of these services can only work through cooperation of the different entities composing the mobile network. Therefore, we also work on the development of mechanisms encouraging entities to cooperate together in a privacy-preserving manner. The envisioned approach consists in the definition of generic primitives such as the management of trust and the incentive to cooperation.

This project is joint between the Université de Rennes I, Supélec, LAAS-CNRS, Mobigis and Tisséo. The research project AMORES received the Innovation Award at the Toulouse Space Show in June 2013. Simon Boche and Paul Lajoie-Mazenc are doing their PhD in the context of this project.

- **ANR INS Project: LYRICS (2011-2015) - http://projet.lyrics.orange-labs.fr/**

With the fast emergence of the contactless technology such as NFC, mobile phones will soon be able to play the role of e-tickets, credit cards, transit pass, loyalty cards, access control badges, e-voting tokens, e-cash wallets, etc. In such a context, protecting the privacy of an individual becomes a particularly challenging task, especially when this individual is engaged during her daily life in contactless services that may be associated with his identity. If an unauthorized entity is technically able to follow all the digital traces left behind during these interactions then that third party could efficiently build a complete profile of this individual, thus causing a privacy breach. Most importantly, this entity can freely use this information for some undesired or fraudulent purposes ranging from targeted spam to identity theft. The objective of LYRICS (ANR INS 2011) is to enable end users to securely access and operate contactless services in a privacy-preserving manner that is, without having to disclose their identity or any other unnecessary information related to personal data. Within this project, we work mainly on the privacy analysis of the risks incurred by users of mobile contactless services as well as on the development of the architecture enabling the development of privacy-preserving mobile contactless services. The project is joint between France Télécom, Atos Wordline, CryptoExperts, ENSI Bourges, ENSI Caen, MoDyCo, Oberthur Technologies, NEC Corporation, Microsoft and Université de Rennes I.

The project was originally suppose to end in 2014 but an extension was granted until May 2015. The project has finished to develop a first prototype that illustrates how can be used privacy preserving protocols for the transport use case. The prototype implements a transportation pass (similar to the Navigo pass) embedded in the SIM card. This transport pass can be interact with a gate at the entrance of the transportation network in order to check the validity of the pass and answers wirelessly, in less than 300ms, without revealing any information about the user. This result has been presented in "Salon Cartes 2012", in [21], and in several French newspapers. It will be published at the end of 2014 in [15]. During 2014, the partners of the LYRICS projects have also worked on two new use cases and their corresponding prototypes: digital surveys and e-cash solutions that respect the privacy of users.

- **ANR INFRA Project: SOCIOPLUG (2013-2017) - http://socioplug.univ-nantes.fr/index.php/ SocioPlug_Project**

SocioPlug is a collaborative ANR project involving Inria (ASAP and CIDRE teams), the Nantes University, and LIRIS (INSA Lyon and Université Claude Bernard Lyon). The project emerges from the observation that the features offered by the Web 2.0 or by social media do not come for free. Rather they bring the implicit cost of privacy. Users are more of less consciously selling personal data for services. SocioPlug aims to provide an alternative for this model by proposing a novel architecture for large-scale, user centric applications. Instead of concentrating information of cloud platforms owned by a few economic players, we envision services made possible by cheap low-end plug computers available in every home or workplace. This will make it possible to provide a high amount of transparency to users, who will be able to decide their own optimal balance between data sharing and privacy.

8.2.2. Inria Project Labs

- **CAPPRIS (2012-2016)**

CAPPRIS stands for "Collaborative Action on the Protection of Privacy Rights in the Information Society". The main objective of CAPPRIS is to tackle the privacy challenges raised by the most recent developments and usages of information technologies such as profiling, data mining, social networking, location-based services or pervasive computing by developing solutions to enhance the protection of privacy in the Information Society. To solve this generic objective, the project focuses in particular on the following four fundamental issues:

– The design of appropriate metrics to assess and quantify privacy, primarily by extending and integrating the various possible definitions existing for the generic privacy properties such as anonymity, pseudonymity, unlinkability and unobservability, as well as notions coming from information theory or databases such as the recent but promising concept of differential privacy;

– The definition and the understanding of the fundamental principles underlying "privacy by design", with the hope of deriving practical guidelines to implement notions such as data minimization, proportionality, purpose specification, usage limitation, data sovereignty and accountability directly in the formal specifications of our information systems;

– The integration between the legal and social dimensions, intensely necessary since the developed privacy concepts, although they may rely on computational techniques, must be in adequacy with the applicable law (even in its heterogeneous and dynamic nature). In particular, privacy-preserving technologies cannot be considered efficient as long as they are not properly understood, accepted and trusted by the general public, an outcome which cannot be achieved by the means of a mathematical proof.

Three major application domains have been identified as interesting experimentation fields for this work: online social networks, location-based services and electronic health record systems. Each of these three domains brings specific privacy-related issues. The aim of the collaboration is to apply the techniques developed to the application domains in a way that promotes the notion of privacy by design, instead of simply considering them as a form of privacy add-ons on the top of already existing technologies. CAPPRIS is a joint project between Inria, LAAS-CNRS, Université de Rennes I, Supélec, Université de Namur, Eurecom, and Université de Versailles. The postdoctoral position of Cristina Onete since September 2014 is funded by CAPPRIS.

8.2.3. Research mission "Droit et Justice"

- **Droit à l'oubli (2012-2014)** The "right to be forgotten" can be viewed as a consequence and an extension of the right to privacy and to personal data protection, emphasized by the inherent difficulty to erase any given information from the omnipresent digital world. The French ministry of Justice has launched two twin projects (one of which is the DAO project), in order to explore the possible legal definitions of a "right to be forgotten". Even though there are no legal foundations for such a right in France at the moment, the concept is already known from the general public and is also present in courts. Furthermore, individuals expect to be protected by such a right, thus it is important to understand why, how, in which circumstances and to which extent this new right may apply before envisioning a legal notion defining it. The DAO project involves a major legal component, a sociological survey and a technical study. In a nutshell, the legal part explores the possible boundaries and requirements of a right to be forgotten with respect to labor law, civil statuses, personal data protection, legal prescription and IT law. The sociological survey aims at understanding the root causes making people build a desire for forgetfulness in others. Finally, the objective of the computer science part is to elaborate a state of the art of the techniques that could be used to enforce a right to be forgotten in practice in the digital world. The expected output of the project as a whole is a detailed recommendation about whether an independent legislation proposal for the right to be forgotten would be justified, and how it should be done. This final report summarizing the thinkings of the project will be published at the end of 2014 or the beginning of 2015. The project is joint between Université de Rennes I, Inria and Supélec.

8.2.4. Competitivity Clusters

The AMORES project (ANR INS 2011, http://www.images-et-reseaux.com/en/content/amores) is recognized by the Images & Réseaux cluster.

8.3. European Initiatives

8.3.1. FP7 & H2020 Projects

The **PANOPTESEC** project (http://www.panoptesec.eu) started on the 1st of November 2013. It deals with the automated and assisted security management of IT and SCADA system. The main objective of PANOPTESEC is to provide an integrated solution that will allow to efficiently monitor SCADA systems, detect intrusions and react to them. To that end, it encompasses many of the research topics that are addressed by the CIDRE team: alerts aggregation and correlation, policy-aware intrusion detection, architecture-aware intrusion detection, automated trust management, trust-based automated reaction and visualization.

The CIDRE team is involved in the project on all of these aspects. The partners are:

- REHA (BE),
- Alcatel-Lucent Bell Labs France (FR),
- Epistematica (IT),
- The University of Rome (IT),
- the University of Hamburg (GE),
- the Institut Mines-Telecom (FR),
- ACEA (IT),
- Supélec (FR).

This year, our work focused on requirements and design. CIDRE was the WP leader of *WP2 - Deficiency and Requirement Analysis* and was also particularly involved in *WP4 - Data Collection and Correlation*, *WP5 - Dynamic Risk Management* and *WP6 - Visual Analytics and Display*. In WP2, we produce an document presenting the state of the art and current limitations in the fields of security data collection and correlation, mission impact evaluation, threat assessment, automated and semi-automated reaction and visualization and interaction. We also produced an operational requirement analysis. In WP4, we produced a document presenting the system requirements for data collectin and low-level correlation. In WP5, we produced a document presenting the system requirements for risk evaluation and dynamic risk management. In WP6, we produced a document presenting visualization challenges and requirements in the context of PANOPTESEC. More generally, we also contributed to the design and architecture of what will be the PANOPTESEC system.

8.4. International Initiatives

8.4.1. Informal International Partners

Sébastien Gambs is collaborating with Jean-Marc Robert (ETS, Montréal, Canada) on the development of privacy-preserving and secure distance-bounding protocols and with Alain Tapp (Université de Montréal, Montréal, Canada) on the design of cryptographic architectures for privacy. He is also collaborating with Panagiotis Papadimitratos (KTH, Stockholm, Sweden) on privacy for location-based services.

8.5. International Research Visitors

8.5.1. Visits of International Scientists

Jean-Marc Robert

Date: June 2014

Institution: École de Technologie Supérieure (Canada).

8.5.1.1. Internships

Sackmann Mario Julián

Date: Sep 2014 - Jan 2015

Institution: Universidad de Buenos Aires (Argentine)

8.5.2. *Visits to International Teams*

8.5.2.1. Explorer programme

> Sébastien Gambs
>
>> Date: May 2014
>>
>> Institution: Institute of Big Data Analytics, Dalhousie University (Halifax, Canada)

8.5.2.2. Research stays abroad

We built a collaboration with Yvan Labiche of the Carleton University in Ottawa to supervise the PhD thesis of Mouna Hkimi. In the context of this collaboration and thanks to the support of SUPELEC and go the SUPELEC foundation, Eric Totel went in Carleton University for four months from March to June 2014, to work on the subject of the modeling of distributed applications.

In May 2014, Sébastien Gambs visited Stan Matwin at the Institute of Big Data Analytics located at Dalhousie university (Halifax, Canada). This visit has foster the beginning of a collaboration on the privacy-preserving analysis of large scale data. In particular, we have started to develop a novel method for sanitizing CDRs (Call Details Records) dataset based on differentially-private variants of sketches, which has been submitted to the D4D challenge. We will also prepare a submission for an associate Inria team for the 2015 call.

Thanks to the support of SUPELEC, Christophe Bidan has joined the ETS (École Supérieure de Technologie) of Montréal from july 2014 to july 2015 for working with Prof. Jean-Marc Robert. This stay results from a collaboration that has been initiated 2 years ago when Prof. Jean-Marc Robert has spent 4 months (from september to december 2012) in the CIDRE research group.

From September 2014 to May 2015, Antoine Guellier has joined the "Securing Cyberspace" team leaded by Prof. Batten, at Deakin University (Melbourne, Australia). This stay is possible thanks to the international outgoing fellowships of Rennes Métropole and of the UEB (Université Européenne de Bretagne).

<p style="text-align:center">**COAST Team**</p>

7. Partnerships and Cooperations

7.1. National Initiatives

7.1.1. ANR ConcoRDanT ANR-10-BLAN-0208 (2010–2014)

Participants: Pascal Urso [contact], Mehdi Ahmed-Nacer, Claudia-Lavinia Ignat, Gérald Oster.

Partners: REGAL project-team (Inria Paris - Rocquencourt / LIP6, coordinator), CITI institute (Universidade Nova de Lisboa, Portugal), GDD team (University of Nantes) and SCORE team.

Website: http://concordant.lip6.fr/

Massive computing systems and their applications suffer from a fundamental tension between scalability and data consistency. Avoiding the synchronisation bottleneck requires highly skilled programmers, makes applications complex and brittle, and is error-prone.

The ConcoRDanT project (oct. 2010 – apr. 2014) investigates a promising new approach that is simple, scales, and provably ensures eventual consistency. A Commutative Replicated Data Type (CRDT) is a data type where all concurrent operations commute. If all replicas execute all operations, they converge; no complex concurrency control is required. We have shown in the past that CRDTs can replace existing techniques in a number of tasks where distributed users can update concurrently, such as co-operative editing, wikis, and version control. However CRDTs are not a universal solution and raise their own issues (e.g., growth of metadata).

The ConcoRDanT project engages in a systematic and principled study of CRDTs, to discover their power and limitations, both theoretical and practical. Its outcome will be a body of knowledge about CRDTs and a library of CRDT designs, and applications using them. We are hopeful that significant distributed applications can be designed using CRDTs, a radical simplification of software, elegantly reconciling scalability and consistency.

7.1.2. ANR STREAMS ANR-10-SEGI-010 (2010–2014)

Participants: Gérald Oster [coordinator], Luc André, Claudia-Lavinia Ignat, Pascal Urso.

Partners: SCORE team (coordinator), ASAP project-team (University of Rennes 1 / Inria Rennes - Bretagne Atlantique), CASSIS project-team (Inria Nancy - Grand Est / Nancy University), REGAL project-team (Inria Paris - Rocquencourt / LIP6) and GDD team (University of Nantes / LINA)

Website: http://streams.loria.fr/

The STREAMS project (nov. 2010 – may 2014) proposes to design peer-to-peer solutions that offer underlying services required by real-time social web applications and that reduce the disadvantages of centralised architectures. These solutions are meant to replace a central authority-based collaboration with a distributed collaboration that offers support for decentralisation of services.

The STREAMS project aims to advance the state of the art on peer-to-peer networks for social and real-time applications. Scalability is generally considered as an inherent characteristic of peer-to-peer systems. It is traditionally achieved using replication techniques. Unfortunately, the current state of the art in peer-to-peer networks does not address replication of continuously updated content due to real-time user changes. Moreover, there exists a tension between sharing data with friends in a social network deployed in an open peer-to-peer network and ensuring privacy. One of the most challenging issue in social applications is how to balance collaboration with access control to shared objects. Interaction is aimed at making shared objects available to all who need them, whereas access control seeks to ensure this availability only to users with proper authorisation. STREAMS project aims at providing theoretical solutions to these challenges as well as practical experimentations.

7.1.3. ANR Kolflow (2011–2014)
Participant: Gérôme Canals.

Partners: GDD team (University of Nantes / LINA), Loria (Orpailleur and SCORE Teams), Silex Team (LIRIS, University of Lyon), Edelweiss (Inria Project).

Website: http://kolflow.univ-nantes.fr/

Kolflow aims at building a social semantic space where humans collaborate with smart agents in order to produce knowledge understandable by humans and machines. Humans are able to understand the actions of smart agents. Smart agents are able to understand actions of humans. Kolflow targets the co-evolution of content and knowledge as the result of interactions of humans and machines. Our work in the Kolflow project focus on implementing knowledge base testing strategies.

7.1.4. FSN OpenPaaS (2012–2015)
Participants: Olivier Perrin, Ahmed Bouchami.

Partners: Samovar team (Telecom SudParis), SCORE team (Université de Lorraine, Loria), ARMINES (Ecole des Mines d'Albi), Brake France, Linagora.

Website: http://www.open-paas.org/

The OpenPaaS project aims at developing a PaaS (Platform as a Service) technology dedicated to enterprise collaborative applications deployed on hybrid clouds (private/public). OpenPaaS is a platform that allows to design and deploy applications based on proven technologies provided by partners such as collaborative messaging systems, integration and workflow technologies that will be extended in order to address Cloud Computing requirements. Available as an open-source Enterprise Social Network, the OpenPaaS project innovates both at the collaborative level and by its capacity to leverage heterogeneous cloud technologies at the IaaS level (Infrastructure as a Service). This project is funded under the French FSN umbrella (Fond National pour la société Numérique).

7.2. European Initiatives

7.2.1. FP7 & H2020 Projects

7.2.1.1. SyncFree (2013-2016)
Participants: Pascal Urso [contact], Jordi Martori Adrian.

Program: FP7-ICT-2013-10

Project acronym: SyncFree

Project title: Large-scale computation without synchronisation

Duration : October 2013 - September 2016

Coordinator: Marc Shapiro, Inria

Other Partners: REGAL project-team (Inria Paris - Rocquencourt / LIP6, coordinator), Basho Technologies Limited (United Kingdom), Trifork AS (Denmark), Rovio Entertaiment OY (Finland), Faculdade de Ciências e Tecnologia (Universidade Nova de Lisboa, Portugal), Université Catholique de Louvain (Belgium), Ko c University (Turkey), Technische Universität Kaiserslautern (Germany) and COAST team.

Abstract: Large-scale on-line services including social networks and multiplayer games handle huge quantities of frequently changing shared data. Maintaining its consistency is relatively simple in a centralised cloud, but no longer possible due to increased scalability requirements. Instead, data must replicated across several distributed data centres, requiring new principled approaches to consistency that will be explored by the SyncFree project. http://syncfree.lip6.fr/

7.3. International Initiatives

7.3.1. Inria Associate Teams

7.3.1.1. USCOAST

Title: User Studies on Trustworthy Collaborative Systems

International Partner (Institution - Laboratory - Researcher):

Wright State University (USA)

Duration: 2013 - 2015

See also: http://uscoast.loria.fr/

USCoast has as main objective the validation of trustworthy collaborative systems using experimental user studies. This type of validation requires the expertise of both computer scientists that designed the systems and social scientists for conceptualizing and measuring human behaviour in collaborative work. The project will focus on the real-time requirements and trust policies in collaborative editing, resulting in a theory for the effect of real-time constraints in collaborative editing and awareness management for the coordination of work in the presence of conflict and disruption. The project includes also validation of proposed light security mechanisms for decentralised collaboration, based on posted measures of voluntary compliance with data sharing restrictions. We will develop new methods for the cost-effective evaluation of collaborative work to compensate for otherwise unrealistic sample sizes and costly engineering, using game theory to inspire task analogues and simulated users along with human users.

7.4. International Research Visitors

7.4.1. Visits of International Scientists

Weihai Yu

Date: August 2013 - June 2014

Institution: University of Tromsø (Norway)

Weihai Yu examined issues concerning undo in collaborative editing and proposed an approach using a layered commutative replicated data type (CRDT) for strings.

Valerie Shalin

Date: Nov 2013 - Jul 2014

Institution: Wright State University (USA)

Valerie Shalin worked on experimental user studies of real-time collaborative editing and on the design of a game theory approach for the validation of trust-based collaboration.

Ehtesham Zahoor

Date: June, 1 2014 - July, 31 2014

Institution: National University of Computer and Emerging Sciences (Pakistan)

7.4.1.1. Internships

Fox Olivia

Date: Apr 2014 - Jul 2014

Institution: Wright State University (USA)

<div align="center" style="color:red">**CTRL-A Exploratory Action**</div>

8. Partnerships and Cooperations

8.1. Regional Initiatives

The Labex Persyval-lab is a large regional initiative, supported by ANR, where we are contributing through two projects:

8.1.1. Projet Exploratoire STAARS

This project, defined for one and a half year, grouped members from Inria, LIG and Gipsa-lab, and concerned the general topic of control for computing, with a special emphasis on relating stochastic models with logical discrete control. It enabled us to organize two international workshops in Grenoble: https://persyval-lab.org/en/exploratory-project/staars

8.1.2. Equipe-action HPES

This project groups members from Inria, LIG, Gipsa-lab, TIMA and Gipsa-lab, around the topic of High-Performance Computing benefitting from technologies originally developed for Embedded Systems. Ctrl-A is directly involved in the co-advising of the PhD of Naweiluo Zhou, with J.F. Méhaut (LIG), on the topic of autonomic management of software transactional memory mechanisms: https://persyval-lab.org/en/sites/hpes

8.2. National Initiatives

8.2.1. ANR

Ctrl-Green[0] is an ANR project on Autonomic energy management for virtualized datacenter. The Coordinator is UJF, and the duration: 2011-2014. Others Partners are: Inria Rennes, IRIT, Eolas.

In Ctrl-A, it is funding the PhD thesis of Soguy Gueye, defended in december 2014; before that it funded the post-doc of Nicolas Berthier in 2012. In both cases, co-advising was done with Noël de Palma (LIG).

8.2.2. Informal National Partners

We have contacts with colleagues in France, with whom we are submitting collaboration projects, co-organizing events and workshops, etc. They feature : Avalon Inria team in Lyon (F. Desprez), LIP6 (J. Malenfant), Scales Inria team in Sophia-Antipolis (L. Henrio), LIRRM in Montpellier (A. Gamatié, K. Godary, D. Simon), IRISA/Inria Rennes (J. Buisson, J.L. Pazat, ...), Telecom Paris-Tech (A. Diaconescu, E. Najm), LAAS (Thierry Monteil).

8.2.3. Informal National Industrial Partners

We have ongoing discussions with several industrial actors in our application domains, some of them in the framework of cooperation contracts, other more informal: Eolas/Business decision (G. Dulac), ST Microelectronics (V. Bertin), Schneider Electric (C. El-Kaed, P. Nappey, M. Pitel), Orange labs (J. Pulou, G. Privat).

8.3. International Initiatives

8.3.1. Inria International Partners

8.3.1.1. Informal International Partners

We have ongoing relations with international colleagues in the emerging community on our topic of control for computing e.g., in Sweden at Lund (K.E. Arzen, M. Maggio) and Linnaeus Universities (D. Weyns, N. Khakpour), in the Netherlands at CWI/leiden University (F. Arbab), in China at Heifei University (Xin An), in Italy at University Milano (C. Ghezzi, A. Leva), in the USA at Ann Arbor University (S. Lafortune).

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[0]http://www.en.ctrlgreen.org/

8.3.2. Participation In other International Programs

Eric Rutten is a member of the IFAC Technical Committee 1.3 on Discrete Event and Hybrid Systems, for the 2011-2014 triennium, and for the 2014-2017 triennum http://tc.ifac-control.org/1/3 ; and of the IEEE Control Systems Society Discrete Event Systems Technical Committee http://discrete-event-systems.ieeecss.org.

<div align="center">

MIMOVE Team

</div>

7. Partnerships and Cooperations

7.1. National Initiatives

7.1.1. ANR

7.1.1.1. ANR MURPHY

Participant: Animesh Pathak [correspondent].

- **Name:** MURPHY – *Dependability-focused Evaluation of Sensor Networks*
- **URL:** http://cedric.cnam.fr/~sailhanf/murphy/
- **Related activities:** § 6.6
- **Period:** [January 2011 – September 2014]
- **Partners:** CNAM (**Coordinator**), Inria MiMove, LAAS - CNRS, SmartGrains, Univ. Valenciennes.

Murphy aims at easing the development of dependable and pervasive applications built on top of robust wireless sensor networks, thus providing a mean for early detection of possible failures, by estimating dependability metrics. This endeavor is undertaken by providing:

- Fault detection based on in-network event processing;
- Fault injection that attempts to accelerate the occurrence of faults so as to judge the quality of the error handling and hence, facilitate the evaluation of dependability;
- Advanced code dissemination across sensor networks, which is intended to enable the dynamic and distributed insertion of faults and hide from the end user the complexity related to this task; and
- Suitable abstractions to reason on faults, wireless sensor networks, data-centric and event-driven applications.

The aforementioned components enable to detect faults, diagnose possible causes and select appropriate corrective actions, and therefore to consolidate the dependability of sensor applications.

7.1.2. Inria Support

7.1.2.1. Inria ADT iConnect

Participant: Valérie Issarny [correspondent].

- **Name:** iConnect – *Emergent Middleware Enablers*
- **Related activities:** § 6.3 and 6.4
- **Period:** [October 2013 – December 2015]
- **Partners:** Inria MiMove.

The pervasive computing vision is hampered by the extreme level of heterogeneity in the underlying infrastructure, which impacts on the ability to seamlessly interoperate. Further, the fast pace at which technology evolves at all abstraction layers increasingly challenges the lifetime of networked systems in the digital environment.

Overcoming the interoperability challenge in pervasive computing systems has been at the heart of the FP7 FET IP CONNECT project (http://www.connect-forever.eu/), which ran from 2009 to 2012, and was coordinated by Inria ARLES (MiMove's predecessor team). Specifically, CONNECT has been investigating the paradigm of *Emergent middleware*, where protocol mediators are dynamically synthesized so as to allow networked systems that provide complementary functionalities to successfully coordinate. The CONNECT project has in particular delivered prototype implementation of key enablers for emergent middleware, spanning discovery, protocol learning, and mediator synthesis and deployment. Further, while CONNECT focused on learning and reconciling interaction protocols at the application layer, the FP7 project CHOReOS (http://www.choreos.eu) to which ARLES contributed as well, investigated a complementary enabler that supports interoperability across systems implementing heterogeneous interaction paradigms (i.e., client-service, event-based and shared memory). The proposed enabler introduces the concept of XSB - eXtensible Service Bus, which revisits the notion of Enterprise Service Bus and features an end-to-end interaction protocol that preserves the interaction paradigms of the individual components, while still allowing interoperability.

The objective of the Inria iConnect ADT is to leverage and integrate the above complementary results, packaging and further enhancing enabler prototypes, for take-up of the results by the relevant open source community. The work will involve development effort focused on the following core enablers:

- Universal discovery of resources composing legacy discovery protocols,
- Dynamic synthesis and deployment of mediators specified as enhanced labelled transition systems,
- XSB as underlying run-time support for mediators so as to support interoperability across systems based on heterogeneous interaction paradigms,
- Experiment in the area of federated social networking.

We are releasing the software prototypes through the OW2 open source initiative FISSi (Future Internet Software and Services initiative – http://www.ow2.org/view/Future_Internet/), as our solutions are of direct relevance to sustaining interoperability in the Future Internet.

7.1.2.2. Inria ADT Yarta
Participant: Animesh Pathak [correspondent].

- **Name:** Yarta – *Middleware for mobile social ecosystems*
- **Related activities:** § 6.8
- **Period:** [October 2012 – September 2014]
- **Partners:** Inria MiMove.

Yarta is a middleware for managing mobile social ecosystems, which builds upon existing research in context-awareness in the pervasive computing domain. The work involves development effort in the multi-layer middleware architecture of Yarta, providing the needed functionalities, including: (*i*) Storage of social data in an interoperable format, using semantic technologies such as RDF; (*ii*) Extraction of social ties from context (both physical and virtual); (*iii*) Enforcement of access control to protect social data from arbitrary access; and (*iv*) A rich set of mobile social ecosystem (MSE) management functionalities, using which mobile social applications can be developed. Specifically, the ADT supports the public open source release and evolution of the Yarta middleware, which is currently a research prototype.

7.1.2.3. Inria ADT CityLab Platform
Participant: Animesh Pathak [correspondent].

- **Name:** CityLab Platform – *A Platform for Smarter Cities Promoting Social and Environmental Sustainability*
- **Related activities:** § 6.5
- **Period:** [November 2014 – October 2016]
- **Partners:** Inria MiMove, Inria CLIME.

The CityLab Platform ADT is part of the CityLab Inria Project Lab focused on the study of ICT-based smart city systems from supporting "sensing" systems up to advanced data analytics and new services for the citizens. While the topic is broad, the lab leverages relevant effort within Inria project-teams that is further revisited as well as integrated to meet the challenges of smart cities

There is the promise of enabling radically new ways of living in, regulating, operating and managing cities through the increasing active involvement of citizens. The latest technology trends of crowd- sourcing/sensing (crowd-Xing) and location-based social networking have reignited citizen engagement, opening new perspectives for cost-effective ways of making local communities and cities more sustainable. However, this requires investigating supporting systems of systems from advanced sensing systems up to integrated data management and associated data analytics. This is specifically the objective of the CityLab Inria ProjectLab, where the related ADT is focused on the development and maintenance of the CityLab Platform. The platform integrates the software prototypes developed as part of the undertaken research and will be made available under open source license. It is further the objective of the ADT to deploy and experiment with the platform within cities.

7.2. European Initiatives

7.2.1. FP7 & H2020 Projects

We provide below information about the latest FP7 project in which we participated, ICT NoE NESSoS, which ended in 2014. We are currently taking part in two H2020 projects, RIA ICT CHOReVOLUTION and RIA ICT FIESTA, which are starting in 2015 and will appear in next year's report.

7.2.1.1. FP7 ICT NoE NESSoS
Participants: Valérie Issarny [correspondent], Animesh Pathak [correspondent].

> **Name:** NESSoS – *Network of Excellence on Engineering Secure Future Internet Software Services and Systems*
>
> **URL:** http://www.nessos-project.eu
>
> **Type:** COOPERATION (ICT)
>
> **Defi:** Trustworthy ICT
>
> **Instrument:** Network of Excellence (NoE)
>
> **Related activities:** § 6.8
>
> **Period:** [October 2010 - March 2014]
>
> **Partners:** Atos Origin (Spain), CNR (Italy) [**coordinator**], ETH Zürich (Switzerland), IMDEA Software (Spain), Inria (teams MiMove, CASSIS, and TRISKELL), KU Leuven (Belgium), LMU München (Germany), Siemens AG (Germany), SINTEF (Norway), University Duisburg-Essen (Germany), Universidad de Malaga (Spain), Università degli studi di Trento (Italy).

The Network of Excellence NESSoS on "Engineering Secure Future Internet Software Services and Systems" aims at constituting and integrating a long lasting research community on engineering secure software-based services and systems. The NESSoS engineering of secure software services is based on the principle of addressing security concerns from the very beginning in system analysis and design, thus contributing to reduce the amount of system and service vulnerabilities and enabling the systematic treatment of security needs through the engineering process. In light of the unique security requirements exposed by the Future Internet, new results are achieved by means of an integrated research, as to improve the necessary assurance level and to address risk and cost during the software development cycle in order to prioritize and manage investments.

7.2.2. Collaborations in European Programs, except FP7

7.2.2.1. EIT ICT Labs 3cixty
Participant: Animesh Pathak [correspondent].

> **Name:** 3cixty – *A Platform for Apps and Services that Offer Comprehensive Views of a City*
> **URL:** http://www.3cixty.com/
> **Period:** [January 2014 - December 2015]
> **Partners:** Ambientic (F), CEFRIEL (IT), DFKI (DE) [**coordinator**], Eurecom (F) [**associate leader**], Fondazione Politechnico di Milano (IT), Innovalor (NL), Inria MiMove [**associate leader**], LocaliData (ES), Mobidot (NL), Politechnico di Milano (IT), Telecom Italia (IT) [**associate leader**], Thales (F), TU Delft (NL), UC London (UK).

3cixty is a platform, well motivated in business terms, for developing apps for city visitors that makes it easy for application developers to access and process comprehensive heterogeneous information about a city; and a Showcase App using the platform that demonstrates its added value. The project will result new opportunities to enable city visitors to exploit the transportation, business, cultural, and touristic opportunities offered by a city more fully and in a more personally and environmentally appropriate way, thereby benefiting cities, their visitors, and application and service developers.

7.3. International Initiatives

7.3.1. Inria International Labs

Valérie Issarny acts as scientific manager of the Inria@Silicon Valley program (https://project.inria.fr/inria-siliconvalley/) since summer 2013; she is visiting scholar at CITRIS, EECS, University of California, Berkeley.

Sara Hachem conducts her postdoc research in the context of the Inria@Silicon Valley program at UC Berkeley.

7.3.2. Inria Associate Teams

7.3.2.1. Inria DRI/DST-CEFIPRA Associate Team: SARATHI
Participant: Animesh Pathak [correspondent].

> **Name:** SARATHI – *Personalized Mobility Services for Urban Travelers*
> **Instrument:** Inria DRI/DST-CEFIPRA Associate Team
> **Period:** [January 2014 - December 2016]
> **Partners:** Indraprastha Institute of Information Technology (IIIT), Delhi (India), Inria MiMove.
> **Website:** https://mimove.inria.fr/inria-associate-team-sarathi/

The focus of the *Sarathi* project is on creating a personalized mobility service platform for urban travelers. The proposed work would require work on large scale mobile participatory sensing, urban transportation, location-aware services, machine learning, and software engineering. The individual strength of MiMove and IIIT provide complementary technical benefits for the project. MiMove leverages its work on large scale mobile participatory sensing (so far focused on EU-based transit contexts) addressing challenges brought to the fore by dynamic large scale systems in India; IIIT will build up on their previous work on mobile based system to provide route information and work on learning and mining techniques for inferring events of interest in transport systems.

Besides the complementary technical benefits, the collaboration will also help the project in evaluating the proposed solution in context of both developing and developed countries with different societal structure and preferences. Since personalized services are an integral part of the solution, the variety in social structures of India and France will help in developing solutions that are valid across continents. A deployment of the proposed solution in India will also test scalability and robustness of the solution in resource-constrained environments (e.g. intermittent network connectivity, low bandwidth) and will help in developing solutions that can be deployed in different working environments. Similarly, France (with already an advanced transit system) offers opportunities in verifying the requirements of a successful sustainable transport system.

7.3.3. Participation in other International Programs

7.3.3.1. International scientific cooperation program Inria/Brazil – Project M@TURE
Participant: Nikolaos Georgantas [correspondent].

Name: M@TURE – *Models @ runtime for self-adaptive pervasive systems*

Instrument: Inria-Brazil cooperation programme

Period: [October 2012 - September 2014]

Partners: Institute of Informatics of Federal University of Goias (Brazil), Inria MiMove.

The overall goal of the M@TURE project is to design, implement and evaluate a novel approach and architecture - comprising conceptual foundations, engineering techniques, and supporting middleware infrastructure - for self-adaptive pervasive systems by building on the notion of Models@run.time. Models@run.time extends the applicability of models and abstractions to the runtime environment. In contrast to design-time models, runtime models are used to reason about the running system taking into account its operating environment, and thus these models enable automating runtime decisions and actions regarding the creation, configuration, and evolution of the system. We in particular focus on the following dimensions and related models: (i) Requirements models making a system requirements-aware at runtime; (ii) Application- and middleware-level interoperability models exposing to an external observer the technological and business features of a system; and (iii) End-user and system engineer models modeling the internal elements of a system at two different abstraction levels. These models are considered both independently and, more importantly, in synergy in order to introduce a comprehensive conceptual and architectural solution for self-adaptive pervasive systems.

7.4. International Research Visitors

7.4.1. Internships

Raphael de Aquino Gomes (from Sep. 2014 until Aug. 2015)

PhD internship funded by a visitor PhD student scholarship of the Brazilian Science without Borders program provided by CAPES and CNPq.

Subject: *Self-Adaptive Use of Cloud Resources for Heterogeneous Dynamic Service Choreographies*

Institution: Federal University of Goias - UFG (Brazil)

MYRIADS Project-Team

6. Partnerships and Cooperations

6.1. Regional Initiatives

6.1.1. *CominLabs EPOC project (2013-2016)*

Participants: Sabbir Hasan Rochi, Yunbo Li, Anne-Cécile Orgerie, Jean-Louis Pazat.

In this project, partners aim at focusing on energy-aware task execution from the hardware to application's components in the context of a mono-site data center (all resources are in the same physical location) which is connected to the regular electric Grid and to renewable energy sources (such as windmills or solar cells). In this context, we tackle three major challenges:

- Optimizing the energy consumption of distributed infrastructures and service compositions in the presence of ever more dynamic service applications and ever more stringent availability requirements for services.
- Designing a clever cloud's resource management which takes advantage of renewable energy availability to perform opportunistic tasks, then exploring the trade-off between energy saving and performance aspects in large-scale distributed systems.
- Investigating energy-aware optical ultra high-speed interconnection networks to exchange large volumes of data (VM memory and storage) over very short periods of time.

6.1.2. *EcoPaaS, Brittany region SAD project(2014-2015)*

Participants: Maria Del Mar Callau Zori, Anne-Cécile Orgerie, Guillaume Pierre, Lavinia Samoila.

Many research efforts have been dedicated to reducing cloud energy consumption, in particular by optimizing the Infrastructure-as-a-Service layer of the Cloud. Infrastructure-as-a-Service (IaaS) is the layer in charge of the virtualization of physical resources, and therefore has direct control over energy-related elements. However, the IaaS layer has no knowledge about the nature of applications which run over these resources, which limits the scope of decisions it can take.

The EcoPaaS project therefore aim at making the IaaS layer (in charge of resources) and the PaaS layer (in charge of applications) collaborate to further reduce the Cloud energy consumption. The idea is to define standard interfaces that allow both layers to exchange relevant information and to coordinate their actions. Exchanging information will for example allow the PaaS layer to estimate the energy consumption of each application it is running. Coordinating actions will in turn allow the system to avoid situations where both layers simultaneously take mutually-damaging actions. This project is funding Maria del Mar Callau-Zori's postdoc.

6.1.3. *Monitoring for Cloud Security, collaboration with DGA-MI (2014-2017)*

Participants: Anna Giannakou, Christine Morin, Jean-Louis Pazat, Louis Rilling.

Our study aims at designing a self-adaptable system for security supervision in clouds. The considered system should cope with the dynamic nature of clouds and have a minimal impact on performance. The funding from DGA funds a PhD student, Anna Giannakou, who joined Myriads team in March 2014. Anna Giannakou is co-advised by Christine Morin (Inria), Jean-Louis Pazat (INSA Rennes) and Louis Rilling (DGA-MI). Louis Rilling was formally appointed as external collaborator in Myriads team effective from March 1st 2014.

6.1.4. *IRT B-Com*

Participants: Yvon Jégou, Edouard Outin, Jean-Louis Pazat.

Yvon Jégou and Jean-Louis Pazat are at IRT B-Com [0] one day per week. With Édouard Outin, B-com PhD student, they contribute to the B-Com *Indeed* project, which aims at developing a distributed cloud software stack with a high degree of adaptability.

6.2. National Initiatives

6.2.1. *Inria ADT GinFlow (2014-2016)*

Participants: Christine Morin, Javier Rojas Balderrama, Matthieu Simonin, Cédric Tedeschi.

The GinFlow technological development action funded by INRIA targets the development of a fully-operational workflow management system based on the HOCL-TS software prototype developed during the PhD thesis of Héctor Fernandez between 2009 and 2012. Also, it allows the integration of this software with the TIGRES workflow engine developed at the Lawrence Berkeley National Lab so as to make the workflows submitted using the TIGRES programming model run in a decentralized fashion.

6.2.2. *Inria ADT Snooze (2012-2014)*

Participants: Eugen Feller, Yvon Jégou, David Margery, Christine Morin, Anne-Cécile Orgerie, Matthieu Simonin.

The Snooze technological development action funded by INRIA aims at developing an IaaS cloud environment based on the Snooze virtual machine framework developed by the team (http://snooze.inria.fr) and to make this new environment available to a wide community. In 2014, we refactored some parts of the code to enable the use of plugins. We also developed the Cloud Agnostic Checkpointing Service (CACS) service on top of Snooze to enable application recovery in the event of the failure of servers hosting virtual machines [31].

6.2.3. *HEMERA Inria AEN (2010-2014)*

Participants: Bogdan Florin Cornea, Yvon Jégou, Anne-Cécile Orgerie.

The Myriads team is involved in the HEMERA large wingspan project funded by INRIA (http://www.grid5000.fr/mediawiki/index.php/Hemera). This project aims at demonstrating ambitious up-scaling techniques for large scale distributed computing by carrying out several dimensioning experiments on the Grid'5000 infrastructure, at animating the scientific community around Grid'5000 and at enlarging the Grid'5000 community by helping newcomers to make use of Grid'5000. Yvon Jégou is co-chair of the "Bring Grids Power to Internet-Users thanks to Virtualization Technologies" working group. Anne-Cécile Orgerie is involved in the "Energy" working group which is currently looking at making energy-aware experiments on Grid'5000 easier for the users. This project funded Bodgan Florin Cornea's postdoc supervised by Anne-Cécile Orgerie and Laurent Lefèvre (Inria, LIP, Lyon).

6.2.4. *Inria IPL CityLab (under submission) (2014-2018)*

Participants: Roberto-Gioacchino Cascella, Christine Morin.

The Inria Project Lab (IPL) CityLab@Inria (informally started - see https://citylab.inria.fr) studies ICT solutions toward smart cities that promote both social and environmental sustainability. A strong emphasis of the Lab is on the undertaking of a multi-disciplinary research program through the integration of relevant scientific and technology studies, from sensing up to analytics and advanced applications, so as to actually enact the foreseen smart city Systems of Systems. City-scale experiments of the proposed platforms and services are planned in cities in California and France, thereby learning lessons from diverse setups.

Myriads investigates advanced cloud solutions for the Future Internet, which are critical for the processing of urban data. It leverages its experience in cloud computing and Internet of services while expanding its research activities to the design and implementation of cloud services to support crowd-Xing applications and mobile social applications.

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[0]http://b-com.org/wp/

6.2.5. MIHMES ANR Investissements d'Avenir (2012 - 2018)

Participants: Yvon Jégou, Christine Morin.

The MIMHES project (http://www.inra.fr/mihmes) led by INRA/BioEpAR aims at producing scientific knowledge and methods for the management of endemic infectious animal diseases and veterinary public health risks. Myriads team will provide software tools to efficiently manage and ease the use of a distributed computing infrastructure for the execution of different simulation applications.

In 2014, we interacted with the INRA/BioEpAR research team in order to improve the initial software prototype and to make it ready for parallelisation. A first parallel version of the code was delivered by Inria during summer 2014. This first version uses the OpenMP standard to exploit multiple processor cores of the same server. A speed-up approaching 20 has been observed on a 24-cores Dell server for a single run. A whole simulation necessitates multiple runs (a few hundreds) to reach precise results. During the next steps, the presence of these runs will be exploited both to increase the volume of the internal computations (increase the efficiency of multi-core computation) and to exploit multiple servers.

6.2.6. CNRS GDS EcoInfo

Participant: Anne-Cécile Orgerie.

The EcoInfo group deals with reducing environmental and societal impacts of Information and Communications Technologies from hardware to software aspects. This group aims at providing critical studies, lifecycle analyses and best practices in order to improve the energy efficiency of printers, servers, data centers, and any ICT equipment in use in public research organizations.

6.3. European Initiatives

6.3.1. FP7 & H2020 Projects

6.3.1.1. CONTRAIL

Participants: Roberto-Gioacchino Cascella, Stefania Costache, Florian Dudouet, Filippo Gaudenzi, Yvon Jégou, Christine Morin.

Type: COOPERATION

Defi: Internet of Services, Software & Virtualisation

Instrument: Integrated Project

Objectif: Internet of Services, Software and Virtualisation

Duration: October 2010 - January 2014

Coordinator: Inria

Partner: XLAB Razvoj Programske Opreme In Svetovanje d.o.o., Slovenia; Italian National Research Council, ISTI-CNR & IIT-CNR, Italy; Vrije Universiteit Amsterdam, The Netherlands; Science and Technology Facilities Council, STFC, UK; Genias Benelux bv, The Netherlands; Tiscali Italia SpA, Italy; Konrad-Zuse-Zentrum für Informationstechnik Berlin, ZIB, Germany; Hewlett Packard Italiana S.r.l - Italy Innovation Center, Italy; Country Constellation Technologies Ltd, UK; Linagora, France.

Inria contact: Christine Morin

Abstract: The goal of the Contrail project is to design, implement, evaluate and promote an open source system for Cloud Federations. Resources that belong to different operators will be integrated into a single homogeneous federated Cloud that users can access seamlessly. The Contrail project has built a complete Cloud platform which integrates Infrastructure-as-a-Service (IaaS) and Platform-as-a-Service (PaaS) offerings [2].

6.3.1.2. ECO$_2$Clouds
Participants: Maxence Dunnewind, Nicolas Lebreton, Julien Lefeuvre, David Margery, Eric Poupart.

Type: FP7

Defi: Future internet experimental facility and experimentally-driven research

Instrument: Specific Targeted Research Project

Objectif: Future Internet Research and Experimentation (FIRE)

Duration: October 2012 - September 2014

Coordinator: Atos Spain SA (ATOS, Spain)

Partner: Atos Spain SA (ATOS, Spain) The University of Manchester (UNIMAN, United Kingdom) The University of Edinburgh (UEDIN, United Kingdom) Universitaet Stuttgart (USTUTT, Germany) Politecnico di Milano (POLIMI, Italy)

Inria contact: David Margery

Abstract: In ECO$_2$Clouds, we add to BonFIRE energy probes to be able to measure power consumption of the infrastructure, combine it with information about energy sources used to produce the power so as to be able to bill CO$_2$ usage to experimenters running VMs. To allow for scheduling and adaptation of running applications, CO$_2$ usage is not only billed after the fact but also quoted in advance for a given period for according to resource usage units.

6.3.1.3. Fed4FIRE
Participants: Maxence Dunnewind, Julien Lefeuvre, David Margery.

Type: FP7

Defi: Future internet experimental facility and experimentally-driven research

Instrument: Integrated Project

Objectif: ICT-2011.1.6 Future Internet Research and Experimentation (FIRE) with a specific focus on b) FIRE Federation

Duration: October 2012 - September 2016

Coordinator:Interdisciplinary institute for broadband technology (iMinds, Belgium)

Partner: Interdisciplinary institute for broadband technology (iMinds, Belgium), University of Southampton (It Innovation, United Kingdom) Universite Pierre et Marie Curie - paris 6 (UPMC, France) Fraunhofer-Gesellschaft zur Foerderung der Angewandten Forschung e.v (Fraunhofer, Germany) Technische Universitat Berlin (TUB, Germany) The University of Edinburgh (UEDIN, United Kingdom) National Ict Australia Limited (NICTA, Australia) Atos Spain SA (Atos, Spain) Panepistimio Thessalias (University of Thessaly) (UTH, Greece) National Technical University of Athens (NTUA, Greece) University of Bristol (UNIVBRIS, United Kingdom) Fundacio Privada i2cat, Internet I Innovacio Digital a Catalunya (i2cat, Spain) Eurescom-European Institute for Research and Strategic Studies in Telecommunications (EUR, Gmbh Germany) Delivery of Advanced Network Technology to Europe limited (DANTE limited, United Kingdom) Universidad de Cantabria (UC, Spain) National Information Society agency (NIA, Korea (republic of))

Inria contact: David Margery

Abstract: In Fed4FIRE, we investigate the means by which our experimental platforms (BonFIRE, and in a secondary way Grid'5000) could be made interoperable with a wider eco-system of experimental platforms in Europe and beyond. The baseline architectural choice for this project is to use the key concepts of the Slice Federation Architecture (SFA) to provision resources on experimental platforms, a Control and Management Framework for Networking Testbeds named OMF for experiment control and OML, the OMF Measurement library for data collection. We investigate whether these can be used to run experiments on BonFIRE and how they need to be extended to support the operating model of BonFIRE.

6.3.1.4. HARNESS

Participants: Eliya Buyukkaya, Georgios Ioannidis, Ancuta Iordache, Guillaume Pierre, Genc Tato.

Type: COOPERATION

Defi: Pervasive and Trusted Network and Service Infrastructures

Instrument: Small or medium-scale focused research project

Objectif: ICT-2011.1.2 Cloud Computing, Internet of Services and Advanced Software Engineering

Duration: October 2012 - September 2015

Coordinator: Imperial College London (IMP, United Kingdom)

Partner: Ecole polytechnique fédérale de Lausanne (EPFL, Switzerland), Université de Rennes 1 (UR1, France), Konrad-Zuse-Zentrum für Informationtechniek Berlin (ZIB, Germany), Maxeler Technologies (MAX, United Kingdom), SAP AG (SAP, Germany)

UR1 contact: Guillaume Pierre

Abstract: The HARNESS FP7 project aims to incorporate innovative hardware and network technologies seamlessly into data centres that provide platform-as-a-service cloud infrastructures.

The dominant approach in offering cloud services today is based on homogeneous commodity resources: large numbers of inexpensive machines, interconnected by off-the-shelf networking equipment, supported by stock disk drives. However, cloud service providers are unable to use this platform to satisfy the requirements of many important and high-value classes of applications.

Today's cloud platforms are missing out on the revolution in new hardware and network technologies for realising vastly richer computational, communication, and storage resources. Technologies such as Field Programmable Gate Arrays (FPGA), General-Purpose Graphics Processing Units (GPGPU), programmable network routers, and solid-state disks promise increased performance, reduced energy consumption, and lower cost profiles. However, their heterogeneity and complexity makes integrating them into the standard Platform as a Service (PaaS) framework a fundamental challenge.

The HARNESS project brings innovative and heterogeneous resources into cloud platforms through a rich programme of research, validated by commercial and open source case studies.

6.3.1.5. PaaSage

Participants: Christine Morin, Nikolaoss Parlavantzas, Aboozar Rajabi.

Type: COOPERATION

Objectif: ICT-2011.1.2 Cloud Computing, Internet of Services and Advanced Software Engineering

Instrument: Collaborative Project

Duration: October 2012 - September 2016

Coordinator: GEIE ERCIM (France)

Partner: SINTEF (Norway), Science and Technology Facilities Council (UK), University of Stuttgart (Germany), Inria (France), Centre d'Excellence en Technologies de l'Information et de la Communication (Belgium), Foundation for Research and Technology Hellas (Greece), BE.Wan SPRL (Belgium), EVRY AS (Norway), SysFera SAS (France), Flexiant Limited (UK), Lufthansa Systems AG (Germany), Gesellschaft fur Wissenschaftliche Datenverarbeitung MBH Gottingen (Germany), Automotive Simulation Center Stuttgart (Germany), University of Ulm (Germany), Akademia Górniczo-Hutnicza im. Stanislawa Staszica (Poland), University of Cyprus (Cyprus), IBSAC-Intelligent Business Solutions ltd (Cyprus), University of Oslo (Norway)

Inria contact: Nikolaos Parlavantzas

See also: http://www.paasage.eu/

Abstract: PaaSage aims to deliver an open and integrated platform to support both deployment and design of Cloud applications, together with an accompanying methodology that allows model-based application development, configuration, optimisation, and deployment on multiple Cloud infrastructures.

6.3.2. Collaborations in European Programs, except FP7 & H2020

6.3.2.1. NESUS

Participant: Anne-Cécile Orgerie.

Program: ICT COST

Project acronym: NESUS

Project title: Network for Sustainable Ultrascale Computing (ICT COST Action IC1305)

Duration: 2014 - 2018

Coordinator: Professor Jesus Carretero, University Carlos III of Madrid, Spain, http://www.nesus.eu

Other partners: 33 COST countries and 11 non-COST countries

Abstract: Ultrascale systems are envisioned as large-scale complex systems joining parallel and distributed computing systems that will be two to three orders of magnitude larger that today's systems. The EU is already funding large scale computing systems research, but it is not coordinated across researchers, leading to duplications and inefficiencies. The goal of the NESUS Action is to establish an open European research network targeting sustainable solutions for ultrascale computing aiming at cross fertilization among HPC, large scale distributed systems, and big data management. The network will contribute to glue disparate researchers working across different areas and provide a meeting ground for researchers in these separate areas to exchange ideas, to identify synergies, and to pursue common activities in research topics such as sustainable software solutions (applications and system software stack), data management, energy efficiency, and resilience. Some of the most active research groups of the world in this area are members of this proposal. This Action will increase the value of these groups at the European-level by reducing duplication of efforts and providing a more holistic view to all researchers, it will promote the leadership of Europe, and it will increase their impact on science, economy, and society.

6.3.2.2. MC-DATA

Participants: Stéphane Chevalier, Teodor Crivat, Guillaume Pierre.

Program: EIT ICT Labs

Project acronym: MC-DATA

Project title: Multi-cloud data management

Duration: Jan-Dec 2014

Coordinator: Dr. Peter Pietzuch, Imperial College London

Other partners: SICS, Vodafone

Abstract: In 2014, the continuation of the MC-Data project had two main innovation objectives: (a) to provide and release a novel open-source Platform-as-a-Service (PaaS) cloud computing software stack (MC-ConPaaS) that explicitly targets cloud application deployments across multiple data centre sites; (b) to demonstrate the business value of the MC-ConPaaS platform through a use case of cloud-assisted real-time smartphone applications, thus affecting the future business models of mobile operators. Its expected outcomes are:

- to release the MC-ConPaaS multi-site cloud platform as open source;
- to foster the adoption of the MC-ConPaaS platform by creating tutorials and documentation;
- to transfer the technology of the MC-ConPaaS platform to a mobile operator (VODAFONE), enabling them to offer a cloud infrastructure that supports cloud-assisted real-time applications;
- to develop new business models for mobile operators based on cloud-assisted real-time services running on virtualised mobile base stations.

6.3.2.3. VEP-S

Participants: Roberto-Gioacchino Cascella, Yvon Jégou, Christine Morin, Arnab Sinha.

Program: EIT ICT Labs

Project acronym: VEP-S

Project title: SLA-Aware Heterogeneous Data-Centers Management through Standards

Duration: Jan-Dec 2014

Coordinator: Christine Morin, Inria

Other partners: Intel (Ireland), Reply (Italy)

Abstract: We designed the VEP-S system, which consists of the Virtual Execution Platform (VEP) component with support for OCCI, integration of the OCCI SLA extension, and the monitoring system for deploying and running distributed applications packaged following the Open Virtualization Format (OVF), a DMTF standard, on top of an IaaS cloud. The Virtual Execution Platform (VEP), developed in the framework of Contrail European project, is in charge of provisioning hardware resources from Cloud providers and to deploy and run distributed applications submitted by users under the control of a negotiated Service Level Agreements (SLA). VEP interacts with the underlying IaaS manager to create application networks, register VM images, generate VM templates and manage the lifecycle of virtual machines. The OCCI SLA API extends the OCCI Core Model to implement a SLA management API. This API allows for the creation and management of resources related with the realization of agreements between an OCCI- enabled cloud service provider and potential consumers of the provider's resources. In the context of the VEP-S project, this extension is used to describe SLA terms and map them with the resources and services a cloud provider can offer. The monitoring component will provide three types of services: monitoring the IaaS resource manager to check whether the machine has started or not; monitoring the IaaS to check the usage of the resources; monitoring on the VM (monitoring agent in the VM and activated by the user). The technology used for the monitoring is Zabbix.

6.4. International Initiatives

6.4.1. Inria International Labs

Christine Morin was one of the co-organizers of the BIS 2014 workshop held in Paris in June 2014 in the framework of the Inria@Silicon Valley Inria International Lab. Christine Morin and Deb Agarwal were the co-chairs of the session on computation and communication for the future internet at BIS 2014. Several Myriads team members (Christine Morin, Anne-Cécile Orgerie, Javier Rojas Balderrama, Matthieu Simonin, Cédric Tedeschi) are involved in the DALHIS associate team on data analysis on large-scale heterogeneous infrastructures for science, which is part of the Inria@SiliconValley program.

6.4.2. Inria Associate Teams

6.4.2.1. DALHIS

Participants: Christine Morin, Anne-Cécile Orgerie, Javier Rojas Balderrama, Matthieu Simonin, Cédric Tedeschi.

Title: Data Analysis on Large Heterogeneous Infrastructures for Science

International Partner (Institution - Laboratory - Researcher):

> Lawrence Berkeley National Laboratory, Berkeley, USA

> Data Science and Technology department

> French PI: Christine Morin

> American PI: Deb Agarwal, head of the Data Science and Technology department

Duration: 2013 - 2015

See also: https://project.inria.fr/dalhis/

The worldwide scientific community is generating large datasets at increasing rates causing data analysis to emerge as one of the primary modes of science. Existing data analysis methods, tools and infrastructure are often difficult to use and unable to handle the "data deluge". A scientific data analysis environment needs to address three key challenges: a) programmability: easily composable and reusable programming environments for analysis algorithms and pipeline execution, b) agility: software that can adapt quickly to changing demands and resources, and, c) scalability: take advantage of all available resource environments including desktops, clusters, grids, clouds and HPC environments. The goal of the DALHIS associated team is to coordinate research and create together a software ecosystem to facilitate data analysis seamlessly across desktops, HPC and cloud environments. Specifically, our end goal is to build a dynamic environment that is user-friendly, scalable, energy-efficient and fault tolerant through coordination of existing projects. We plan to design a programming environment for scientific data analysis workflows that will allow users to easily compose their workflows in a programming environment such as Python and execute them on diverse high-performance computing (HPC) and cloud resources. We will develop an orchestration layer for coordinating resource and application characteristics. The adaptation model will use real-time data mining to support elasticity, fault-tolerance, energy efficiency and provenance. We investigate how to provide execution environments that allow users to seamlessly execute their dynamic data analysis workflows in various research environments. The work done in 2014 on scientific workflows, energy efficiency and data management is described respectively in Sections 5.5.1 , 5.4.1 and 5.3.3 . Christine Morin, Anne-Cécile Orgerie, Javier Rojas Balderrama, Cédric Tedeschi and Deb Agarwal participated in the BIS 2014 workshop held in Paris in June 2014. Christine Morin and Deb Agarwal were the co-chairs of the session on Computation and communication for the Future Internet at BIS 2014. Cédric Tedeschi presented the DALHIS activities during this session focusing on our results on scientific workflows. Deb Agarwal has been awarded an Inria International Chair for the 2015-2019 period enabling long visits in the Myriads team.

6.4.3. Inria International Partners

6.4.3.1. Informal International Partners

Northeastern University   We started a collaboration with Professor Gene Cooperman, Northeastern University, Boston, USA on the design of a cloud agnostic checkpointing service on top of IaaS clouds for reliable application execution, inter-cloud application migration and easing application "cloudification". Gen Cooperman was hosted in Myriads team for a 1.5-month visit in March-April 2014. His PhD student, Jiajun Cao did a 3-month internship in Myriads team from May to August 2014.

ORNL/TTU   We collaborate on cloud computing with Stephen Scott, Professor at Tennessee Tech University (TTU) and researcher at Oak Ridge National Laboratory (ORNL) in the USA. He visited Myriads team in July 2014 to investigate synergetic work directions on cloud security.

Argonne/ Chicago University   We collaborate on cloud computing with Kate Keahey from Argonne National Laboratory, USA. She hosted Ismael Cuadrado Cordero in her team for a 12-week summer internship (June-September 2014) on using extended on-availability leases to increase utilization in scientific IaaS clouds.

University of Guadalajara   Nikolaos Parlavantzas is collaborating with the team of Prof. Héctor Duran-Limon of the University of Guadalajara, Mexico, preparing a joint ANR-CONACYT project submission.

VU University amsterdam   We collaborate with Thilo Kielmann's research group at VU University Amsterdam on research and development around the ConPaaS system. This collaboration has lead to two joint publications this year, and another paper has been accepted in 2015.

6.5. International Research Visitors

6.5.1. *Visits of International Scientists*

Jiajun Cao, PhD student at the Northeastern University (Boston, USA), made a 3-month visit in Myriads team (May-August 2014). He contributed to the design, implementation and evaluation of a cloud agnostic checkpointing service exploiting the DMTCP process-level checkpointing technology developed in Gene Cooperman's team at the Northeastern University. This service was experimented on top of Snooze IaaS cloud management system developed in Myriads team. A paper on this work will be presented at CC-Grid 2015.

Gene Cooperman, Professor at the Northeastern University (Boston, USA), made a 1.5 month sabbatical visit in Myriads team (March-April 2014). His visit was partially funded by the University of Rennes 1.

Georgios Ioannidis (PhD student at EPFL, Switzerland) made a 3-months visit in the Myriads team (Oct-Dec 2014). The goal was to reinforce the collaboration between the two teams in the context of the HARNESS FP7 project.

Palakiyem Wallah, assistant professor at the University of Kara (Togo) visited Myriads team from October to December 2014 in the framework of his PhD thesis, which is co-advised by Jean-Louis Pazat and Cédric Tedeschi.

Qian Zhang (PhD student at the Australian National University) spent 3 weeks in Myriads team in October 2014 to learn more about our research activities on SLA management. Her visit was supported by a grant from the Australian-French Association for Science and Technology (AFAS).

6.5.1.1. Internships

Vishrut Mehta Vishrut

Date: May 2014 - Jul 2014

Institution: IITH (India)

6.5.2. *Visits to International Teams*

6.5.2.1. Research stays abroad

Ancuta Iordache visited Maxeler Technologies (London, U.K.) from May 1st 2014 to July 31st 2014. This visit reinforced the collaboration between the two teams in the context of the HARNESS E.U. project, and was funded by the EIT ICT Labs Doctoral Training Center. We plan another 3-months visit in 2015.

Ismael Cuadrado Cordero, who is a student of the EIT ICT Labs Doctoral School, visited the Argonne National Laboratory (USA) for a research internship from June to September 2014. He was hosted in Kate Keahey's team working on resource management in scientific clouds.

<div align="center">

REGAL Project-Team

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7. Partnerships and Cooperations

7.1. National Initiatives

7.1.1. Labex SMART - (2012–2019)

Members: ISIR (UPMC/CNRS), LIP6 (UPMC/CNRS), LIB (UPMC/INSERM), LJLL (UPMC/CNRS), LTCI (Institut Mines-Télécom/CNRS), CHArt-LUTIN (Univ. Paris 8/EPHE), L2E (UPMC), STMS (IRCAM/CNRS).

Funding: Sorbonne Universités, ANR.

Description: The SMART Labex project aims globally to enhancing the quality of life in our digital societies by building the foundational bases for facilitating the inclusion of intelligent artifacts in our daily life for service and assistance. The project addresses underlying scientific questions raised by the development of Human-centered digital systems and artifacts in a comprehensive way. The research program is organized along five axes and Regal is responsible of the axe "Autonomic Distributed Environments for Mobility."

The project involves a PhD grant of 100 000 euros over 2,5 years.

7.1.2. InfraJVM - (2012–2015)

Members: LIP6 (Regal), Ecole des Mines de Nantes (Constraint), IRISA (Triskell), LaBRI (LSR).

Funding: ANR Infra.

Objectives: The design of the Java Virtual Machine (JVM) was last revised in 1999, at a time when a single program running on a uniprocessor desktop machine was the norm. Today's computing environment, however, is radically different, being characterized by many different kinds of computing devices, which are often mobile and which need to interact within the context of a single application. Supporting such applications, involving multiple mutually untrusted devices, requires resource management and scheduling strategies that were not planned for in the 1999 JVM design. The goal of InfraJVM is to design strategies that can meet the needs of such applications and that provide the good performance that is required in an MRE.

The coordinator of InfraJVM is Gaël Thomas, who left the team in 2014. Infra-JVM brings a grant of 202 000 euros from the ANR to UPMC over three years.

7.1.3. Nuage - (2012–2014)

Members: Non Stop Systems (NSS), Oodrive, Alphalink (Init SYS), CELESTE, DotRiver, NewGeneration, LIP6 (Regal et Phare)

Funding: Fonds National pour la Société Numérique, CDC

Objectives: The Nuage project aims at designing and building an open source, energy-aware, cloud based on OpenStack. In this project, the Regal group contributes on the storage axis. In clouds, virtualization forms the basis to ensure flexibility, portability and isolation. However, the price to pay for flexibility and isolation is memory fragmentation. We thus propose to pool unused memory by allowing nodes to use memory of other nodes to extend their cache, at the kernel level.

It involves a grant of 153 000 euros over 2,5 years.

7.1.4. ODISEA - (2011–2014)

Members: Orange, LIP6 (Regal), UbiStorage, Technicolor, Institut Telecom

Funding: FUI project, Ile de France Region

Objectives: ODISEA aims at designing new on-line data storage and data sharing solutions. Current solutions rely on large data centers, which induce many drawbacks: (i) a high cost, (ii) proprietary solutions, (iii) inefficiency (one single location, not necessarily close to the user). The goal is to tackle these issues by designing a distributed/decentralized solution that leverage edge resources like set-top boxes.

It involves a grant of 159 000 euros from Region Ile de France over three years.

7.1.5. Richelieu - (2012–2014)

Members: LIP6 (Regal), Scilab Entreprise, Silkan, OCaml Pro, Inria Saclay, Arcelor Mittal, CNES, Dassault Aviation.

Funding: FUI.

Objectives: The goal of Richelieu is to design a new runtime for the Scilab language based on VMKit. Scilab is a scientific language and its runtime relies on a costly interpretation loop. In the Richelieu project, we propose to replace the interpretation loop by VMKit, which provides both an efficient Just In Time Compiler and advanced memory management techniques.

It involves a grant of 135 000 euros from Region Ile de France over two years.

7.1.6. MyCloud (2011–2014)

Members: Inria Rhones-Alpes (SARDES), LIP6 (REGAL), EMN, WeAreCloud, Elastic Cloud.

Funding: MyCloud project is funded by ANR Arpège.

Objectives: Cloud Computing is a paradigm for enabling remote, on-demand access to a set of configurable computing resources. The objective of the MyCloud project is to define and implement a novel cloud model: SLAaaS (SLA aware Service). Novel models, control laws, distributed algorithms and languages will be proposed for automated provisioning, configuration and deployment of cloud services to meet SLA requirements, while tackling scalability and dynamics issues. It involves a grant of 155 000 euros from ANR to LIP6 over three years.

7.1.7. ConcoRDanT (2010–2014)

Members: Inria Regal, project leader; LORIA, Université de Nantes, Universdade Nova de Lisboa.

Funding: ConcoRDanT is funded by ANR Blanc.

Objectives: CRDTs for consistency without concurrency control in Cloud and Peer-To-Peer systems. Massive computing systems and their applications suffer from a fundamental tension between scalability and data consistency. Avoiding the synchronisation bottleneck requires highly skilled programmers, makes applications complex and brittle, and is error-prone. The ConcoRDanT project investigates a promising new approach that is simple, scales indefinitely, and provably ensures eventual consistency. A Commutative Replicated Data Type (CRDT) is a data type where all concurrent operations commute. If all replicas execute all operations, they converge; no complex concurrency control is required. We have shown in the past that CRDTs can replace existing techniques in a number of tasks where distributed users can update concurrently, such as co-operative editing, wikis, and version control. However CRDTs are not a universal solution and raise their own issues (e.g., growth of meta-data). The ConcoRDanT project engages in a systematic and principled study of CRDTs, to discover their power and limitations, both theoretical and practical. Its outcome will be a body of knowledge about CRDTs and a library of CRDT designs, and applications using them. We are hopeful that significant distributed applications can be designed using CRDTs, a radical simplification of software, elegantly reconciling scalability and consistency. ConcoRDanT involves a grant of 192 637 euros from ANR to Inria over three and a half years.

7.1.8. STREAMS (2010–2014)

Members: LORIA (Score, Cassis), Inria (Regal, ASAP), Xwiki.

Funding: STREAMS is funded by ANR Arpège.

Objectives: Solutions for a peer-To-peer REAl-tiMe Social web The STREAMS project proposes to design peer-to-peer solutions that offer underlying services required by real-time social web applications and that eliminate the disadvantages of centralised architectures. These solutions are meant to replace a central authority-based collaboration with a distributed collaboration that offers support for decentralisation of services. The project aims to advance the state of the art on peer-to-peer networks for social and real-time applications. Scalability is generally considered as an inherent characteristic of peer-to-peer systems. It is traditionally achieved using replication techniques. Unfortunately, the current state of the art in peer-to-peer networks does not address replication of continuously updated content due to real-time user changes. Moreover, there exists a tension between sharing data with friends in a social network deployed in an open peer-to-peer network and ensuring privacy. One of the most challenging issues in social applications is how to balance collaboration with access control to shared objects. Interaction is aimed at making shared objects available to all who need them, whereas access control seeks to ensure this availability only to users with proper authorisation. STREAMS project aims at providing theoretical solutions to these challenges as well as practical experimentation. It involves a grant of 57 000 euros from ANR to Inria over three and a half years.

7.2. European Initiatives

7.2.1. FP7 & H2020 Projects

7.2.1.1. SyncFree

Type: COOPERATION

Challenge: Pervasive and Trusted Network and Service Infrastructures

Instrument: Specific Targeted Research Project

Objectives: ICT-2013.1.2 "Software Engineering, Services and Cloud Computing," ICT-2013.1.6 "Connected and Social Media"

Duration: October 2013 - September 2016

Coordinator: Marc Shapiro (Inria)

Partners: Inria (Regal & Score), Basho Technologies Inc., Trifork A/S, Rovio Entertainment Oy, U. Nova de Lisboa, U. Catholique de Louvain, Koç U., Technische U. Kaiserslautern.

Inria contact: Marc Shapiro

Abstract: The goal of SyncFree is to enable large-scale distributed applications *without global synchronisation*, by exploiting the recent concept of *Conflict-free Replicated Data Types* (CRDTs). CRDTs allow unsynchronised concurrent updates, yet ensure data consistency. This radical new approach maximises responsiveness and availability; it enables locating data near its users, in decentralised clouds.

Global-scale applications, such as virtual wallets, advertising platforms, social networks, online games, or collaboration networks, require consistency across distributed data items. As networked users, objects, devices, and sensors proliferate, the consistency issue is increasingly acute for the software industry. Current alternatives are both unsatisfactory: either to rely on synchronisation to ensure strong consistency, or to forfeit synchronisation and consistency altogether with ad-hoc eventual consistency. The former approach does not scale beyond a single data centre and is expensive. The latter is extremely difficult to understand, and remains error-prone, even for highly-skilled programmers.

SyncFree avoids both global synchronisation and the complexities of ad-hoc eventual consistency by leveraging the formal properties of CRDTs. CRDTs are designed so that unsynchronised concurrent updates do not conflict and have well-defined semantics. By combining CRDT objects from a standard library of proven datatypes (counters, sets, graphs, sequences, etc.), large-scale distributed programming is simpler and less error-prone. CRDTs are a practical and cost-effective approach.

The SyncFree project will develop both theoretical and practical understanding of large-scale synchronisation-free programming based on CRDTs. Project results will be new industrial applications, new application architectures, large-scale evaluation of both, programming models and algorithms for large-scale applications, and advanced scientific understanding.

7.2.2. Collaborations in European Programs, except FP7 & H2020

Program: COST Action IC1001

Project acronym: Euro-TM

Project title: Transactional Memories: Foundations, Algorithms, Tools, and Applications

Duration: 2011–2015

Coordinator: Dr. Paolo Romano (INESC)

Other partners: Austria, Czech Republic, Denmark, France, Germany, Greece, Israel, Italy, Norway, Poland, Portugal, Serbia, Spain, Sweden, Switzerland, Turkey, United Kingdom.

Inria contact: Marc Shapiro

Abstract: Parallel programming (PP) used to be an area once confined to a few niches, such as scientific and high-performance computing applications. However, with the proliferation of multicore processors, and the emergence of new, inherently parallel and distributed deployment platforms, such as those provided by cloud computing, parallel programming has definitely become a mainstream concern. Transactional Memories (TMs) answer the need to find a better programming model for PP, capable of boosting developers' productivity and allowing ordinary programmers to unleash the power of parallel and distributed architectures avoiding the pitfalls of manual, lock based synchronization. It is therefore no surprise that TM has been subject to intense research in the last years. This Action aims at consolidating European research on this important field, by coordinating the European research groups working on the development of complementary, interdisciplinary aspects of Transactional Memories, including theoretical foundations, algorithms, hardware and operating system support, language integration and development tools, and applications.

7.2.3. Collaborations with Major European Organizations

Ecole Polytechnique Fédérale de Lausanne, Distributed Programming Laboratory (Switzerland)

Caracterization of the weakest failure detector for eventual consistency

7.3. International Initiatives

7.3.1. Inria Associate Teams

7.3.1.1. ARMADA

Title: hARnessing MAssive DAta flows

International Partner (Institution - Laboratory - Researcher):

Universidad Tecnica Federico Santa Maria (CHILI)

Duration: 2014 - 2016

See also: http://web.inria-armada.org

The ARMADA project aims at designing and implementing a reliable framework for the management and processing of massive dynamic dataflows. The project is two-pronged: fault-tolerant middleware support for processing massive continuous input, and a redundant storage service for mutable data on a massive scale.

7.3.2. Inria International Partners

7.3.2.1. Declared Inria International Partners

7.3.2.1.1. PHC MAIMONIDE

Title: Application Dependent Intrusion (Byzantine) Detection in Dynamic Cloud Systems

International Partner (Institution - Laboratory - Researcher):

Technion, Haifa (Israel)

Duration: 2014 – 2015

The goal of this project is to study the ability to detect intrusions, and more broadly Byzantine failures, in standard cloud services. The goal is to provide a formal model and a corresponding formal definition of Byzantine failure detection in dynamic cloud environments, and provide formally provable implementations of these detectors. We also intend to study how to combine such Byzantine failure detectors in standard open source cloud building blocks, such as ZooKeeper, Hadoop, and Cassandra, and harden them in order to make them resilient to such attacks.

7.3.3. Participation In other International Programs

Luciana Arantes and Olivier Marin participated to the STIC-AmSud project RESPOND, which ended with a workshop in Punta Arenas, Chile, from November 17th to November 21st, 2014

7.4. International Research Visitors

7.4.1. Visits of International Scientists

Serdar Tasiran

Date: 07/2014 – 09/2014

Institution: Koç University (Turkey)

Anubis Graciela de Moraes Rossetto

Date: 03/2014 – 05/2014

Institution: Federal University of Rio Grande do Sul Porto Alegre (Brazil)

Vivien Quéma

Date: 01/2014 – 08/2014

Institution: LIG (FRANCE)

7.4.1.1. Internships

Dastagiri Reddy Malikireddy

Date: May–Aug 2014

Institution: IIT Kharagpur, India.

SCALE Team

8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. ANR Songs

Title: Simulation of Next Generation Systems

Program: Infra 13

Duration: January 2012 - December 2015

Coordinator: Inria (Nancy, Grenoble, Bordeaux)

Others partners: IN2P3 Villeurbanne, LSIIT Strasbourg, I3S Sophia-Antipolis, LINA Nantes

See also: http://infra-songs.gforge.inria.fr/

Abstract: SONGS (2012-2015) is the continuity of SIMGRID project (2009-2012), in the ANR INFRA program. The aim of SONGS is to continue the development of the SimGrid simulation platform for the study of large distributed architectures, including data grids, cloud computing facilities, peer-to-peer applications and HPC/exascale architectures.

8.1.2. FUI CloudForce (now OpenCloudWare)

Program: FSN, labelled by Minalogic, Systematic and SCS.

Duration: January 2012 - September 2015

Coordinator: France-Telecom Research

Others partners: ActiveEon, Armines, Bull, eNovance, eXo Platform, France Telecom (coordinator), Inria, IRIT-INP Toulouse, Linagora, OW2, Peergreen, Télécom Paris Tech, Télécom Saint Etienne, Thales Communications, Thales Services, Université Joseph Fourier, Université de Savoie - LISTIC, UShareSoft

See also: http://www.opencloudware.org/

Abstract: The OpenCloudware project aims at building an open software engineering platform for the collaborative development of distributed applications to be deployed on multiple Cloud infrastructures.

The results of OpenCloudware will contain a set of software components to manage the lifecycle of such applications, from modelling (Think), developing and building images (Build), to a multi-IaaS compliant PaaS platform (Run) for their deployment, orchestration, performance testing, self-management (elasticity, green IT optimisation), and provisioning. Applications will be deployed potentially on multi IaaS (supporting either one IaaS at a time, or hybrid scenarios).The results of the project will be made available as open source components through the OW2 Open Source Cloudware initiative.

8.1.3. Oseo-Isis Spinnaker

Duration: June 2011 - May 2015

Coordinator: Tagsys-RFID

Others partners: SMEs: Inside-Secure, STIC, Legrand; Academic: IPG, ENS des Mines de St Etienne, Un. du Maine, Un, F. Rabelais Tours, AETS ESEO Angers, Un. Marne la Vallée, Un. Paris 6, Un. Rennes 1, Inria.

See also: http://www.spinnaker-rfid.com/

Abstract: The objective of Spinnaker is to really allow RFID technology to be widely and easily deployed. The role of the OASIS team in this project is to allow the wide scale deployment and management of the specific RFID application servers in the cloud, so to build an end-to-end robust and flexible solution using GCM technology.

8.2. European Initiatives

8.2.1. FP7 & H2020 Projects

8.2.1.1. FI-WARE

Type: COOPERATION

Defi: PPP FI: Technology Foundation: Future Internet Core Platform

Instrument: Integrated Project

Objectif: PPP FI: Technology Foundation:Future Internet Core Platform

Duration: September 2011 - May 2014

Coordinator: Telefonica (Spain)

Others partners: Thales, SAP, Inria

Inria contact: Olivier Festor

See also: http://www.fi-ware.eu/

Abstract: FI-WARE will deliver a novel service infrastructure, building upon elements (called Generic Enablers) which offer reusable and commonly shared functions making it easier to develop Future Internet Applications in multiple sectors. This infrastructure will bring significant and quantifiable improvements in the performance, reliability, and production costs linked to Internet applications, building a true foundation for the future Internet.

8.2.1.2. DC4Cities

Type: COOPERATION

Defi: FP7 Smartcities 2013

Instrument: Specific Targeted REsearch Project

Objectif: ICT-2013.6.2: Data Centers in an energy-efficientand environmentally friendly Internet

Duration: September 2013 - February 2016

Coordinator: Freemind Consulting (BE)

Partners: U. Mannheim (DE), U. Passau (DE), HP Italy Innovation Center (IT), Create-Net (IT), ENEA (IT), CESCA Catalunia (ES), Gas Natural SA (ES), Inst. Munic. Informatica Barcelona (ES), Inria (FR)

Inria contact: Eric Madelaine

See also:

Abstract: Data centres play two different and complementary roles in Smart Cities' energy policies: as ICT infrastructures supporting Smart City resource optimization systems - more in general, delivering ICT services to the citizens - and as large energy consumers. Therefore there are huge expectations on data centres being able to run at the highest levels of renewable energy sources: this is the great challenge of DC4Cities project.
The goal of DC4Cities is to make existing and new data centres energy adaptive, without requiring any modification to the logistics, and without impacting the quality of the services provided to their users. Finally new energy metrics, benchmarks, and measurement methodologies will be developed and proposed for the definition of new related standards. DC4Cities will promote the data centres role as an " eco-friendly" key player in the Smart Cities energy policies, and will foster the integration of a network of local renewable energy providers (also interconnected with local Smart Grids and Micro Grids) to support the pursued increase of renewable energy share.

8.2.2. Collaborations with Major European Organizations

Program: EIT ICTLabs

Project acronym: Data Science programme, Activity 15 327 from Master School action line (MSL)

Project title: EIT ICT Labs Data Science Master

Duration: submitted in 2014, funded from 2014 onwards

Coordinator: Martin Klabbers, Technische Universiteit Eindhoven

Other partners (besides UNS, with Françoise Baude as local coordinator): Univ. Politechnico Madrid, Univ. Trento, Politechnico Milano, Tech. Univ. Berlin, KTH

Abstract: The activity aims to create a new major for the ICT Labs master called "Data Science", with the purpose of breeding a new generation of ICT professionals, equipped with advanced technical and entrepreunarial skills in the key area of data science and data engineering. There is a tremendous demand in industry/society for data scientists, and hence a huge market potential for DS programs. DS positions in the industry requires a different educational program, with next to technical skills, more emphasis on awareness of multifaceted challenges and improving business efficiency based on the challenge outcomes. Expected impact is that DS graduates will be quickly recruited for attractive positions as they can help EU ICT industry achieve a higher rate of innovation successes.

8.3. International Initiatives

8.3.1. Inria International Labs

8.3.1.1. CIRIC Chili

Ciric research line: Telecommunications

Inria principal investigator: Eric Madelaine

Duration: 2012 - 2021

This CIRIC activity is loosely coupled with our SCADA associated team with the Universidad de Chile (UdC). We have had some contacts with a software company in Santiago, and starting exploring some possible collaboration in the area of formal specification of distributed applications for Android systems, and generation of "safe by construction" android code. But the effective involvment of CIRIC manpower in this activity has not yet started.

8.3.1.2. LIAMA Shanghai

Liama project: HADES

Inria principal investigator: Robert de Simone

Oasis researchers involved: Eric Madelaine, Ludovic Henrio

Duration: 2013 - 2016

Modern computing architectures are becoming increasingly parallel, at all levels. Meanwhile, typical applications also display increasing concurrency aspects, specially streaming applications involving data and task parallelism. Cyber physical system interactions also add extra-functional requirements to this high degree of concurrency. The goal of best fitting applications onto architectures becomes a crucial problem, which must be tackled from any possible angle. Our position in the HADES LIAMA project is to consider modeling of applications using formal models of concurrent computation, and specialized model-driven engineering approaches to embody the design flow for such models (analysis, verification, mapping allocation, representation of non-functional properties and constraints). We build on various previous domains of expertise : synchronous languages for embedded system design, asynchronous languages for high-performance cloud computing, and real-time specification languages for cyber-physical interaction aspects.

8.3.2. Inria Associate Teams

8.3.2.1. DAESD

Title: Distributed/Asynchronous, Embedded/synchronous System Development

Inria principal investigator: Eric Madelaine

International Partner (Institution - Laboratory - Researcher):

East China Normal University (ECNU) Shanghai - SEI - Yixiang Chen

Duration: 2012 - 2014

See also: http://team.inria.fr/DAESD

The development of concurrent and parallel systems has traditionally been clearly split in two different families; distributed and asynchronous systems on one hand, now growing very fast with the recent progress of the Internet towards large scale services and clouds; embedded, reactive, or hybrid systems on the other hand, mostly of synchronous behaviour. The frontier between these families has attracted less attention, but recent trends, e.g. in industrial systems, in "Cyber-Physical systems", or in the emerging "Internet of Things", give a new importance to research combining them.

The aim of the DAESD associate team is to combine the expertise of the Oasis/Scale and Aoste teams at Inria, the SEI-Shone team at ECNU-Shanghai, and to build models, methods, and prototype tools inheriting from synchronous and asynchronous models. We plan to address modelling formalisms and tools, for this combined model; to establish a method to analyze temporal and spatial consistency of embedded distributed real-time systems; to develop scheduling strategies for multiple tasks in embedded and distributed systems with mixed constraints.

In 2014, the DAESD associated team co-organized a "Summer School" at ECNU Shanghai.

8.3.2.2. SCADA

Title: Safe Composition of Autonomic Distributed Applications

Inria principal investigator: Ludovic Henrio

International Partner (Institution - Laboratory - Researcher):

University of Chile (Chile) - NIC Chile Research Labs - Javier Bustos

Duration: 2012 - 2014

See also: http://team.inria.fr/scada

The SCADA project aims at promoting the collaboration between NIC LABS (Santiago - Chile) and OASIS team, now SCALE (Inria Sophia Antipolis - France) in the domain of the safe composition of applications. More precisely the project will extend existing composition patterns dedicated to parallel or distributed computing to ease the reliable composition of applications. The strong interactions between formal aspects and practical implementation are a key feature of that project, where formal methods, and language theory will contribute to the practical implementation of execution platforms, development and debugging tools, and verification environments. The composition models we focus on are algorithmic skeletons, and distributed components; and we will particularly focus on the programming and verification of non-functional features. Overall, from formal specification and proofs, this project should lead to the implementation of tools for the design and execution of distributed and parallel applications with a guaranteed behavior.

8.3.3. Inria International Partners

8.3.3.1. Informal International Partners

- Florian Kammuller, Middlesex University.

8.4. International Research Visitors

8.4.1. Visits of International Scientists

- Min Zhang, ECNU Shanghai, from Sep. 25th to Nov. 9th

8.4.1.1. Internships

- Siqi Li, ECNU Shanghai, master internship, from Oct. 15 to Dec. 15th.

8.4.2. Visits to International Teams

- Eric Madelaine visited ECNU Shanghai July. 6-12th.
- Ludovic Henrio, Oleksandra Kulankhina, and Eric Madelaine visited ECNU Shanghai from Nov. 29th to Dec. 6th.

8.4.2.1. Research stays abroad

- Damian Vicino, ARS Laboratory at Carleton University, Ottawa, Canada, January 2014-December 2014 (12 months)

<p style="text-align:center">**SPIRALS Team**</p>

8. Partnerships and Cooperations

8.1. Regional Initiatives

8.1.1. ADT eSurgeon

Participants: Maxime Colmant, Loïc Huertas, Romain Rouvoy [correspondant].

ADT eSurgeon (2013–15) is a technology development initiative supported by the Inria Lille - Nord Europe Center that aims at supporting the development of the POWERAPI software library (see Section 5.3) for measuring and monitoring the energy consumption of middleware and software systems.

8.1.2. ADT Spoon3R

Participants: Gérard Paligot, Martin Monperrus [correspondant].

ADT Spoon3R (2014–16) is a technology development initiative supported by the Inria Lille - Nord Europe Center that aims at supporting the development of the SPOON software library. (see Section 5.5) Spoon3R aims at extending SPOON with the features defined in the context of our research activities on automated software repair.

8.1.3. North European Lab SOCS

Participants: María Gómez Lacruz, Nicolas Haderer, Christophe Ribeiro, Romain Rouvoy [correspondant], Lionel Seinturier.

North European Lab SOCS (2013–15) is an international initiative supported by the Inria Lille - Nord Europe Center that takes place in the context of a well-established collaboration between Inria and *Universitetet i Oslo* (UiO) initiated in 2008. SOCS (Self-Optimization of Cyber-physical Systems) focuses on the self-optimization issues in cyber-physical systems. Cyber-Physical Systems (CPS) are complex systems-of-systems that blend hardware and software to fulfill specific missions. However, traditional CPS are statically configured to achieve predefined goals, which not only limit their sharing and their reuse, but also hinder their sustainability. We believe that this waste of resources stems from the lack of agility of CPS to adapt to change in their environment or objectives. The SOCS Inria Lab takes advantage of the technologies developed as part of the APISENSE® crowdsensing platform (see Section 5.1) to leverage the development of agile CPS.

8.1.4. LEDA

Participant: Philippe Merle [correspondant].

LEDA (2013–16) Laboratoire d'Expérimentation et de Démonstrations Ambiantes is a demonstration space allocated by the Inria Lille - Nord Europe Center whose goal is to show the scientific results of the Spirals team in the domains of distributed systems, adaptable middleware, software product lines, green computing, and ambiant computing. These results are illustrated around the scenario of a mock digital home.

8.2. National Initiatives

8.2.1. ANR

8.2.1.1. ANR MOANO
Participant: Laurence Duchien [correspondant].

MOANO (Models & Tools for Pervasive Applications focusing on Territory Discovery) is a 46-month project of the ANR CONTINT program which started in December 2010. The partners are LIUPPA/University of Pau and Pays de L'Adour, University of Toulouse/IRIT, University of Grenoble/LIG, University Lille 1/LIFL. While going through a territory, mobile users often encounter problems with their handheld computers/mobiles. Some locally stored data become useless or unnecessary whereas other data is not included in the handheld computer. Some software components, part of the whole applications can become unnecessary to process some information or documents that the user did no plan to manage during his mission. In order to answer such difficulties, our project has three operational studies which are i) to enlarge the communication scale, ii) to provide people without computer-science skills with a toolset that will enable them to produce/configure mapping applications to be hosted on their mobile phone and iii) to process all the documents of interest in order to make their spatial and thematic semantics available to mobile users.

8.2.1.2. ANR YourCast
Participants: Laurence Duchien [correspondant], Clément Quinton, Daniel Romero Acero.

YourCast (Software Product Lines for Broadcasting Systems) is a 36-month ANR Emergence project that started in January 2012 and that involves University of Nice Sophia Antipolis, Valorpaca and University Lille 1. The project aims at defining an information broadcasting system by a dedicated software product line which will be used in schools or events, such as gatherings of scouts.

8.2.2. Competitivity Clusters

8.2.2.1. FUI Hermes
Participants: Laurence Duchien, Romain Rouvoy, Lionel Seinturier [correspondant].

Hermes is a 41-month project funded by FUI and labelized by the PICOM (Pôle des Industries du COMmerce) competitivity cluster which has started in August 2012. The goal of the project is to define a modular and context-aware marketing platform for the retail industry. The focus is put on the interactions with customers in order to extract and mine relevant informations related to shopping habits, and on a multi-device, cross-canal, approach to better match customer usages.

8.2.3. Programme Investissement d'Avenir (PIA)

8.2.3.1. PIA Datalyse
Participants: Filip Krikava, Romain Rouvoy, Lionel Seinturier [correspondant], Bo Zhang.

Datalyse is a 36-month project of the Programme Investissement d'Avenir Cloud Computing 3rd call for projects. The project started in May 2013. The partners are Business & Decision Eolas, Groupement des Mousquetaires, Université Grenoble 1, Université Lille 1, Inria, Université Montpellier 2. The project aims at defining an elastic cloud computing infrastructure for processing big volumes of data. The originality of the project is to consider jointly data generated by users and by the infrastructure, and to correlate data at these two levels.

8.2.3.2. PIA OCCIware
Participants: Romain Rouvoy, Philippe Merle [correspondant], Lionel Seinturier.

OCCIware is a 36-month project of the Programme Investissement d'Avenir Cloud Computing and Big Data 4th call for projects. The project started in Decembre 2014. The partners are Open Wide (leader), ActiveEon SA, CSRT, Institut Mines-Télécom/Télécom SudParis, Inria, Linagora GSO, Obeo, OW2 Consortium, Pôle Numérique, and Université Joseph Fourier - Grenoble. The project aims at defining a formal framework for managing every digital resources in the clouds, based on Open Cloud Computing Interface (OCCI) recommendations from Open Grid Forum (OGF).

8.2.4. Inria National Initiatives

8.2.4.1. Inria ADT AntDroid
Participants: María Gómez Lacruz, Nicolas Haderer, Christophe Ribeiro, Romain Rouvoy [correspondant].

ADT AntDroid (2012–14) is a technology development initiative supported by Inria that aims at pushing the results of Nicolas Haderer PhD thesis [12] into production. AntDroid therefore focuses on deploying and disseminating the APISENSE® crowdsensing platform (see Section 5.1) to the public and to support the users of the platform.

8.2.4.2. Inria ADT Focus CrowdLab

Participants: Clive Ferret-Canape, Julien Duribreux, María Gómez Lacruz, Christophe Ribeiro, Romain Rouvoy [correspondant], Antoine Veuiller.

The purpose of the ADT Focus CrowdLab (2014–2016) is to strengthen the technological part of the Metroscope consortium and to promote the APISENSE® crowdsensing platform (see Section 5.1) as a reference platform fo gathering mobile data within the scientific community. The CrowdLab project focuses on three stringent goals: (1) consolidating the current technological solutions, (2) technical and logistical support of the research activities initiated in different scientific domains, and (3) the improvement of security and anonymity of collected data. In addition to the Metroscope consortium, the Inria research teams participating of the ADT Focus CrowdLab project are: Spirals (coordinator), Madynes, Diana, Muse.

8.3. European Initiatives

8.3.1. FP7 & H2020 Projects

Program: FP7 ICT.

Project acronym: PaaSage.

Project title: Model Based Cloud Platform Upperware.

Duration: October 2012–September 2016.

Coordinator: ERCIM.

Other partners: ERCIM (Fr), SINTEF (No), STFC (UK), U. of Stuttgart (De), Inria (Fr), CETIC (Be), FORTH (El), Be.Wan (Be), EVRY Solutions (No), SysFera (Fr), Flexiant (UK), Lufthansa Systems AG (De), Gesellschaft fur wissenschaftliche Datenverarbeitung mbh Gottingen (De), Automotive Simulation Center Stuttgart (De).

Abstract: Cloud computing is a popular and over-hyped concept in ICT. The concept of infinitely scalable elastic resources changing without complex systems administration and paying only for resources used is attractive. These benefits are not immediately realizable. Within organisation benefits are realizable at considerable cost. IaaS (*Infrastructure-as-a-Service*) public Clouds have different interfaces and conditions of use thus for an organisation to "scale out" requires considerable investment using skilled technical staff. The business need is to allow organisations to "scale out" from their private Cloud to public Clouds without a technical chasm between. This cannot easily be achieved. Aligned with the EU strategic direction of an open market for services, SOA (*Service-Oriented architecture*) offers a way to virtualize across heterogeneous public Clouds and organizational private Clouds. It opens a market for European SMEs to provide services to be utilized (and paid for) by business applications and for all organisations to benefit from a catalogue of services that can be used across the environment. PaaSage will deliver an open and integrated platform, to support both deployment and design of Cloud applications, together with an accompanying methodology that allows model-based development, configuration, optimisation, and deployment of existing and new applications independently of the existing underlying Cloud infrastructures. Specifically it will deliver an IDE (*Integrated Development Environment*) incorporating modules for design time and execution time optimisation of applications specified in the Cloud Modeling Language (Cloud ML), execution-level mappers and interfaces and a metadata database.

Participants: Laurence Duchien, Clément Quinton, Daniel Romero Acero [correspondant], Romain Rouvoy, Lionel Seinturier.

Program: FP7 FET.

Project acronym: DIVERSIFY.

Project title: More software diversity. More adaptivity in CAS.

Duration: 36 months (2013-16).

Coordinator: Inria.

Other partners: SINTEF (Norway), Trinity College Dublin (Ireland), University of Rennes 1 (France).

Abstract: DIVERSIFY explores diversity as the foundation for a novel software design principle and increased adaptive capacities in CASs (*Collective Adaptive Systems*). Higher levels of diversity in the system provide a pool of software solutions that can eventually be used to adapt to unforeseen situations at design time. The scientific development of DIVERSIFY is based on a strong analogy with ecological systems, biodiversity, and evolutionary ecology. DIVERSIFY brings together researchers from the domains of software-intensive distributed systems and ecology in order to translate ecological concepts and processes into software design principles.

Participants: Martin Monperrus [correspondant], Matias Martinez.

8.4. International Initiatives

8.4.1. Inria Associate Teams

Title: Service-Oriented Architecture anti-patterns in Mobile and Cloud Applications (SOMCA).

Inria principal investigator: Romain Rouvoy.

International Partner (Institution - Laboratory - Researcher):

> Université du Québec à Montréal (Canada) - LATECE Laboratory

Duration: 2014–2016.

See also: http://seas.ifi.uio.no.

The long-term goal of this research program is to propose a novel and innovative methodology embodied in a software platform, to support the runtime detection and correction of anti-patterns in large-scale service-oriented distributed systems in order to continuously optimize their quality of service. One originality of this program lies in the dynamic nature of service-oriented environments, the application on emerging frameworks for embedded and distributed systems (e.g., Android/iOS for mobile devices, PaaS/SaaS for Cloud environments), and in particular mobile systems interacting with remote services hosted on the Cloud. To achieve this goal, we propose to follow a three-step methodology targeting three objectives: (1) Identify and specify service-oriented anti-patterns, (2) Develop an approach to detect automatically, at runtime, service-oriented anti-patterns, (3) Develop an approach to suggest refactorings and automatically, at runtime, correct service-oriented anti-patterns. The ongoing PhD thesis of Geoffrey Hecht, in co-supervision between Montréal and Lille, is part of this associated team.

Participants: Laurence Duchien, María Gómez Lacruz, Geoffrey Hecht, Philippe Merle, Romain Rouvoy [correspondant], Lionel Seinturier.

8.4.2. Inria International Partners

8.4.2.1. Declared Inria International Partners

8.4.2.1.1. University of Los Andes, Bogota, Colombia

We have a long term collaboration since 2005 with this university. Over the years, four PhD thesis (Carlos Noguera, Carlos Parra, Daniel Romero Acero, Gabriel Tamura) have been defended in our team with students who obtained their MSc in this university. The first three were full French PhD, whereas the last one was a co-tutelle with this university. Professor Rubby Casallas from University of Los Andes is frequently visiting our team. The most recently defended PhD thesis, that of Gabriel Tamura, deals with QoS (quality-of-service) contract preservation in distributed service-oriented architectures. A formal theory to perform, in a safe way, the process of self-adaptation in response to quality-of-service (QoS) contracts violation has been proposed. The results have been published in [121], [119] and in the PhD thesis document itself [118].

Participants: Laurence Duchien [correspondant], Clément Quinton, Daniel Romero Acero, Romain Rouvoy, Lionel Seinturier.

8.4.2.1.2. University of Oslo, Norway

The scientific collaboration with this international partner deals with complex distributed systems that have to seamlessly adapt to a wide variety of deployment targets. This is due to the fact that developers cannot anticipate all the runtime conditions under which these systems are immersed. A major challenge for these software systems is to develop their capability to continuously reason about themselves and to take appropriate decisions and actions on the optimizations they can apply to improve themselves. This challenge encompasses research contributions in different areas, from environmental monitoring to real-time symptoms diagnosis, to automated decision making. The collaboration has been supported by the SEAS Inria associated team (2012-14).

Participants: María Gómez Lacruz, Nicolas Haderer, Daniel Romero Acero, Romain Rouvoy [correspondant], Lionel Seinturier.

8.4.3. Participation In Other International Programs

8.4.3.1. OW2

Participants: Philippe Merle [correspondant], Fawaz Paraiso, Romain Rouvoy, Lionel Seinturier.

OW2, previously ObjectWeb, is an international consortium to promote high quality open source middleware. The vision of OW2 is that of a set of components which can be assembled to offer high-quality middleware systems. We are members of this consortium since 2002. Philippe Merle is the leader of both FRACTAL and FRASCATI projects, which are hosted by this consortium. Philippe Merle and Lionel Seinturier are members of the Technology Council of OW2.

8.4.3.2. ERCIM Working Group on Software Evolution

Participant: Laurence Duchien [correspondant].

The Working Group (WG) on Software Evolution is one of the working groups supported by ERCIM. The main goal of the WG is to identify a set of formally-founded techniques and associated tools to support software developers with the common problems they encounter when evolving large and complex software systems. With this initiative, the WG plans to become a Virtual European Research and Training Centre on Software Evolution.

8.5. International Research Visitors

8.5.1. Visits of International Scientists

Participant: Earl Barr.
   Subject: Anti-fragility of Software Systems
   Date: June 2014
   Institution: University College London (UK)

8.5.1.1. Internships

Sebastian Lamelas Marcote
   Subject: Automatic Software Repair
   Date: from May 2014 until Oct 2014
   Institution: University of Buenos Aires (Argentina)

Carolina Valdez Gandara
   Subject: SmartGate: An Android-based Gateway for the Internet of Things
   Date: from May 2014 until Nov 2014
   Institution: University of Central Buenos Aires (Argentina)

Mohamed Lamine Berkane
   Subject: Advanced Modularity Concepts in Distributed Applications
   Date: from Jan 2014 until Sep 2014
   Institution: University Constantine 2 (Algeria)

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

8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. ANR

InfraJVM - (2012 - 2015)

Members: LIP6 (Regal-Whisper), Ecole des Mines de Nantes (Constraint), IRISA (Triskell), LaBRI (LSR).

Coordinator: Gaël Thomas

Whisper members: Julia Lawall, Gilles Muller

Funding: ANR Infra, 202 000 euros.

Objectives: The design of the Java Virtual Machine(JVM) was last revised in 1999, at atime when a single program running on a uniprocessor desktop machine was the norm. Today's computing environment, however, is radically different, being characterized by many different kinds of computing devices, which are often mobile and which need to interact within the context of a single application. Supporting such applications, involving multiple mutually untrusted devices, requires resource management and scheduling strategies that were not planned for in the 1999 JVM design. The goal of InfraJVM is to design strategies that can meet the needs of such applications and that provide the good performance that is required in an MRE.

Chronos network, Time and Events in Computer Science, Control Theory, Signal Processing, Computer Music, and Computational Neurosciences and Biology

Coordinator: Gerard Berry

Whisper member: Gilles Muller

Funding: ANR 2014, Défi "Société de l'information et de la communication".

The Chronos interdisciplinary network aims at placing in close contact and cooperation researchers of a variety of scientific fields: computer science, control theory, signal processing, computer music, neurosciences, and computational biology. The scientific object of study will be the understanding, modeling, and handling of time- and event-based computation across the fields.

Chronos will work by organizing a regular global seminar on subjects ranging from open questions to concrete solutions in the research fields, workshops gathering subsets of the Chronos researchers to address specific issues more deeply, a final public symposium presenting the main contributions and results, and an associated compendium.

8.1.2. Multicore Inria Project Lab

The Multicore IPL is an Inria initiative led by Gilles Muller, whose goal is to develop techniques for being able to deploy parallel programs on heterogeneous multicore machines while preserving scalability and performance. The IPL brings together researchers from the ALF, Algorille, CAMUS, Compsys, DALI, REGAL, Runtime and Whisper Inria Teams. These connections provide access to a diversity of expertise on open source development and parallel computing, respectively. In this context, we are working with Jens Gustedt of Inria Lorraine and on developing a domain-specific language that eases programming with the ordered read-write lock (ORWL) execution model. The goal of this work is to provide a single execution model for parallel programs and allow them to be deployed on multicore machines with varying architectures.

8.2. European Initiatives

8.2.1. Collaborations in European Programs, except FP7 & H2020

Program: COST Action IC1001

Project acronym: Euro-TM

Project title: Transactional Memories: Foundations, Algorithms, Tools, and Applications

Duration: 2011 - 2014

Coordinator: Dr. Paolo Romano (INESC)

Whisper member: Gilles Muller, leader of the working group on Hardware's & Operating System's Supports

Other partners: Austria, Czech Republic, Denmark, France, Germany, Greece, Israel, Italy, Norway, Poland, Portugal, Serbia, Spain, Sweden, Switzerland, Turkey, United Kingdom.

Abstract: Parallel programming (PP) used to be an area once confined to a few niches, such as scientific and high-performance computing applications. However, with the proliferation of multicore processors, and the emergence of new, inherently parallel and distributed deployment platforms, such as those provided by cloud computing, parallel programming has definitely become a mainstream concern. Transactional Memories(TMs) answer the need to find a better programming model for PP, capable of boosting developer's productivity and allowing ordinary programmers to unleash the power of parallel and distributed architectures avoiding the pitfalls of manual, lock based synchronization. It is therefore no surprise that TM has been subject to intense research in the last years. This Action aims at consolidating European research on this important field, by coordinating the European research groups working on the development of complementary, interdisciplinary aspects of Transactional Memories, including theoretical foundations, algorithms, hardware and operating system support, language integration and development tools, and applications.

8.3. International Initiatives

8.3.1. Participation In other International Programs

Julia Lawall obtained the renewal of a Merlion collaboration grant, started in 2013, for collaboration with David Lo of Singapore Management University. This collaboration resulted in a two-week visit of Julia Lawall to Singapore Management University, a one-week visit of David Lo to the Whisper team, and a two-week visit of Lo's PhD student Ferdian Thung to the Whisper team. It also resulted in four publications during 2014 [26], [21], [23], [19].

8.4. International Research Visitors

8.4.1. Visits of International Scientists

8.4.1.1. Internships

Julia Lawall supervised the remote internships of Himangi Saraogi (summer 2014) and Tapasweni Pathak (winter 2014, in progress) as part of the Gnome Outreach Program for Women (OPW). Both interns carried out projects related to Coccinelle and the Linux kernel. Julia Lawall has taken over the responsability for the coordination of the Linux kernel's participation in the OPW program in winter 2014.

Julia Lawall also supervised the internship of the undergraduate student (L2) Chi Pham from the University of Copenhagen. Pham developed a tool for transforming Coccinelle semantic patches to make them suitable for inclusion in the Linux kernel.

<p style="text-align:center">**ALGORILLE Project-Team**</p>

7. Partnerships and Cooperations

7.1. National Initiatives

7.1.1. ANR

Plate-form(E)[3]   (2012-2015, 87k€) has been accepted in 2012 in the ANR SEED program. It deals with the design and implementation of a multi-scale computing and optimization platform for energetic efficiency in industrial environment. It gathers 7 partners either academic (LEMTA, Fédération Charles Hermite (including AlGorille), Mines Paris, INDEED) or industrial (IFPEN, EDF, IDEEL). We will contribute to the design and development of the platform. The engineer P. Kalitine has been recruited to work on this project from May 2014 to June 2015.

ANR SONGS   (2012–2015, 1800k€) Martin Quinson is also the principal investigator of this project, funded by the ANR INFRA program. SONGS (Simulation Of Next Generation Systems) aims at increasing the target community of SimGrid to two new research domains, namely Clouds (restricted to the *Infrastructure as a Service* context) and High Performance Computing. We develop new models and interfaces to enable the use of SimGrid for generic and specialized researches in these domains.

As project leading team, we are involved in most parts of this project, which allows the improvement of our tool even further and sets it as the reference in its domain (see Section 6.2.1).

7.1.2. Inria financed projects and clusters

AEN Hemera   (2010-2014, 2k€) aims at demonstrating ambitious up-scaling techniques for large scale distributed computing by carrying out several dimensioning experiments on the Grid'5000 infrastructure, and at animating and enlarging the scientific community around the testbed. M. Quinson, L. Nussbaum and S. Genaud lead three working groups, respectively on *simulating large-scale facilities*, on *conducting large and complex experimentations on real platforms*, and on *designing scientific applications for scalability*.
Other partners: 20 research teams in France, see https://www.grid5000.fr/mediawiki/index.php/Hemera for details.

ADT Aladdin-G5K (2007-2014, 200k€ locally)   aims at the construction of a scientific instrument for experiments on large-scale parallel and distributed systems, building on the Grid'5000 testbed (http://www.grid5000.fr/). It structures INRIA's leadership role (8 of the 9 Grid'5000 sites) concerning this platform. The technical team is now composed of 10 engineers, of which 2 are currently hosted in the AlGorille team. As a member of the executive committee, L. Nussbaum is in charge of following the work of the technical team, together with the Grid'5000 technical director.
Other partners: EPI DOLPHIN, GRAAL, MESCAL, MYRIADS, OASIS, REGAL, RESO, RUNTIME, IRIT (Toulouse), Université de Reims - Champagne Ardennes

ADT LAPLACE   (2014-2016, AlGorille is major partner, 100k€) builds upon the foundations of the Grid'5000 testbed to reinforce and extend it towards new use cases and scientific challenges. Several directions are being explored: networks and Software Defined Networking, Big Data, HPC, and production computation needs. Already developed prototypes are also being consolidated, and the necessary improvements to user management and tracking are also being performed.

ADT Cosette　(2013-2016, AlGorille is the only partner, 120k€), for *COherent SET of Tools for Experimentation* aims at developing or improving a tool suite for experimentation at large scale on testbeds such as Grid'5000. Specifically, we will work on (1) the development of Ruby-CUTE, a library gathering features useful when performing such experiments; (2) the porting of Kadeploy, Distem and XPFlow on top of Ruby-CUTE; (3) the release of XPFlow, developed in the context of Tomasz Buchert's PhD; (4) the improvement of the Distem emulator to address new scientific challenges in Cloud and HPC. E. Jeanvoine (SED) is delegated in the AlGorille team for the duration of this project.

INRIA Project Lab MultiCore　(2013-) Supporting multicore processors in an efficient way is still a scientific challenge. This project introduces a novel approach based on virtualization and dynamicity, in order to mask hardware heterogeneity, and to let performance scale with the number and nature of cores. Our main partner within this project is the Camus team on the Strasbourg site. The move of J. Gustedt there, has strengthened the collaboration within this project.

ADT PLM　(2014-2016, Martin Quinson is leading this project in collaboration with G. Oster from the Coast project-team, 100k€) This project is not directly in line with the goal of the AlGorille project-team, as its goal is to establish an experimental platform to study of the didactic of informatics, specifically centered on introductory programming courses.

The project builds upon a pedagogical programming exerciser developed for our own teaching, and improves this base in several ways. We want to provide more adapted feedback to the learners, and gather more data to better understand how beginners learn programming.

7.2. European Initiatives

7.2.1. FP7 Projects

7.2.1.1. FED4FIRE

Participant: Lucas Nussbaum.

Title: Federation for Future Internet Research and Experimentation

Type: ICT

Instrument: Integrated Project

Duration: October 2012 - September 2016

Coordinator: iMinds

Other partners: IT Innovation, UPMC, Fraunhofer, TUB, UEDIN, Inria, NICTA, ATOS, UTH, NTUA, UNIVBRIS, i2CAT, EUR, DANTE Limited, UC, NIA.

See also: http://www.fed4fire.eu

Abstract: The key outcome of Fed4FIRE will be an open federation solution supporting all stakeholders of FIRE. Fed4FIRE is bringing together key players in Europe in the field of experimentation facilities and tool development who play a major role in the European testbeds of the FIRE initiative projects.

Lucas Nussbaum started participating in the project in September 2013, mainly with an expert role.

7.3. International Research Visitors

7.3.1. Visits of International Scientists

7.3.1.1. Internships

Ezequiel Torti Lopez

Subject: Parallel and Distributed Simulation of Large-Scale Distributed Applications

Date: from May 2014 until October 2014

Institution: Universidad National de Rosario (Argentina)

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

7. Partnerships and Cooperations

7.1. National Initiatives

7.1.1. ANR

7.1.1.1. Medimax

ANR-MN (Modèles Numériques) October 2013 - September 2017

The main goal is the methodological and numerical development of a new robust inversion tool, associated with the numerical solution of the electromagnetic forward problem, including the benchmarking of different other existing approaches (Time Reverse Absorbing Condition, Method of Small-Volume Expansions, Level Set Method). This project involves the development of a general parallel open source simulation code, based on the high-level integrated development environment of FreeFEm++, for modeling an electromagnetic direct problem, the scattering of arbitrary electromagnetic waves in highly heterogeneous media, over a wide frequency range in the microwave domain. The first applications considered here will be medical applications: microwave tomographic images of brain stroke, brain injuries, from both synthetic and experimental data in collaboration with EMTensor GmbH, Vienna (Austria), an Electromagnetic Medical Imaging company.

7.2. European Initiatives

7.2.1. FP7 & H2020 Projects

7.2.1.1. EXA2CT

Type: COOPERATION
Instrument: Specific Targeted Research Project
Objectif: NC
Duration: September 2013 - August 2016
Coordinator: Imec, Belgium
Partner: UA Belgium, USI Switzerland, Intel France, NAG England, UVSQ France, T-Systems SfR Germany, IT4Inovations Czech Republic.
Inria contact: Luc Giraud
Abstract: The goal of this project is to develop novel algorithms and programming models to tackle what will otherwise be a series of major obstacles to using a crucial component of many scientific codes at exascale, namely solvers and their constituents. The results of this work will be combined in running programs that demonstrate the application-targeted use of these algorithms and programming models in the form of proto-applications. The application targeting will be done by an analysis of a representative selection of scientific applications using solvers and/or the constituent parts that we target. The results of the project will be disseminated to the reference application owners through a scientific and industrial board (SIB), and board-partner specific code targeting activities, to help generate momentum behind our approach in the HPC community. The proto-applications will serve as a proof-of-concept, a benchmark for doing machine/software co-design, and as a basis for constructing future exascale full applications. In addition, the use of the SIB is a means to extract the commonalities of a range of HPC problems from different scientific domains and different industrial sectors to be able to concentrate on maximising the impact of the project by improving precisely those parts that are common across different simulation needs.
Alpines role: in charge of the Task "Preconditioners" in the working group focusing on numerical algorithms.

7.3. International Initiatives

7.3.1. Inria International Labs

Members of Alpines are part of the International Lab JLPC Etats-Unis.

7.3.2. Inria Associate Teams

7.3.2.1. COALA

Title: Communication Optimal Algoritms for Linear Algebra

International Partner (Institution - Laboratory - Researcher):

University of California Berkeley (ÉTATS-UNIS)

Duration: 2010 - 2015

See also: https://who.rocq.inria.fr/Laura.Grigori/COALA2010/coala.html

Our goal is to continue COALA associated team that focuses on the design and implementation of numerical algorithms for today's large supercomputers formed by thousands of multicore processors, possibly with accelerators. We focus on operations that are at the heart of many scientific applications as solving linear systems of equations or least squares problems. The algorithms belong to a new class referred to as communication avoiding that provably minimize communication, where communication means the data transferred between levels of memory hierarchy or between processors in a parallel computer. This research is motivated by studies showing that communication costs can already exceed arithmetic costs by orders of magnitude, and the gap is growing exponentially over time. An important aspect that we consider here is the validation of the algorithms in real applications through our collaborations. COALA is an Inria associate team that focuses on the design and implementation of numerical algorithms for today's large supercomputers formed by thousands of multicore processors, possibly with accelerators. We focus on operations that are at the heart of many scientific applications as solving linear systems of equations or least squares problems. The algorithms belong to a new class referred to as communication avoiding that provably minimize communication, where communication means the data transferred between levels of memory hierarchy or between processors in a parallel computer. This research is motivated by studies showing that communication costs can already exceed arithmetic costs by orders of magnitude, and the gap is growing exponentially over time. An important aspect that we consider here is the validation of the algorithms in real applications through our collaborations.

7.3.3. Inria International Partners

7.3.3.1. Informal International Partners

A collaboration focused on the theoretical and numerical analysis for the simulation of wave scattering by means of boundary integral formulation has been in place for several years between Xavier Claeys and the group of Ralf Hiptmair from the Seminar of Applied Mathematics at ETH Zürich.

7.3.4. Participation In other International Programs

Joint Laboratory for Petascale Computing, JLPC Etats-Unis. We take part in this joint effort, in the numerical libraries aspects of the joint laboratory. We collaborate and interact in particular with B. Gropp, UIUC, and J. Brown and M. Knepley, Argonne.

7.4. International Research Visitors

7.4.1. Visits of International Scientists

- Visit of Jed Brown, Argonne National Laboratory, 1 week, June 2014, in the context of JLPC, Etats-Unis.

7.4.1.1. Internships

- Jean-Yves Pallaro, Master 2 student, University of Lille. Jean-Yves worked on LORASC preconditioner.

7.4.2. Visits to International Teams

7.4.2.1. Sabbatical programme

Grigori Laura

Date: Aug 2014 - Aug 2015

Institution: University of California Berkeley (USA)

7.4.2.2. Research stays abroad

- Xavier Claeys, Visit to SAM ETH Zürich for collaboration with Ralf Hitpmair, 3rd August - 16th August 2014.
- Sebastien Cayrols, Visit to UC Berkeley in the context of COALA associated team, December 2014 - April 2015.

AVALON Project-Team

8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. French National Fund for the Digital Society Project (FSN)

8.1.1.1. FSN XLcloud, 2012-2014

Participants: Jean-Patrick Gelas, Laurent Lefèvre, François Rossigneux.

Focused on high-performance computing, the XLcloud collaborative project sets out to define and demonstrate a cloud platform based on *HPC-as-a-Service*. This is designed for computational intensive workloads, with interactive remote visualisation capabilities, thus allowing different users to work on a common platform. XLcloud project's members design, develop and integrate the software elements of a High Performance Cloud Computing (HPCC) System.

Expected results of the projects include : Functional and technical specification of the XLcloud platform architecture, open source API of the XLcloud platform, implementation of algorithms for 3D and video streaming display, prototype of the XLcloud platform including the support of on-demand virtual clusters and remote visualisation service, use cases for validation, illustrating the performance and suggesting future improvements.

XLcloud aims at overcoming some of the most important challenges of implementing operationally high performance applications in the Cloud. The goal is to allow partners of the project to take leadership position in the market, as cloud service providers, or as technology providers. XLcloud relies on a consortium of various partners (BULL (project leader), TSP, Silkan, EISTI, Ateme, Inria, CEA List, OW2, AMG.Lab).

In this project, the Avalon team investigates the issue of energy awareness and energy efficiency in OpenStack Cloud based platforms.

8.1.2. French National Research Agency Projects (ANR)

8.1.2.1. ANR EMERGENCE CloudPower, Cloud Service providing HPC on-demand to innovative SME's, 35 months, ANR-12-EMMA-0038

Participants: Gilles Fedak, Sylvain Bernard.

High performance computing (HPC) allows scientists and industries to run large numerical application on huge data volumes. The HPC is a key factor in knowledge and innovation in many fields of industry and service, with high economic and social issues: aerospace, finance and business intelligence, energy and environment, chemicals and materials, medicine and biology , digital art and games, Web and social networks, ... Today, acquiring HPC supercomputer is very expensive, making HPC unreachable to SMIs / SMEs for their research and development. The CloudPower project results from the XtremWeb research and development project. Its goal is to offer a low cost Cloud HPC service for small and medium-sized innovative companies. With CloudPower, companies and scientists will run their simulations to design and develop new products on a powerful, scalable, economical, reliable and secure infrastructure.

The project will lead the creation of a new and innovative company operating the platform implemented in the framework of the ANR Emergence. CloudPower will implement SaaS / PaaS portal for customers and develop extensions to allow commercial exploitation of unused resources. Building on the network of SMIs from the competitiveness clusters System@tic and LyonBiopole, we will implement scenarios and/or demonstrators which illustrate the ability of CloudPower to increase competitiveness, research and marketing of innovative SMEs.

8.1.2.2. ANR INFRA MOEBUS, Multi-objective scheduling for large computing platforms, 4 years, ANR-13-INFR-000, 2013-2016
Participants: Christian Perez, Laurent Lefèvre, Frédéric Suter.

The ever growing evolution of computing platforms leads to a highly diversified and dynamic landscape. The most significant classes of parallel and distributed systems are supercomputers, grids, clouds and large hierarchical multi-core machines. They are all characterized by an increasing complexity for managing the jobs and the resources. Such complexity stems from the various hardware characteristics and from the applications characteristics. The MOEBUS project focuses on the efficient execution of parallel applications submitted by various users and sharing resources in large-scale high-performance computing environments.

We propose to investigate new functionalities to add at low cost in actual large scale schedulers and programming standards, for a better use of the resources according to various objectives and criteria. We propose to revisit the principles of existing schedulers after studying the main factors impacted by job submissions. Then, we will propose novel efficient algorithms for optimizing the schedule for unconventional objectives like energy consumption and to design provable approximation multi-objective optimization algorithms for some relevant combinations of objectives. An important characteristic of the project is its right balance between theoretical analysis and practical implementation. The most promising ideas will lead to integration in reference systems such as SLURM and OAR as well as new features in programming standards implementations such as MPI or OpenMP.

8.1.2.3. ANR ARPEGE MapReduce, Scalable data management for Map-Reduce-based data-intensive applications on cloud and hybrid infrastructures, 4 years, ANR-09-JCJC-0056-01, 2010-2014
Participants: Frédéric Desprez, Gilles Fedak, Sylvain Gault, Christian Perez, Anthony Simonet.

MapReduce is a parallel programming paradigm successfully used by large Internet service providers to perform computations on massive amounts of data. After being strongly promoted by Google, it has also been implemented by the open source community through the Hadoop project, maintained by the Apache Foundation and supported by Yahoo! and even by Google itself. This model is currently getting more and more popular as a solution for rapid implementation of distributed data-intensive applications. The key strength of the MapReduce model is its inherently high degree of potential parallelism.

In this project, the AVALON team participates to several work packages which address key issues such as efficient scheduling of several MapReduce applications, integration using components on large infrastructures, security and dependability, and MapReduce for Desktop Grid.

8.1.2.4. ANR INFRA SONGS, Simulation Of Next Generation Systems, 4 years, ANR-12-INFRA-11, 2012-2015
Participants: Frédéric Desprez, Jonathan Rouzaud-Cornabas, Frédéric Suter.

The last decade has brought tremendous changes to the characteristics of large scale distributed computing platforms. Large grids processing terabytes of information a day and the peer-to-peer technology have become common even though understanding how to efficiently such platforms still raises many challenges. As demonstrated by the USS SIMGRID project, simulation has proved to be a very effective approach for studying such platforms. Although even more challenging, we think the issues raised by petaflop/exaflop computers and emerging cloud infrastructures can be addressed using similar simulation methodology.

The goal of the SONGS project is to extend the applicability of the SIMGRID simulation framework from Grids and Peer-to-Peer systems to Clouds and High Performance Computation systems. Each type of large-scale computing system will be addressed through a set of use cases and lead by researchers recognized as experts in this area.

Any sound study of such systems through simulations relies on the following pillars of simulation methodology: Efficient simulation kernel; Sound and validated models; Simulation analysis tools; Campaign simulation management.

8.1.3. Inria Large Scale Initiative

8.1.3.1. HEMERA, 4 years, 2010-2014
Participants: Christian Perez, Laurent Pouilloux, Laurent Lefèvre.

Hemera deals with the scientific animation of the GRID'5000 community. It aims at making progress in the understanding and management of large scale infrastructure by leveraging competences distributed in various French teams. Hemera contains several scientific challenges and working groups. The project involves around 24 teams located in all around France.

C. Pérez is leading the project; L. Lefevre and L. Pouilloux are managing scientific challenges on GRID'5000.

8.1.3.2. C2S@Exa, Computer and Computational Sciences at Exascale, 4 years, 2013-2017
Participants: Frédéric Desprez, Christian Perez, Laurent Lefèvre, Jérôme Richard.

Since January 2013, the team is participating to the C2S@Exa Inria Project Lab (IPL). This national initiative aims at the development of numerical modeling methodologies that fully exploit the processing capabilities of modern massively parallel architectures in the context of a number of selected applications related to important scientific and technological challenges for the quality and the security of life in our society. At the current state of the art in technologies and methodologies, a multidisciplinary approach is required to overcome the challenges raised by the development of highly scalable numerical simulation software that can exploit computing platforms offering several hundreds of thousands of cores. Hence, the main objective of C2S@Exa is the establishment of a continuum of expertise in the computer science and numerical mathematics domains, by gathering researchers from Inria project-teams whose research and development activities are tightly linked to high performance computing issues in these domains. More precisely, this collaborative effort involves computer scientists that are experts of programming models, environments and tools for harnessing massively parallel systems, algorithmists that propose algorithms and contribute to generic libraries and core solvers in order to take benefit from all the parallelism levels with the main goal of optimal scaling on very large numbers of computing entities and, numerical mathematicians that are studying numerical schemes and scalable solvers for systems of partial differential equations in view of the simulation of very large-scale problems.

8.1.4. Inria ADT

8.1.4.1. Inria ADT Aladdin, 4 years, 2008-2014
Participants: Simon Delamare, Frédéric Desprez, Matthieu Imbert, Laurent Lefèvre, Christian Perez.

ADT ALADDIN is an Inria support action of technological development which supports the GRID'5000 instrument. Frédéric Desprez is leading this action (with David Margery from Rennes as the Technical Director). More information at Section 5.8 .

8.2. European Initiatives

8.2.1. FP7 & H2020 Projects

8.2.1.1. PRACE 2IP
Participants: Vincent Lanore, Christian Perez, Jérôme Richard.

Title: PRACE – Second Implementation Phase Project

Type: Integrated Infrastructure Initiative Project (I3)

Instrument: Combination of Collaborative projects and Coordination and support action

Duration: September 2011 - August 2014

Coordinator: Thomas Lippert (Germany)

Others partners: Jülich GmbH, GCS, GENCI, EPSRC, BSC, CSC, ETHZ, NCF, JKU, Vetenskap-sradet, CINECA, PSNC, SIGMA, GRNET, UC-LCA, NUI Galway, UYBHM, CaSToRC, NCSA, Technical Univ. of Ostrava, IPB, NIIF

See also: http://prace-ri.eu

Abstract: The purpose of the PRACE RI is to provide a sustainable high-quality infrastructure for Europe that can meet the most demanding needs of European HPC user communities through the provision of user access to the most powerful HPC systems available worldwide at any given time. In tandem with access to Tier-0 systems, the PRACE-2IP project will foster the coordination between national HPC resources (Tier-1 systems) to best meet the needs of the European HPC user community. To ensure that European scientific and engineering communities have access to leading edge supercomputers in the future, the PRACE-2IP project evaluates novel architectures, technologies, systems, and software. Optimizing and scaling of application for Tier-0 and Tier-1 systems is a core service of PRACE.

Inria participates to Work Package 12 which is about novel programming techniques.

8.2.1.2. PaaSage

Participants: Christian Perez, Jonathan Rouzaud-Cornabas.

Title: PaaSage: Model-based Cloud Platform Upperware

Type: Seventh Framework Programme

Instrument: Collaborative project

Duration: October 2012 - September 2016 (48 months)

Coordinator: Pierre Guisset (GEIE ERCIM)

Others partners: SINTEF, STFC, HLRS, University of Stuttgart, Inria, CETIC, FORTH, be.wan, EVRY, SysFera, Flexiant, Lufthansa Systems, AG GWDG, Automotive Simulation Center Stuttgart e.V.

See also: http://paasage.eu

Abstract: PaaSage will deliver an open and integrated platform, to support both deployment and design of Cloud applications, together with an accompanying methodology that allows model-based development, configuration, optimization, and deployment of existing and new applications independently of the existing underlying Cloud infrastructures. Specifically it will deliver an IDE (Integrated Development Environment) incorporating modules for design time and execution time optimizations of applications specified in the CLOUD Modeling Language (CLOUD ML), execution-level mappers and interfaces and a metadata database.

8.2.2. Collaborations in European Programs, except FP7 & H2020

8.2.2.1. CHIST-ERA STAR

Participants: Laurent Lefèvre, Olivier Glück.

Title: SwiTching And tRansmission project

Type: CHIST-ERA (European Coordinated Research on Long-term Challenges in Information and Communication Sciences & Technologies ERA-Net)

Duration: 2013-2015

Coordinator: Jaafar Elmirghani (University of Leeds - UK)

Others partners: Inria ,University of Cambridge (UK), University of Leeds (UK), AGH University of Science and Technology Department of Telecommunications (Poland)

See also: http://www.chistera.eu/projects/star

Abstract: The Internet power consumption has continued to increase over the last decade as a result of a bandwidth growth of at least 50 to 100 times. Further bandwidth growth between 40% and 300% is predicted in the next 3 years as a result of the growing popularity of bandwidth intensive applications. Energy efficiency is therefore increasingly becoming a key priority for ICT organizations given the obvious ecological and economic drivers. In this project we adopt the GreenTouch energy saving target of a factor of a 100 for Core Switching and Routing and believe this ambitious target is achievable should the research in this proposal prove successful. A key observation in core networks

is that most of the power is consumed in the IP layer while optical transmission and optical switching are power efficient in comparison, hence the inspiration for this project. Initial studies by the applicants show that physical topology choices in networks have the potential to significantly reduce the power consumption, however network optimization and the consideration of traffic and the opportunities afforded by large, low power photonic switch architectures will lead to further power savings. Networks are typically over provisioned at present to maintain quality of service. We will study optimum resource allocation to reduce the overprovisioning factor while maintaining the quality of service. Protection is currently provided in networks through the allocation of redundant paths and resources, and for full protection there is a protection route for every working route. Avalon is contributing to STAR in terms of software network protocols and services optimizations which will be combined with more efficient photonic switches in order to obtain a factor of 100 power saving in core networks can be realised through this project with significant potential for resulting impact on how core photonic networks are designed and implemented.

8.2.2.2. COST IC1305 : Nesus

Participants: Laurent Lefèvre, Marcos Dias de Assunçao.

Program: COST

Project acronym: IC1305

Project title: Network for Sustainable Ultrascale Computing (NESUS)

Duration: 2014-2019

Coordinator: Jesus Carretero (Univ. Madrid)

Abstract: Ultrascale systems are envisioned as large-scale complex systems joining parallel and distributed computing systems that will be two to three orders of magnitude larger that today's systems. The EU is already funding large scale computing systems research, but it is not coordinated across researchers, leading to duplications and inefficiencies. The goal of the NESUS Action is to establish an open European research network targeting sustainable solutions for ultrascale computing aiming at cross fertilization among HPC, large scale distributed systems, and big data management. The network will contribute to glue disparate researchers working across different areas and provide a meeting ground for researchers in these separate areas to exchange ideas, to identify synergies, and to pursue common activities in research topics such as sustainable software solutions (applications and system software stack), data management, energy efficiency, and resilience. In Nesus, Laurent Lefevre is co-chairing the Working on Energy Efficiency (WG5).

8.2.2.3. SEED4C

Program: Celtic-Plus

Project acronym: SEED4C

Project title: Security Embedded Element and Data privacy for the Cloud.

Duration: 2012-2015

Coordinator: Stéphane Betge-Brezetz (Alcatel-Lucent lab)

Other partners: Gemalto, ENSI Bourges, Inria, Wallix, VTT Technical Research centre of Finland, Mikkelin Puhelin Oyj, Cygate, Nokia Siemens Networks, Finceptum OY (Novell), Solacia, Innovalia Association, Nextel, Software Quality Systems, Ikusi, Vicomtech, Biscaytik

Abstract: SEED4C is a Celtic-Plus project: an industry-driven European research initiative to define, perform and finance through public and private funding common research projects in the area of telecommunications, new media, future Internet, and applications and services focusing on a new "Smart Connected World" paradigm. Celtic-Plus is a EUREKA ICT cluster and is part of the inter-governmental EUREKA network.

The cloud security challenge not only reflects on the secure running of software on one single machine, but rather on managing and guaranteeing security of a computer group or cluster seen as a single entity. Seed4C focus is to evolve from cloud security with an isolated point or centralized points of enforcement for security to cloud security with cooperative points of enforcement for security.

8.3. International Initiatives

8.3.1. Inria International Labs

8.3.1.1. Inria-UIUC-NCSA Joint Laboratory for Petascale Computing

Participants: Eddy Caron, Frédéric Desprez, Olivier Glück, Vincent Lanore, Laurent Lefèvre, Christian Perez, Jonathan Rouzaud-Cornabas.

The Joint Laboratory for Petascale Computing focuses on software challenges found in complex high-performance computers. The Joint Laboratory is based at the University of Illinois at Urbana-Champaign and includes researchers from the French national computer science institute called Inria, Illinois' Center for Extreme-Scale Computation, and the National Center for Supercomputing Applications. Much of the Joint Laboratory's work will focus on algorithms and software that will run on Blue Waters and other petascale computers.

8.3.2. Participation In other International Programs

8.3.2.1. HPC visibility and strategy Workshop Algeria- Inria – Bull

Under high patronage of his Excellency the Minister for Higher Education and Scientific Research in Association of the Head Office of Scientific Research and Technological Development, this meeting comes within the framework of the partnership between Algeria, Inria and the Bull company, to set up an ambitious program, based on a great show of a material and software infrastructure for the digital simulation which will allow major steps forward in various scientific fields and important progress in term of industrial competitiveness and innovation.

Facing the growing evolution of the complexity of the feigned systems and the used volumes of data, the supercomputing becomes so major. This meeting which will gather about 150 participants, of whom persons in charge of supercomputing Algerian centers, will allow to exchange on problems related to modeling, simulation and HPC. The meeting will be organized around three main points: education research, bridge industry - research and ecosystem.

Eddy Caron (Avalon team) is an expert in the steering committee of the Ecosystem group.

8.4. International Research Visitors

8.4.1. Visits of International Scientists

Tchimou N'Takpé, Assistant Professor

Date: Oct 2014 - Nov 2014

Institution: Université Nangui Abrogoua, Abidjan (Cote d'Ivoire)

Mircea Moca, Assistant Professor

Date: Nov 15th, 2014 - Dec 15th, 2014

Institution: Babes-Bolyai University (Roumania)

Mircea Moca, Assistant Professor

Date: Nov 15th, 2014 - Dec 15th, 2014

Institution: Babes-Bolyai University (Roumania)

Asma Ben Cheikh Ahmed, PhD Student

Date: Sep 15th, 2014 - Dec 15th, 2014

Institution: Faculté des Sciences de Tunis (Tunisia)

Miranda Qian Zhang, PhD Student

Date: Sep 8th, 2014 - Oct 9th, 2014

Institution: Australian National University (Australia)

Julio Anjos, PhD student

Date: May 4th, 2014 - May 4th, 2015

Institution: Universidade Federal do Rio Grande do Sul (Brazil)

8.4.1.1. Internships

Anshul Gupta

Date: May 2014 - Jul 2014

Institution: LNM Institute of Information Technology (India)

HIEPACS Project-Team

8. Partnerships and Cooperations

8.1. Regional Initiatives

8.1.1. Innovative simulation methods for large scale numeric prototypes on emerging architectures computers

Participants: Emmanuel Agullo, Olivier Coulaud, Aurélien Esnard, Mathieu Faverge, Luc Giraud, Abdou Guermouche, Pierre Ramet, Jean Roman.

Grant: Regional council
Dates: 2013 – 2015
Partners: EPIs REALOPT, RUNTIME from Inria Bordeaux Sud-Ouest, CEA-CESTA and l'Institut pluridisciplinaire de recherche sur l'environnement et les matériaux (IPREM) .
Overview: Numerical simulation is now integrated into all the design levels and the scientific studies for both academic and industrial contexts. Given the increasing size and sophistication of the simulations carried out, the use of parallel computing is inescapable. The complexity of such achievements requires collaboration of multidisciplinary teams capable of mastering all the necessary scientific skills for each component constituting the chain of expertise. In this project we consider each of these elements as well as efficient methods for parallel codes coupling. All these works are intended to contribute to the design of large scale parallel multi-physics simulations. In addition to this research human activities the regional council also support some innovative computing equipment that will be embedded in the PlaFRIM experimental plateform, project led by O. Coulaud.

8.2. National Initiatives

8.2.1. Inria Project Lab

8.2.1.1. C2S@Exa - Computer and Computational Sciences at Exascale

Since January 2013, the team is participating to the C2S@Exa Inria Project Lab (IPL). This national initiative aims at the development of numerical modeling methodologies that fully exploit the processing capabilities of modern massively parallel architectures in the context of a number of selected applications related to important scientific and technological challenges for the quality and the security of life in our society. At the current state of the art in technologies and methodologies, a multidisciplinary approach is required to overcome the challenges raised by the development of highly scalable numerical simulation software that can exploit computing platforms offering several hundreds of thousands of cores. Hence, the main objective of C2S@Exa is the establishment of a continuum of expertise in the computer science and numerical mathematics domains, by gathering researchers from Inria project-teams whose research and development activities are tightly linked to high performance computing issues in these domains. More precisely, this collaborative effort involves computer scientists that are experts of programming models, environments and tools for harnessing massively parallel systems, algorithmists that propose algorithms and contribute to generic libraries and core solvers in order to take benefit from all the parallelism levels with the main goal of optimal scaling on very large numbers of computing entities and, numerical mathematicians that are studying numerical schemes and scalable solvers for systems of partial differential equations in view of the simulation of very large-scale problems.

8.2.2. ANR

8.2.2.1. SOLHAR: SOLvers for Heterogeneous Architectures over Runtime systems

Participants: Emmanuel Agullo, Mathieu Faverge, Andra Hugo, Abdou Guermouche, Xavier Lacoste, Pierre Ramet, Jean Roman, Guillaume Sylvand.

Grant: ANR-MONU

Dates: 2013 – 2017
Partners: Inria (REALOPT, RUNTIME Bordeaux Sud-Ouest et ROMA Rhone-Alpes), IRIT/INPT, CEA-CESTA et Airbus Group Innovations.
Overview:

During the last five years, the interest of the scientific computing community towards accelerating devices has been rapidly growing. The reason for this interest lies in the massive computational power delivered by these devices. Several software libraries for dense linear algebra have been produced; the related algorithms are extremely rich in computation and exhibit a very regular pattern of access to data which makes them extremely good candidates for GPU execution. On the contrary, methods for the direct solution of sparse linear systems have irregular, indirect memory access patterns that adversely interact with typical GPU throughput optimizations.

This project aims at studying and designing algorithms and parallel programming models for implementing direct methods for the solution of sparse linear systems on emerging computer equipped with accelerators. The ultimate aim of this project is to achieve the implementation of a software package providing a solver based on direct methods for sparse linear systems of equations. To date, the approaches proposed to achieve this objective are mostly based on a simple offloading of some computational tasks to the accelerators and rely on fine hand-tuning of the code and accurate performance modeling to achieve efficiency. This project proposes an innovative approach which relies on the efficiency and portability of runtime systems. The development of a production-quality, sparse direct solver requires a considerable research effort along three distinct axes:

- linear algebra: algorithms have to be adapted or redesigned in order to exhibit properties that make their implementation and execution on heterogeneous computing platforms efficient and reliable. This may require the development of novel methods for defining data access patterns that are more suitable for the dynamic scheduling of computational tasks on processing units with considerably different capabilities as well as techniques for guaranteeing a reliable and robust behavior and accurate solutions. In addition, it will be necessary to develop novel and efficient accelerator implementations of the specific dense linear algebra kernels that are used within sparse, direct solvers;

- runtime systems: tools such as the `StarPU` runtime system proved to be extremely efficient and robust for the implementation of dense linear algebra algorithms. Sparse linear algebra algorithms, however, are commonly characterized by complicated data access patterns, computational tasks with extremely variable granularity and complex dependencies. Therefore, a substantial research effort is necessary to design and implement features as well as interfaces to comply with the needs formalized by the research activity on direct methods;

- scheduling: executing a heterogeneous workload with complex dependencies on a heterogeneous architecture is a very challenging problem that demands the development of effective scheduling algorithms. These will be confronted with possibly limited views of dependencies among tasks and multiple, and potentially conflicting objectives, such as minimizing the makespan, maximizing the locality of data or, where it applies, minimizing the memory consumption.

Given the wide availability of computing platforms equipped with accelerators and the numerical robustness of direct solution methods for sparse linear systems, it is reasonable to expect that the outcome of this project will have a considerable impact on both academic and industrial scientific computing. This project will moreover provide a substantial contribution to the computational science and high-performance computing communities, as it will deliver an unprecedented example of a complex numerical code whose parallelization completely relies on runtime scheduling systems and which is, therefore, extremely portable, maintainable and evolvable towards future computing architectures.

8.2.2.2. SONGS: Simulation Of Next Generation Systems
Participant: Abdou Guermouche.

Grant: ANR 11 INFRA 13
Dates: 2011 – 2015

Partners: Inria (Bordeaux Sud-Ouest, Nancy - Grand Est, Rhone-Alpes, Sophia Antipolis - Méditerranée), I3S, LSIIT

Overview:

The last decade has brought tremendous changes to the characteristics of large scale distributed computing platforms. Large grids processing terabytes of information a day and the peer-to-peer technology have become common even though understanding how to efficiently exploit such platforms still raises many challenges. As demonstrated by the USS SimGrid project funded by the ANR in 2008, simulation has proved to be a very effective approach for studying such platforms. Although even more challenging, we think the issues raised by petaflop/exaflop computers and emerging cloud infrastructures can be addressed using similar simulation methodology.

The goal of the SONGS project is to extend the applicability of the SimGrid simulation framework from Grids and Peer-to-Peer systems to Clouds and High Performance Computation systems. Each type of large-scale computing system will be addressed through a set of use cases and lead by researchers recognized as experts in this area.

Any sound study of such systems through simulations relies on the following pillars of simulation methodology: Efficient simulation kernel; Sound and validated models; Simulation analysis tools; Campaign simulation management.

8.2.2.3. ANEMOS: Advanced Numeric for ELMs : Modeling and Optimized Schemes

Participants: Xavier Lacoste, Guillaume Latu, Pierre Ramet.

Grant: ANR-MN
Dates: 2012 – 2016
Partners: Univ. Nice, CEA/IRFM, CNRS/MDS.
Overview: The main goal of the project is to make a significant progress in understanding of active control methods of plasma edge MHD instabilities Edge Localized Modes (ELMs) wich represent particular danger with respect to heat and particle loads for Plasma Facing Components (PFC) in ITER. The project is focused in particular on the numerical modelling study of such ELM control methods as Resonant Magnetic Perturbations (RMPs) and pellet ELM pacing both foreseen in ITER. The goals of the project are to improve understanding of the related physics and propose possible new strategies to improve effectiveness of ELM control techniques. The tool for the non-linear MHD modeling is the JOREK code which was essentially developed within previous ANR ASTER. JOREK will be largerly developed within the present project to include corresponding new physical models in conjunction with new developments in mathematics and computer science strategy. The present project will put the non-linear MHD modeling of ELMs and ELM control on the solid ground theoretically, computationally, and applications-wise in order to progress in urgently needed solutions for ITER.

Regarding our contributions, the JOREK code is mainly composed of numerical computations on 3D data. The toroidal dimension of the tokamak is treated in Fourier space, while the poloidal plane is decomposed in Bezier patches. The numerical scheme used involves a direct solver on a large sparse matrix as a main computation of one time step. Two main costs are clearly identified: the assembly of the sparse matrix, and the direct factorization and solve of the system that includes communications between all processors. The efficient parallelization of JOREK is one of our main goals, to do so we will reconsider: data distribution, computation distribution or GMRES implementation. The quality of the sparse solver is also crucial, both in term of performance and accuracy. In the current release of JOREK, the memory scaling is not satisfactory to solve problems listed above , since at present as one increases the number of processes for a given problem size, the memory footprint on each process does not reduce as much as one can expect. In order to access finer meshes on available supercomputers, memory savings have to be done in the whole code. Another key point for improving parallelization is to carefully profile the application to understand the regions of the code that do not scale well. Depending on the timings obtained, strategies to diminish communication overheads will be evaluated and schemes that improve load balancing will be initiated. JOREK uses PaStiX sparse matrix library for matrix inversion. However, large number of toroidal harmonics and particular thin structures to resolve for realistic plasma parameters and ITER machine size still require more aggressive optimisation in numeric

dealing with numerical stability, adaptive meshes etc. However many possible applications of JOREK code we proposed here which represent urgent ITER relevant issues related to ELM control by RMPs and pellets remain to be solved.

8.2.2.4. OPTIDIS: OPTImisation d'un code de dynamique des DISlocations

Participants: Olivier Coulaud, Aurélien Esnard, Arnaud Etcheverry, Luc Giraud.

Grant: ANR-COSINUS
Dates: 2010 – 2014
Partners: CEA/DEN/DMN/SRMA (leader), SIMaP Grenoble INP and ICMPE / Paris-Est.
Overview: Plastic deformation is mainly accommodated by dislocations glide in the case of crystalline materials. The behavior of a single dislocation segment is perfectly understood since 1960 and analytical formulations are available in the literature. However, to understand the behavior of a large population of dislocations (inducing complex dislocations interactions) and its effect on plastic deformation, massive numerical computation is necessary. Since 1990, simulation codes have been developed by French researchers. Among these codes, the code TRIDIS developed by the SIMAP laboratory in Grenoble is the pioneer dynamic dislocation code. In 2007, the project called NUMODIS had been set up as team collaboration between the SIMAP and the SRMA CEA Saclay in order to develop a new dynamics dislocation code using modern computer architecture and advanced numerical methods. The objective was to overcome the numerical and physical limits of the previous code TRIDIS. The version NUMODIS 1.0 came out in December 2009, which confirms the feasibility of the project. The project OPTIDIS is initiated when the code NUMODIS is mature enough to consider parallel computation. The objective of the project is to develop and validate the algorithms in order to optimize the numerical and performance efficiency of the NUMODIS code. We are aiming at developing a code able to tackle realistic material problems such as the interaction between dislocations and irradiation defects in a grain plastic deformation after irradiation. These kinds of studies where "local mechanisms" are correlated with macroscopic behavior is a key issue for nuclear industry in order to understand material aging under irradiation, and hence predict power plant secured service life. To carry out such studies, massive numerical optimizations of NUMODIS are required. They involve complex algorithms lying on advanced computational science methods. The project OPTIDIS will develop through joint collaborative studies involving researchers specialized in dynamics dislocations and in numerical methods. This project is divided in 8 tasks over 4 years. Two PhD theses will be directly funded by the project. One will be dedicated to numerical development, validation of complex algorithms and comparison with the performance of existing dynamics dislocation codes. The objective of the second is to carry out large scale simulations to validate the performance of the numerical developments made in OPTIDIS. In both cases, these simulations will be compared with experimental data obtained by experimentalists.

8.2.2.5. RESCUE: RÉsilience des applications SCientifiqUEs

Participants: Emmanuel Agullo, Luc Giraud, Abdou Guermouche, Jean Roman, Mawussi Zounon.

Grant: ANR-Blanc (computer science theme)
Dates: 2010 – 2015
Partners: Inria EPI ROMA (leader) and GRAND LARGE.
Overview: The advent of exascale machines will help solve new scientific challenges only if the resilience of large scientific applications deployed on these machines can be guaranteed. With 10,000,000 core processors, or more, the time interval between two consecutive failures is anticipated to be smaller than the typical duration of a checkpoint, i.e., the time needed to save all necessary application and system data. No actual progress can then be expected for a large-scale parallel application. Current fault-tolerant techniques and tools can no longer be used. The main objective of the RESCUE project is to develop new algorithmic techniques and software tools to solve the exascale resilience problem. Solving this problem implies a departure from current approaches, and calls for yet-to-be-discovered algorithms, protocols and software tools.

This proposed research follows three main research thrusts. The first thrust deals with novel checkpoint protocols. This thrust will include the classification of relevant fault categories and the development of a software package for fault injection into application execution at runtime. The main research activity will be the design and development of scalable and light-weight checkpoint and migration protocols, with on-the-fly storing of key data, distributed but coordinated decisions, etc. These protocols will be validated via a prototype implementation integrated with the public-domain MPICH project. The second thrust entails the development of novel execution models, i.e., accurate stochastic models to predict (and, in turn, optimize) the expected performance (execution time or throughput) of large-scale parallel scientific applications. In the third thrust, we will develop novel parallel algorithms for scientific numerical kernels. We will profile a representative set of key large-scale applications to assess their resilience characteristics (e.g., identify specific patterns to reduce checkpoint overhead). We will also analyze execution trade-offs based on the replication of crucial kernels and on decentralized ABFT (Algorithm-Based Fault Tolerant) techniques. Finally, we will develop new numerical methods and robust algorithms that still converge in the presence of multiple failures. These algorithms will be implemented as part of a software prototype, which will be evaluated when confronted with realistic faults generated via our fault injection techniques.

We firmly believe that only the combination of these three thrusts (new checkpoint protocols, new execution models, and new parallel algorithms) can solve the exascale resilience problem. We hope to contribute to the solution of this critical problem by providing the community with new protocols, models and algorithms, as well as with a set of freely available public-domain software prototypes.

8.2.2.6. BOOST: Building the future Of numerical methOdS for iTer

Participants: Emmanuel Agullo, Luc Giraud, Abdou Guermouche, Jean Roman.

Grant: ANR-Blanc (applied math theme)
Dates: 2010 – 2014
Partners: Institut de Mathématiques de Toulouse (leader); Laboratoire d'Analyse, Topologie, Probabilités in Marseilles; Institut de Recherche sur la Fusion Magnétique, CEA/IRFM and HIEPACS.
Overview: This project regards the study and the development of a new class of numerical methods to simulate natural or laboratory plasmas and in particular magnetic fusion processes. In this context, we aim at giving a contribution, from the mathematical, physical and algorithmic point of view, to the ITER project.

The core of this project consists in the development, the analysis, the implementation and the testing on real physical problems of the so-called Asymptotic-Preserving methods which allow simulations over a large range of scales with the same model and numerical method. These methods represent a breakthrough with respect to the state-of-the art. They will be developed specifically to handle the various challenges related to the simulation of the ITER plasma. In parallel with this class of methodologies, we intend to design appropriate coupling techniques between macroscopic and microscopic models for all the cases in which a net distinction between different regimes can be done. This will permit to describe different regimes in different regions of the machine with a strong gain in term of computational efficiency, without losing accuracy in the description of the problem. We will develop full 3-D solver for the asymptotic preserving fluid as well as kinetic model. The Asymptotic-Preserving (AP) numerical strategy allows us to perform numerical simulations with very large time and mesh steps and leads to impressive computational saving. These advantages will be combined with the utilization of the last generation preconditioned fast linear solvers to produce a software with very high performance for plasma simulation. For HIEPACS this project provides in particular a testbed for our expertise in parallel solution of large linear systems.

8.2.2.7. DEDALES: Algebraic and Geometric Domain Decomposition for Subsurface/Groundwater Flows

Participants: Emmanuel Agullo, Luc Giraud, Mathieu Faverge, Louis Poirel.

Grant: ANR-14-CE23-0005
Dates: 2014 – 2018
Partners: Inria EPI POMDAPI (leader); Université Paris 13 - Laboratoire Analyse, Géométrie et Applications; Maison de la Simulation; Andra.

Overview: Project DEDALES aims at developing high performance software for the simulation of two phase flow in porous media. The project will specifically target parallel computers where each node is itself composed of a large number of processing cores, such as are found in new generation many-core architectures. The project will be driven by an application to radioactive waste deep geological disposal. Its main feature is phenomenological complexity: water-gas flow in highly heterogeneous medium, with widely varying space and time scales. The assessment of large scale model is of major importance and issue for this application, and realistic geological models have several million grid cells. Few, if at all, software codes provide the necessary physical features with massively parallel simulation capabilities. The aim of the DEDALES project is to study, and experiment with, new approaches to develop effective simulation tools with the capability to take advantage of modern computer architectures and their hierarchical structure. To achieve this goal, we will explore two complementary software approaches that both match the hierarchical hardware architecture: on the one hand, we will integrate a hybrid parallel linear solver into an existing flow and transport code, and on the other hand, we will explore a two level approach with the outer level using (space time) domain decomposition, parallelized with a distributed memory approach, and the inner level as a subdomain solver that will exploit thread level parallelism. Linear solvers have always been, and will continue to be, at the center of simulation codes. However, parallelizing implicit methods on unstructured meshes, such as are required to accurately represent the fine geological details of the heterogeneous media considered, is notoriously difficult. It has also been suggested that time level parallelism could be a useful avenue to provide an extra degree of parallelism, so as to exploit the very large number of computing elements that will be part of these next generation computers. Project DEDALES will show that space-time DD methods can provide this extra level, and can usefully be combined with parallel linear solvers at the subdomain level. For all tasks, realistic test cases will be used to show the validity and the parallel scalability of the chosen approach. The most demanding models will be at the frontier of what is currently feasible for the size of models.

8.3. European Initiatives

8.3.1. FP7 & H2020 Projects

8.3.1.1. EXA2CT

Type: FP7

Defi: Special action

Instrument: Specific Targeted Research Project

Objectif: Exascale computing platforms, software and applications

Duration: September 2013 - August 2016

Coordinator: IMEC, Belgium

Partner: Particular specializations and experience of the partners are:

- Applications:
    - NAG - long experience in consultancy for HPC applications
    - Intel France - collaboration with industry on the migration of software for future HPC systems
    - TS-SFR - long experience in consultancy for HPC applications in Aerospace and Oil & Gas
- Algorithms – primarily numerical:
    - UA - broad experience in numerical solvers, with some taken up by the PETSc numerical library and other work published in high-ranking journals such as Science.
    - USI - expertise in parallel many-core algorithms for real-world applications on emerging architectures
    - Inria - expertise on large scale parallel numerical algorithms

  – IT4I - experience in the development of scalable solvers for large HPC systems
    (e.g. PRACE)
- Programming Models & Runtime Environments:
  – Imec - leads the programming model research within the Flanders ExaScience
    Lab
  – UVSQ - specialized in code optimization and performance evaluation in the area
    of HPC
  – TS-SFR - leading the BMBF funded GASPI project
  – Fraunhofer - developed a GASPI runtime environment used in industrial appli-
    cations
- Hardware Optimization:
  – Intel France - investigates workloads for new hardware architectures within the
    context of the Exascale Computing Research centre

Inria contact: Luc Giraud

Abstract: The EXA2CT project brings together experts at the cutting edge of the development of solvers, related algorithmic techniques, and HPC software architects for programming models and communication. We will produce modular open source proto-applications that demonstrate the algorithms and programming techniques developed in the project, to help boot-strap the creation of genuine exascale codes.

Numerical simulation is a crucial part of science and industry in Europe. The advancement of simulation as a discipline relies on increasingly compute intensive models that require more computational resources to run. This is the driver for the evolution to exascale. Due to limits in the increase in single processor performance, exascale machines will rely on massive parallelism on and off chip, with a complex hierarchy of resources. The large number of components and the machine complexity introduce severe problems for reliability and programmability.

8.4. International Initiatives

8.4.1. Inria International Labs

We are involved in the Inria@SiliconValley initiative through the associate team FASTLA described below.

8.4.2. Inria Associate Teams

8.4.2.1. MORSE

Title: Matrices Over Runtime Systems @ Exascale

International Partner (Institution - Laboratory - Researcher):

KAUST Supercomputing Laboratory (ÉTATS-UNIS)

Duration: 2014 - 2016

See also: http://icl.cs.utk.edu/projectsdev/morse/index.html

The goal of Matrices Over Runtime Systems at Exascale (MORSE) project is to design dense and sparse linear algebra methods that achieve the fastest possible time to an accurate solution on large-scale multicore systems with GPU accelerators, using all the processing power that future high end systems can make available. To develop software that will perform well on petascale and exascale systems with thousands of nodes and millions of cores, several daunting challenges have to be overcome, both by the numerical linear algebra and the runtime system communities. By designing a research framework for describing linear algebra algorithms at a high level of abstraction,the MORSE team will enable the strong collaboration between research groups in linear algebra, runtime systems and scheduling needed to develop methods and libraries that fully benefit from the potential of future large-scale machines. Our project will take a pioneering step in the effort to bridge the immense software gap that has opened up in front of the High-Performance Computing (HPC) community.

8.4.2.2. FASTLA

Title: Fast and Scalable Hierarchical Algorithms for Computational Linear Algebra

International Partner (Institution - Laboratory - Researcher):

Stanford University (ÉTATS-UNIS)

Lawrence Berkeley National Laboratory (ÉTATS-UNIS)

Duration: 2014 - 2016

See also: http://people.bordeaux.inria.fr/coulaud/projets/FastLA_Website/

In this project, we propose to study fast and scalable hierarchical numerical kernels and their implementations on heterogeneous manycore platforms for two major computational kernels in intensive challenging applications. Namely, fast multipole methods (FMM) and sparse hybrid linear solvers, that appear in many intensive numerical simulations in computational sciences. Regarding the FMM we plan to study novel generic formulations based on $\mathcal{H}$-matrices techniques, that will be eventually validated in the field of material physics: the dislocation dynamics. For the hybrid solvers, new parallel preconditioning approaches will be designed and the use of $\mathcal{H}$-matrices techniques will be first investigated in the framework of fast and monitored approximations on central components. Finally, the innovative algorithmic design will be essentially focused on heterogeneous manycore platforms. The partners, Inria HiePACS, Lawrence Berkeley Nat. Lab and Stanford University, have strong, complementary and recognized experiences and backgrounds in these fields.

8.4.3. Participation In other International Programs

8.4.3.1. HOSCAR

We are involved in the Inria-CNPq HOSCAR project led by Stéphane Lanteri.

The general objective of the project is to setup a multidisciplinary Brazil-France collaborative effort for taking full benefits of future high-performance massively parallel architectures. The targets are the very large-scale datasets and numerical simulations relevant to a selected set of applications in natural sciences: (i) resource prospection, (ii) reservoir simulation, (iii) ecological modeling, (iv) astronomy data management, and (v) simulation data management. The project involves computer scientists and numerical mathematicians divided in 3 fundamental research groups: (i) numerical schemes for PDE models (Group 1), (ii) scientific data management (Group 2), and (iii) high-performance software systems (Group 3).

An annual meeting has been organized in Gramado, Brazil on September, 2014.

8.4.3.2. G8-ECS

Title: Enabling Climate Simulations at Extreme Scale

Inria principal investigator: Luc Giraud

International Partners (Institution - Researcher):

Univ. Illinois at Urbanna Champaign & Argonne National Lab. - Franck Cappello,

Univ. Tennessee at Knoxville - George Bosilca,

German Research School for Simulation Sciences - Felix Wolf,

Univ. Victoria - Andrew Weaver,

Titech - Satoshi Matsuoka,

Univ. Tsukuba - Mitsuhisa Sato,

NCAR - Rich Loft,

Barcelona Supercomputing Center - Jesus Labarta.

Duration: 2011 - 2014

See also: G8 ESC-Enabling Climate Simulations at Extreme Scale

Exascale systems will allow unprecedented reduction of the uncertainties in climate change predictions via ultra-high resolution models, fewer simplifying assumptions, large climate ensembles and simulation at a scale needed to predict local effects. This is essential given the cost and consequences of inaction or wrong actions about climate change. To achieve this, we need careful co-design of future exascale systems and climate codes, to handle lower reliability, increased heterogeneity, and increased importance of locality. Our effort will initiate an international collaboration of climate and computer scientists that will identify the main roadblocks and analyze and test initial solutions for the execution of climate codes at extreme scale. This work will provide guidance to the future evolution of climate codes. We will pursue research projects to handle known roadblocks on resilience, scalability, and use of accelerators and organize international, interdisciplinary workshops to gather and disseminate information. The global nature of the climate challenge and the magnitude of the task strongly favor an international collaboration. The consortium gathers senior and early career researchers from USA, France, Germany, Spain, Japan and Canada and involves teams working on four major climate codes (CESM1, EC-EARTH, ECSM, NICAM).

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

8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. ANR

MapReduce (2010–2014). An ANR project (ARPEGE 2010) with international partners, which focuses on optimized Map-Reduce data processing on cloud platforms. This project started in October 2010 in collaboration with Argonne National Lab, the University of Illinois at Urbana Champaign, the UIUC/Inria Joint Lab on Petascale Computing, IBM, IBCP, MEDIT and the GRAAL Inria Project-Team. URL: http://mapreduce.inria.fr/.

8.1.2. ADT

ADT BlobSeer (2013–2014). To support the development of the BlobSeer software for ongoing cooperations, Inria provided support for a research engineer. Loïc Cloatre has been hired as a senior engineer for the second year of this project, starting in February 2014.

8.1.3. Other National projects

HEMERA (2010–2014). An Inria Large Wingspan Project, started in 2010. Within Hemera, G. Antoniu (KerData Inria Team) and Gilles Fedak (GRAAL Inria Project-Team) co-lead the Map-Reduce scientific challenge.

KerData also co-initiated a working group called *Efficient management of very large volumes of information for data-intensive applications*, co-led by G. Antoniu and Jean-Marc Pierson (IRIT, Toulouse).

Grid'5000. We are members of the Grid'5000 community: we make experiments on the Grid'5000 platform on a daily basis.

8.2. European Initiatives

8.2.1. FP7 and H2020 Projects

BigStorage (2015–2018)

Program: European Training Network (ETN).

Coordinator: María S. Pérez.

Partners: Universidad Politécnica de Madrid (UPM), Barcelona Supercomputing Center (PSC), Johannes Gutenberg Universität Mainz, Foundation for Research and Technology - Hellas (FORTH), Xyratex Technology Limited, Deutsches Klimarechenzentrum, CA Technologies, Fujitsu Technology Solutions GmbH, French Atomic Agency CEA, IBM Research Ireland, Bull SAS, and Informatica El Corte Ingles.

Abstract: The consortium of this Marie-Curie Innovative Training Networks (ITN) *BigStorage: Storage-based Convergence between HPC and Cloud to handle Big Data* aims at training future data scientists in order to enable them and us to apply holistic and interdisciplinary approaches for taking advantage of a data-overwhelmed world, which requires HPC and Cloud infrastructures with a redefinition of storage architectures underpinning them — focusing on meeting highly ambitious performance and energy usage objectives. KerData mainly collaborates with UPM and PSC 2 co-advised PhD theses).

8.2.2. Collaborations in European Programs, except FP7 and H2020

Program: EIT ICT Labs.

Project acronym: EUROPA Activity - Future Cloud Action Line.

Project title: Big Data Analytics with Apache Flink for Real Business Use-Cases.

Duration: May 2014–December 2014.

Coordinator: Gabriel Antoniu, Alexandru Costan.

Participants: Anirvan Basu, Camelia Ciolac.

Other partners: TU Berlin (Germany), VTT (Finland), F-Secure (Finland).

Abstract: In this project, we study the requirements with respect to Big Data analytics today, following several interviews with representative companies from various domains ranging from online mobile gaming to security and logistics. The goal is to identify those requirements that could be addressed by the Apache Flink (formerly known as Stratosphere) platform and apply them in some real-life business scenarios. We first present the state-of-the-art in the field of Big Data analytics, then validate the novel features of Flink. Finally we study how some of the requirements needed by the industry could be addressed by the latter, and illustrate them with 2 real use-cases. To this end, Camelia Ciolac and Anirvan Basu were hired and implemented two demos showing the use of Flink to solve Big Data problems from 2 companies: a mobile games developer (Tribeflame) and a security company (F-Secure), respectively.

8.3. International Initiatives

8.3.1. Inria International Labs

JLESC: Joint Laboratory on Extreme-Scale Computing. This laboratory is jointly run by Inria, UIUC, ANL and BSC. It has ben created in 2014 as a follow-up of the Inria-UIUC JLPC to collaborate on concurrency-optimized I/O for Extreme-scale platforms (see details in Section 4.3). This project is an extension of the Joint Inria-UIUC Laboratory for Petascale Computing (JLPC) which was used as the basis of the Data@Exascale Associate Team with ANL and UIUC (2013–2015).

8.3.2. Inria Associate Teams

Data@Exascale

Title: Ulta-scalable I/O and storage for Exascale systems

Inria principal investigator: Gabriel Antoniu

International Partners:

Argonne National Laboratory (United States) - Mathematics and Computer Science Division - Rob Ross

University of Illinois at Urbana Champaign (United States) - Marc Snir

Duration: 2013–2015

See also: http://www.irisa.fr/kerdata/data-at-Exascale/

Description: as the computational power used by large-scale scientific applications increases, the amount of data manipulated for subsequent analysis increases as well. Rapidly storing this data, protecting it from loss and analyzing it to understand the results are significant challenges, made more difficult by decades of improvements in computation capabilities that have been unmatched in storage. For many applications, the overall performance and scalability becomes clearly driven by the performance of the I/O subsystem. As we anticipate Exascale systems in 2020, there is a growing consensus in the scientific community that revolutionary new approaches are needed in computational science storage. These challenges are at the center of the activities of the Joint Inria-UIUC Lab for Petascale Computing, recently extended to Argonne National Lab. This project gathers researchers from Inria, Argonne National Lab and the University of Illinois at Urbana Champaign to address 3 goals: 1) investigate new storage architectures for Exascale systems; 2) investigate new approaches to the design of I/O middleware for Exascale systems to optimize data processing and visualization, leveraging dedicated I/O cores and I/O forwarding techniques; 3) explore techniques enabling adaptive cloud data services for HPC.

8.3.3. Participation In other International Programs

FP3C ANR-JST project (2010–2014).   This project co-funded by ANR and by JST (Japan Science and Technology Agency) started in October 2010 for 42 months. It focuses on programming issues for Post-Petascale architectures. In this framework, KerData collaborates with the University of Tsukuba on data management issues. Rohit Saxena was hired as an engineer until February 2014.

8.3.4. Inria International Partners

8.3.4.1. Declared Inria International Partners

Politehnica University of Bucharest.   This status was established since January 2013, right after the end of our former DataCloud@work Associate Team.

8.3.4.2. Informal International Partners

Huazhong University of Science and Technology (HUST), China.   We collaborate on optimizing Map-Reduce in virtualized environments.

Nanyang Technological University (NTU).   We collaborate on optimizing Big Data applications in the Cloud and HPC systems.

8.4. International Research Visitors

8.4.1. Visits of International Scientists

Robert Ross (Argonne National Lab) visited the KerData team for one week (June 2014) within the framework of the Data@Exascale Associate Team, as an Invited Professor funded by the University of Rennes 1.

8.4.2. Internships

Stefan Ene

> Subject: Overlapping cloud data transfers and computation for incremental Map-Reduce.
>
> Date: April–September 2014.
>
> Institution: Master student from Politehnica University of Bucharest (Romania). Co-funded by the Inria Internships Program.

Andreea Pintilie

> Subject: Bio-informatics inspired algorithms for fast cloud data transfers.
>
> Date:April–September 2014.
>
> Institution: Master student from Politehnica University of Bucharest (Romania). Co-funded by the Inria Internships Program.

Anh-Phuong Tran

> Subject: Failure-aware job scheduling in Hadoop cloud data centers.
>
> Date: February–June 2014.
>
> Institution: Master student enrolled in the European Master in Distributed Computing (EMDC) program, a joint program between KTH Royal Institute of Technology in Sweden and Instituto Superior Tecnico in Portugal.

Tien Dat Phan

> Subject: A simulation approach to evaluate Map-Reduce performance under failure.
>
> Date: February 2014–June 2014.
>
> Institution: Master student from University Rennes 1, Rennes (France)

Orçun Yildiz

Subject: (In-)Efficiency in energy consumption of data management on Petascale supercomputers.

Date: February–July 2014.

Institution: Master student enrolled in the European Master in Distributed Computing (EMDC) program, a joint program between KTH Royal Institute of Technology in Sweden and Instituto Superior Tecnico in Portugal.

Thomas Bouguet

Subject: Development of a web platform for the analysis of Darshan I/O log files.

Date: May–July 2014.

Institution: Master student from University Rennes 1, Rennes (France).

8.4.3. Visits to International Teams

Lokman Rahmani visited ANL (Rob Ross, Tom Peterka) for 2 months, funded by the PUF NextGen project in the context of the Joint Laboratory for Extreme-Scale Computing (JLESC).

MESCAL Project-Team

8. Partnerships and Cooperations

8.1. Regional Initiatives

8.1.1. CIMENT

The CIMENT project (Intensive Computing, Numerical Modeling and Technical Experiments, http://ciment.ujf-grenoble.fr/) gathers a wide scientific community involved in numerical modeling and computing (from numerical physics and chemistry to astrophysics, mechanics, bio-modeling and imaging) and the distributed computer science teams from Grenoble. Several heterogeneous distributed computing platforms were set up (from PC clusters to IBM SP or alpha workstations) each being originally dedicated to a scientific domain. More than 600 processors are available for scientific computation. The MESCAL project-team provides expert skills in high performance computing infrastructures. The members of MESCAL involved in this project are Pierre Neyron and Olivier Richard.

8.1.2. Cluster Région

Partners: the Inria GRAAL project-team, the LSR-IMAG and IN2P3-LAPP laboratories.

The MESCAL project-team is a member of the regional "cluster" project on computer science and applied mathematics, the focus of its participation is on handling large amount of data large scale architecture.

8.2. National Initiatives

8.2.1. Inria Large Scale Initiative

- *HEMERA, 2010-2014* Leading action "Completing challenging experiments on Grid'5000 (Methodology)" (see https://www.grid5000.fr/Hemera).

  Experimental platforms like Grid'5000 or PlanetLab provide an invaluable help to the scientific community, by making it possible to run very large-scale experiments in controlled environment. However, while performing relatively simple experiments is generally easy, it has been shown that the complexity of completing more challenging experiments (involving a large number of nodes, changes to the environment to introduce heterogeneity or faults, or instrumentation of the platform to extract data during the experiment) is often underestimated.

  This working group explores different complementary approaches, that are the basic building blocks for building the next level of experimentation on large scale experimental platforms.

8.2.2. ANR

- *ANR GAGA (2014-2017)*

  GAGA is a "Young Researchers" project funded by the French National Research Agency (ANR) to explore the Geometric Aspects of GAmes. The GAGA team is spread over three different locations in France (Paris, Toulouse and Grenoble), and is coordinated by Vianney Perchet, assistant professor (Maître de Conférences) in the Probabilities and Random Models laboratory in Université Paris VII.

  As the name suggests, our project's focus is game theory, a rapidly developing subject with growing applications in economics, social sciences, computer science, engineering, evolutionary biology, etc. As it turns out, many game theoretical topics and tools have a strong geometrical or topological flavor: the structure of a game's equilibrium set, the design of equilibrium-computing algorithms, Blackwell approachability, the geometric character of the replicator dynamics, the use of semi-algebraicity concepts in stochastic games, and many others. Accordingly, our objective is to perform a systematic study of these geometric aspects of game theory and, by so doing, to establish new links between areas that so far appeared unrelated (such as Hessian-Riemannian geometry and discrete choice theory).

- *ANR MARMOTE, 2013-2016.* Partners: Inria Sophia (MAESTRO), Inria Rocquencourt (DIOGEN), PRiSM laboratory from University of Versailles-Saint-Quentin, Telecom SudParis (SAMOVAR), University Paris-Est Créteil (*Spécification et vérification de systèmes*), Université Pierre-et-Marie-Curie/LIP6.

  The project aims at realizing a software prototype dedicated to Markov chain modeling. It gathers seven teams that will develop advanced resolution algorithms and apply them to various domains (reliability, distributed systems, biology, physics, economy).

- *ANR NETLEARN, 2013-2015.* Partners: PRiSM laboratory from University of Versailles-Saint-Quentin, Telecom ParisTech, Orange Labs, LAMSADE/University Paris Dauphine, Alcatel-Lucent, Inria (MESCAL).

  The main objective of the project is to propose a novel approach of distributed, scalable, dynamic and energy efficient algorithms for managing resources in a mobile network. This new approach relies on the design of an orchestration mechanism of a portfolio of algorithms. The ultimate goal of the proposed mechanism is to enhance the user experience, while at the same time to better utilize the operator resources. User mobility and new services are key elements to take into account if the operator wants to improve the user quality of experience. Future autonomous network management and control algorithms will thus have to deal with a real-time dynamicity due to user mobility and to traffic variations resulting from various usages. To achieve this goal, we focus on two central aspects of mobile networks (the management of radio resources at the Radio Access Network level and the management of the popular contents users want to get access to) and intend to design distributed learning mechanisms in non-stationary environments, as well as an orchestration mechanism that applies the best algorithms depending on the situation.

- *ANR SONGS, 2012-2015.* Partners: Inria Nancy (Algorille), Inria Sophia (MASCOTTE), Inria Bordeaux (CEPAGE, HiePACS, RunTime), Inria Lyon (AVALON), University of Strasbourg, University of Nantes.

  The last decade has brought tremendous changes to the characteristics of large scale distributed computing platforms. Large grids processing terabytes of information a day and the peer-to-peer technology have become common even though understanding how to efficiently exploit such platforms still raises many challenges. As demonstrated by the USS SimGrid project funded by the ANR in 2008, simulation has proved to be a very effective approach for studying such platforms. Although even more challenging, we think the issues raised by petaflop/exaflop computers and emerging cloud infrastructures can be addressed using similar simulation methodology.

  The goal of the SONGS project (Simulation of Next Generation Systems) is to extend the applicability of the SimGrid simulation framework from grids and peer-to-peer systems to clouds and high performance computation systems. Each type of large-scale computing system will be addressed through a set of use cases and led by researchers recognized as experts in this area.

  Any sound study of such systems through simulations relies on the following pillars of simulation methodology: Efficient simulation kernel; Sound and validated models; Simulation analysis tools; Campaign simulation management.

8.2.3. National Organizations

Jean-Marc Vincent is member of the scientific committees of the CIST (Centre International des Sciences du Territoire).

8.3. European Initiatives

8.3.1. FP7 & H2020 Projects

8.3.1.1. Mont-Blanc

Program: FP7 Programme

Project acronym: Mont-Blanc

Project title: Mont-Blanc: European scalable and power efficient HPC platform based on low-power embedded technology

Duration: October 2011 - October 2014

Coordinator: Alex Ramirez

Other partners: BSC (Barcelone), Bull, ARM (UK), Julich (Germany), Genci, CINECA (Italy), CNRS (LIRMM, LIG)

Abstract: There is a continued need for higher compute performance: scientific grand challenges, engineering, geophysics, bioinformatics, etc. However, energy is increasingly becoming one of the most expensive resources and the dominant cost item for running a large supercomputing facility. In fact, the total energy cost of a few years of operation can almost equal the cost of the hardware infrastructure. Energy efficiency is already a primary concern for the design of any computer system and it is unanimously recognized that Exascale systems will be strongly constrained by power.

The analysis of the performance of HPC systems since 1993 shows exponential improvements at the rate of one order of magnitude every 3 years: One petaflops was achieved in 2008, one exaflops is expected in 2020. Based on a 20 MW power budget, this requires an efficiency of 50 GFLOPS/Watt. However, the current leader in energy efficiency achieves only 1.7n GFLOPS/Watt. Thus, a 30x improvement is required.

In this project, the partners believe that HPC systems developed from today's energy-efficient solutions used in embedded and mobile devices are the most likely to succeed. As of today, the CPUs of these devices are mostly designed by ARM. However, ARM processors have not been designed for HPC, and ARM chips have never used in HPC systems before, leading to a number of significant challenges.

8.3.1.2. Mont-Blanc 2

Program: FP7 Programme

Project acronym: Mont-Blanc 2

Project title: Mont-Blanc: European scalable and power efficient HPC platform based on low-power embedded technology

Duration: October 2013 - September 2016

Coordinator: BSC (Barcelone)

Other partners: BULL - Bull SAS (France), STMicroelectronics - (GNB SAS) (France), ARM - (United Kingdom), JUELICH - (Germany), BADW-LRZ - (Germany), USTUTT - (Germany), CINECA - (Italy), CNRS - (France), Inria - (France), CEA - (France), UNIVERSITY OF BRISTOL - (United Kingdom), ALLINEA SW LIM - (United Kingdom)

Abstract: Energy efficiency is already a primary concern for the design of any computer system and it is unanimously recognized that future Exascale systems will be strongly constrained by their power consumption. This is why the Mont-Blanc project has set itself the following objective: to design a new type of computer architecture capable of setting future global High Performance Computing (HPC) standards that will deliver Exascale performance while using 15 to 30 times less energy. Mont-Blanc 2 contributes to the development of extreme scale energy-efficient platforms, with potential for Exascale computing, addressing the challenges of massive parallelism, heterogeneous computing, and resiliency. Mont-Blanc 2 has great potential to create new market opportunities for successful EU technology, by placing embedded architectures in servers and HPC.

The Mont-Blanc 2 proposal has 4 objectives:
1. To complement the effort on the Mont-Blanc system software stack, with emphasis on programmer tools (debugger, performance analysis), system resiliency (from applications to architecture support), and ARM 64-bit support.

2. To produce a first definition of the Mont-Blanc Exascale architecture, exploring different alternatives for the compute node (from low-power mobile sockets to special-purpose high-end ARM chips), and its implications on the rest of the system.

3. To track the evolution of ARM-based systems, deploying small cluster systems to test new processors that were not available for the original Mont-Blanc prototype (both mobile processors and ARM server chips).

4. To provide continued support for the Mont-Blanc consortium, namely operations of the Mont-Blanc prototype, and hands-on support for our application developers

8.3.1.3. QUANTICOL

Program: The project is a member of Fundamentals of Collective Adaptive Systems (FOCAS), a FET-Proactive Initiative funded by the European Commission under FP7.

Project acronym: QUANTICOL

Project title: A Quantitative Approach to Management and Design of Collective and Adaptive Behaviours

Duration: 04 2013 – 03 2017

Coordinator: Jane Hillston (University of Edinburgh, Scotland)

Other partners: University of Edinburgh (Scotland); Istituto di Scienza e Tecnologie della Informazione (Italy); IMT Lucca (Italy) and University of Southampton (England).

Abstract: The main objective of the QUANTICOL project is the development of an innovative formal design framework that provides a specification language for collective adaptive systems (CAS) and a large variety of tool-supported, scalable analysis and verification techniques. These techniques will be based on the original combination of recent breakthroughs in stochastic process algebras and associated verification techniques, and mean field/continuous approximation and control theory. Such a design framework will provide scalable extensive support for the verification of developed models, and also enable and facilitate experimentation and discovery of new design patterns for emergent behaviour and control over spatially distributed CAS.

8.3.1.4. NEWCOM#

Program: FP7-ICT-318306

Project acronym: NEWCOM#

Project title: Network of Excellence in Wireless Communications

Duration: 11 2012 – 10 2015

Coordinator: Consorzio Nazionale Interuniversitario per le Telecomunicazioni (Italy)

Other partners: Aalborg Universitet (AAU). Denmark; Bilkent Üniversitesi (Bilkent). Turkey; Centre National de la Recherche Scientifique (CNRS). France; Centre Tecnològic de Telecomunicacions de Catalunya (CTTC). Spain; Institute of Accelerating Systems and Applications (IASA). Greece; Inesc Inovacao; Instituto de Novas Tecnologias (INOV). Portugal; Poznan University of Technology (PUT). Poland; Technion - Israel Institute of Technology (TECHNION). Israel; Technische Universitaet Dresden (TUD). Germany; University of Cambridge (UCAM). United Kingdom; Universite Catholique de Louvain (UCL). Belgium; Oulun Yliopisto (UOULU). Finland

Abstract: NEWCOM# is a project funded under the umbrella of the 7th Framework Program of the European Commission (FP7-ICT-318306). NEWCOM# pursues long-term, interdisciplinary research on the most advanced aspects of wireless communications like Finding the Ultimate Limits of Communication Networks, Opportunistic and Cooperative Communications, or Energy- and Bandwidth-Efficient Communications and Networking.

8.3.2. Collaborations in European Programs, except FP7 & H2020

8.3.2.1. CROWN

Program: European Community and Greek General Secretariat for Research and Technology

Project acronym: CROWN

Project title: Optimal Control of Self Organized Wireless Networks

Duration: 2012-2015

Coordinator: Tassiulas Leandros

Other partners: Thales, University of Thessaly, National and Kapodistrian University of Athens, Athens University of Economics and Business

Abstract: Wireless networks are rapidly becoming highly complex systems with large numbers of heterogeneous devices interacting with each other, often in a harsh environment. In the absence of central control, network entities need to self-organize to reach an efficient operating state, while operating in a distributed fashion. Depending on whether the operating criteria are individual or global, nodes interact in an autonomic or coordinated way. Despite recent progress in autonomic networks, the fundamental understanding of the operational behaviour of large-scale networks is still lacking. This project will address these emergent network properties, by introducing new tools and concepts from other disciplines.

We will first analyze how imperfect network state information can be harvested and distributed efficiently through the network using machine learning techniques. We will design flexible method-ologies to shape the competition between autonomous nodes for resources, with aim to maintain robust social optimality. Both cooperating and non-cooperating game-theoretic models will be used. We also consider networks with nodes coordinating to achieve a joint task, e.g., global optimization. Using algorithms inspired from statistical physics, we will address two representative paradigms in the context of wireless ad hoc networks, namely connectivity optimization and the localization of a network of primary sources from a sensor network.

Finally, we will explore delay tolerant networks as a case study of an emerging class of networks that, while sharing most of the characteristics of traditional autonomic or coordinated networks, they present unique challenges, due to the intermittency and constant fluctuations of the connectivity. We will study tradeoffs involving delay, the impact of mobility on information transfer, and the optimal usage of resources by using tools from information theory and stochastic evolution theory.

8.3.3. Collaborations with Major European Organizations

University of Athens: Panayotis Mertikopoulos was an invited professor for 3 months.

EPFL: Laboratoire pour les communications informatiques et leurs applications 2, Institut de systèmes de communication ISC, Ecole polytechnique fédérale de Lausanne (Switzerland). We collaborate with Jean-Yves Leboudec (EPFL) and Pierre Pinson (DTU) on electricity markets.

University of Antwerp: we collaborate with Benny Van Houdt on caching problems.

TU Wien: Research Group Parallel Computing, Technische Universität Wien (Austria). We collabo-rate with Sascha Hunold on experimental methodology and reproducibility of experiments in HPC.

8.4. International Initiatives

8.4.1. Inria International Labs

8.4.1.1. North America

- JLESC (former JLPC) (Joint Laboratory for Extreme-Scale Computing) with University of Univer-sity of Illinois Urbana Champaign, Argonne Nat. Lab and BSC. Several members of MESCAL are partners of this laboratory, and have done several visits to Urbana-Champaign or NCSA.
- Associated Team with Berkeley. MESCAL is thus involved in the Inria@SiliconValley program.

8.4.2. Inria Associate Teams

8.4.2.1. EXASE

Title: Exascale Computing Scheduling and Energy

International Partner (Institution - Laboratory - Researcher):

Universidade Federal do Rio Grande do Sul (Brazil)

Duration: 2014 -

See also: https://team.inria.fr/exase/

The main scientific goal of this collaboration for the three years is the development of state-of-the-art energy-aware scheduling algorithms for exascale systems. Three complementary research directions have been identified : (1) Fundamentals for the scaling of schedulers: develop new scheduling algorithms for extreme exascale machines and use existing workloads to validate the proposed scheduling algorithms (2) Design of schedulers for large-scale infrastructures : propose energy-aware schedulers in large-scale infrastructures and develop adaptive scheduling algorithms for exascale machines (3) Tools for the analysis of large scale schedulers : develop aggregation methodologies for scheduler analysis to propose synthetized visualizations for large traces analysis and then analyze schedulers and energy traces for correlation analysis

8.4.2.2. CLOUDSHARE

Title: Guaranteed Application Performance on Idle Data Center Resources

International Partner (Institution - Laboratory - Researcher):

University of California Berkeley (United States)

Duration: 2009 - 2014

See also: http://mescal.imag.fr/membres/derrick.kondo/ea/ea.html

Data centers are often 85% idle as they must over-provision to ensure service level agreements. At the same time, high data center utilization is essential for efficient resource usage and optimal revenue. One way to improve utilization is for low-priority applications to use the idle resources of data centers, allowing high-priority applications to preempt them at any time. While users benefit from the lower costs of using these idle resources, parallel applications such as Map-Reduce can suffer severe overheads and unpredictable performance due to unexpected preemption and unavailability. The goal of this project is to enable complex applications to utilize idle data center resources with guaranteed performance. Our approach will be as follows. First, we will investigate novel statistical methods to predict the execution time of complex batch applications. Second, we will apply machine learning methods to predict idleness in data centers. Third, we will craft fair scheduling algorithms for multiple applications that compete for idle data center resources. The collaboration bridges experts in statistical modeling and simulation from the Inria MESCAL team with system and scheduling experts in the Berkeley BOINC team and the Google Infrastructure team.

8.4.3. Inria International Partners

8.4.3.1. Declared Inria International Partners

- MESCAL has strong connections with both UFRGS (Porto Alegre, Brazil) and USP (Sao Paulo, Brazil). The creation of the LICIA common laboratory (see next section) has made this collaboration even tighter.
- MESCAL has strong bounds with the University of Illinois Urbana Champaign, within the (Joint Laboratory on Petascale Computing, see previous section).
- MESCAL also has long lasting collaborations with University of California in Berkeley.

8.4.4. Participation In other International Programs

8.4.4.1. South America

- LICIA. The CNRS, Inria, the Universities of Grenoble, Grenoble INP and Universidade Federal do Rio Grande do Sul have created the LICIA (*Laboratoire International de Calcul intensif et d'Informatique Ambiante*). Jean-Marc Vincent is the director of the laboratory, on the French side.

  The main themes are high performance computing, language processing, information representation, interfaces and visualization as well as distributed systems.

  More information can be found at http://www.inf.ufrgs.br/licia/.

8.5. International Research Visitors

8.5.1. Visits of International Scientists

- Rhonda Righter (UC Berkeley), two weeks in May.
- Mario Bravo (University of Chile), one week in March.
- Josu Donsel (LAAS), two weeks in September.
- William H. Sandholm (University of Wisconsin), 4 days in September.
- Jian Li (Texas-A&M University) visited as a PhD intern for two months.
- Wenjing Wu (Chinese Academy of Science) (one month, Sept.- Oct.)
- Rafael Tesser (UFRGS) visited as a PhD intern for one month.
- Philippe Navaux (UFRGS), Nicolas Maillard (UFRGS) and Alexandre Carissimi (UFRGS) and Lucas Schnorr (UFRGS) visited Mescal for two weeks in Jan. and Oct. 2014.

8.5.2. Visits to International Teams

8.5.2.1. Research stays abroad

- Panayotis Mertikopoulos visited the University of Athens for one trimester to the Department of Physics and the Department of Economics (invited by Aris L. Moustakas and Andreas Polydoros).
- Panayotis Mertikopoulos visited the Univeristy of Neuchâtel for one week (Department of Mathematics, invited by Michel Benaïm).
- Panayotis Mertikopoulos visited the University of Wisconsin–Madison for one week (Department of Economics, invited by William H. Sandholm).
- Arnaud Legrand, Luka Stanisic and Augustin Degomme visited the Barcelona Supercomputer Center in November 2014.
- Jean-Marc Vincent visited UFRGS for two weeks in Feb. - Mar. 2014.

<h1 style="text-align:center;color:red;">MOAIS Project-Team</h1>

7. Partnerships and Cooperations

7.1. National Initiatives

7.1.1. ANR

- **ANR grant MOEBIUS (2013-2015).** Multi-objective scheduling for large computing platforms. Coordinator: Grenoble INP (Moais team). Partners: Grenoble INP, Inria, BULL.

- **ANR grant EXAVIZ (2011-2015).** Large Scale Interactive Visual Analysis for Life Science. Partners: Inria Rhône-Alpes, Université d'Orléans, the LBT lab from IBPC, the LIMSI from Université d'Orsay, and the CEMHTI labs from CNRS.

- **ANR HPAC (2012-2015)**. High Performance Algebraic Computing. Coordinator: UJF (LJK/CASYS team). Partners: project-team MOAIS (Grenoble), project-team ARENAIRE (LIP, Lyon), project-team SALSA (LIP6, Paris), the ARITH group (LIRMM lab, Montpellier).

- **Equipex Kinovis (2012-2017)**. 2.6 Meuros. Large scale multi-camera platform (extension of the Grimage platform to 60 cameras, depth and X-ray cameras). Coordinator E Boyer, LJK Inria MORPHEO team. Partners: Inria Rhône-Alpes and the LJK, LIG, LADAF and GIPSA labs.

- **ANR-11-LABX-0025 PERSYVAL-Lab** funds the following PhD in collaboration with other labs:
    - in collaboration with Verimag: Multi-objective optimization for resource management on multicore systems, (PhD Abhinav Srivastav, since 9/2012)
    - In collaboration with Gipsa-lab and Inria BiBop: Simulations of Fibrous Materials. (PhD Gilles Daviet, since 9/2013)
    - in collaboration with Inria Privatics and Verimag: Secure Outsourcing (PhD Amrit Kumar, since 11/2013)

7.1.2. Competitivity Clusters

- **SoC-Trace**, Minalogic 2011-2014 contract. This project aims the development of tools for the monitoring and debug of mumticore systems on chip. Leader: ST-Microelectonic. Partners: Inria (Mescal, Moais); UJF (TIMA, LIG/Hadas); Magilem, ProBayes. Moais contributes with technics and tools for visual aggregation of application traces. The contract funds 1 phD thesis (Damien Dosimont) and 1 year engineer.

- **ARAMIS, PIA contract n°P3342-146798 (2014-2017)**: Architecture Robuste pour les Automates et Maté´riels des Infrastructures Sensibles. Coordinator: ATOS-WorldGrid; Partners: CEA, SecLab, UJF. The UJF gathers the folowing teams: LIG (Moais, Drakkar, Vasco); LJK (Casys); IF; Verimag (DCS). BPI funds UJF with 775 ke (funds 4 PhDs and 5 years egineers), among which 410ke for LIG. Moais co-advises two PhD Thesis: Nicolas Kox with LIG-VASCO team (Rupture de protocole avec garanties de se´curite´ pour les syste`mes de controˆle-commande); Maxime Puys with VERIMAG-DCS (Processus de ge´ne´ration de filtres certifie´s pour les syste`mes de controˆle-commande).

- **PIA ELCI (2014-2017)**. Environnement Logiciel pour le Calcul Intensif. Coordinator BULL. Partners: BULL, CEA, Inria, SAFRAB, UVSQ.

7.1.3. National ADT

- ADT K'STAR with cooperation between EPIs MOAIS and RUNTIME (Bordeaux). Coordinator: T. Gautier. https://gforge.inria.fr/projects/kstar. The main objective is to provide OpenMP-3.1 with some extension from OpenMP-4.0 standard to perform OpenMP programs on multi-CPUs multi-GPUs by using XKaapi and StarPU runtimes.

7.1.4. Inria Project Lab

7.1.4.1. C2S@Exa - Computer and Computational Scienecs at Exascale

Participants: Olivier Aumage [RUNTIME project-team, Inria Bordeaux - Sud-Ouest], Jocelyne Erhel [SAGE project-team, Inria Rennes - Bretagne Atlantique], Philippe Helluy [TONUS project-team, Inria Nancy - Grand-Est], Laura Grigori [ALPINE project-team, Inria Saclay - Île-de-France], Jean-Yves L'excellent [ROMA project-team, Inria Grenoble - Rhône-Alpes], Thierry Gautier [MOAIS project-team, Inria Grenoble - Rhône-Alpes], Luc Giraud [HIEPACS project-team, Inria Bordeaux - Sud-Ouest], Michel Kern [POMDAPI project-team, Inria Paris - Rocquencourt], Stéphane Lanteri [Coordinator of the project], François Pellegrini [BACCHUS project-team, Inria Bordeaux - Sud-Ouest], Christian Perez [AVALON project-team, Inria Grenoble - Rhône-Alpes], Frédéric Vivien [ROMA project-team, Inria Grenoble - Rhône-Alpes].

Since January 2013, the team is participating to the C2S@Exa http://www-sop.inria.fr/c2s_at_exa Inria Project Lab (IPL). This national initiative aims at the development of numerical modeling methodologies that fully exploit the processing capabilities of modern massively parallel architectures in the context of a number of selected applications related to important scientific and technological challenges for the quality and the security of life in our society. At the current state of the art in technologies and methodologies, a multidisciplinary approach is required to overcome the challenges raised by the development of highly scalable numerical simulation software that can exploit computing platforms offering several hundreds of thousands of cores. Hence, the main objective of C2S@Exa is the establishment of a continuum of expertise in the computer science and numerical mathematics domains, by gathering researchers from Inria project-teams whose research and development activities are tightly linked to high performance computing issues in these domains. More precisely, this collaborative effort involves computer scientists that are experts of programming models, environments and tools for harnessing massively parallel systems, algorithmists that propose algorithms and contribute to generic libraries and core solvers in order to take benefit from all the parallelism levels with the main goal of optimal scaling on very large numbers of computing entities and, numerical mathematicians that are studying numerical schemes and scalable solvers for systems of partial differential equations in view of the simulation of very large-scale problems.

T. Gautier is coordinator of the Pole 4: Programming Models.

7.2. European Initiatives

7.2.1. FP7 & H2020 Projects

7.2.1.1. VISIONAIR

> Type: FP7
>
> Defi: NC
>
> Instrument: Combination of COLLABORATIVE PROJECTS and COORDINATION and SUPPORT ACTIONS
>
> Objectif: NC
>
> Duration: February 2011 - January 2015
>
> Coordinator: Frederic Noël, Grenoble INP.
>
> Partner: Gather 27 European Partners.
>
> Inria contact: G. Dumont
>
> Abstract: Federation of European Virtual Reality and Scientific Visualization Platforms opened to European researchers. Moais involved through the Grimage Platform.

7.3. International Initiatives

7.3.1. Inria Associate Teams

7.3.1.1. ANOMALIES@EXASCALE

Title: Anomalies Detection and Handling towards Exascale Platforms

International Partner (Institution - Laboratory - Researcher):

University of Chicago (ÉTATS-UNIS)

Duration: 2014 - 2016

See also: http://intra-id.imag.fr/

The Anomalies@exascale project intends to prospect new scheduling solutions for very large parallel computing platforms. In particular, we consider the new problems related to fault tolerance raising with the developments of exascale platforms. We expect to define new ways to detect both execution failures and more transient performance anomalies. Information gathered from the detectors will then be taken into account by schedulers to implement corrective measures.

7.3.1.2. ExaSE

Title: Exascale Computing Scheduling and Energy

International Partner (Institution - Laboratory - Researcher):

UFRGS, PUC Minas and UPS (Brazil)

Duration: 2014 - 2016

See also: https://team.inria.fr/exase/

The main scientific context of this project is high performance computing on Exascale systems: large-scale machines with billions of processing cores and complex hierarchical structures. This project intends to explore the relationship between scheduling algorithms and techniques and the energy constraints present on such exascale systems.

7.3.2. Participation to other International Programs

7.3.2.1. LICIA

Title: International Laboratory in High Performance and Ubiquitous Computing

International Partner (Institution - Laboratory - Researcher):

UFRGS (Brazil)

Duration: 2011 - 2018

See also: http://licia-lab.org/

The LICIA is an Internacional Laboratory and High Performance and Ubiquitous Computing born in 2011 from the common desire of members of Informatics Institute of the Federal University of Rio Grande do Sul and of Laboratoire d'Informatique de Grenoble to enhance and develop their scientific parternship that started by the end of the 1970. LICIA is an Internacional Associated Lab of the CNRS, a public french research institution. It has support from several brazilian and french research funding agencies, such as CNRS, Inria, ANR, European Union (from the french side) and CAPES, CNPq, FAPERGS (from the Brazilian side). Moais is deeply invovled in the creation and animation of LICIA. Bruno Raffin is LICIA associate director.

7.3.2.2. CAPES/COFECUB StarShip

Title: Scalable Tools and Algorithms para Resilient, Scalable, Hybrid Interactive Processing

International Partner (Institution - Laboratory - Researcher):

UFRGS (Brazil)

Duration: 2013 - 2016

7.4. International Research Visitors

7.4.1. Visits of International Scientists

- Guochuan Zhang. Professor at Zhejiang University, China, one month stay at Moais in 2014.
- Adel Safi, Associate Professor ar ESSTT, Tunisia, 2 weeks stay at Moais in 2014.
- Andreï Tchernykh, Researcher at CICESE, Mexico, one month stay at Moais in 2014.
- Monica Liliana Hernandez Ariza, Master Student at University of Santander, Colombia, 4 months stay at Moais in 2014.

<p style="text-align:center">**ROMA Team**</p>

8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. ANR

ANR White Project RESCUE (2010-2015), 4 years. The ANR White Project RESCUE was launched in November 2010, for a duration of 48 months (and was later extended for 6 additional months). It gathers three Inria partners (ROMA, Grand-Large and Hiepacs) and is led by ROMA. The main objective of the project is to develop new algorithmic techniques and software tools to solve the *exascale resilience problem*. Solving this problem implies a departure from current approaches, and calls for yet-to-be-discovered algorithms, protocols and software tools.

This proposed research follows three main research thrusts. The first thrust deals with novel *checkpoint protocols*. The second thrust entails the development of novel *execution models*, i.e., accurate stochastic models to predict (and, in turn, optimize) the expected performance (execution time or throughput) of large-scale parallel scientific applications. In the third thrust, we will develop novel *parallel algorithms* for scientific numerical kernels.

ANR Project SOLHAR (2013-2017), 4 years. The ANR Project SOLHAR was launched in November 2013, for a duration of 48 months. It gathers five academic partners (the HiePACS, Cepage, ROMA and Runtime Inria project-teams, and CNRS-IRIT) and two industrial partners (CEA/CESTA and EADS-IW). This project aims at studying and designing algorithms and parallel programming models for implementing direct methods for the solution of sparse linear systems on emerging computers equipped with accelerators.

The proposed research is organized along three distinct research thrusts. The first objective deals with linear algebra kernels suitable for heterogeneous computing platforms. The second one focuses on runtime systems to provide efficient and robust implementation of dense linear algebra algorithms. The third one is concerned with scheduling this particular application on a heterogeneous and dynamic environment.

8.1.2. Inria Project Lab C2S@Exa - Computer and Computational Scienecs at Exascale

Participants: Olivier Aumage [RUNTIME project-team, Inria Bordeaux - Sud-Ouest], Jocelyne Erhel [SAGE project-team, Inria Rennes - Bretagne Atlantique], Philippe Helluy [TONUS project-team, Inria Nancy - Grand-Est], Laura Grigori [ALPINE project-team, Inria Saclay - Île-de-France], Jean-Yves L'excellent [ROMA project-team, Inria Grenoble - Rhône-Alpes], Thierry Gautier [MOAIS project-team, Inria Grenoble - Rhône-Alpes], Luc Giraud [HIEPACS project-team, Inria Bordeaux - Sud-Ouest], Michel Kern [POMDAPI project-team, Inria Paris - Rocquencourt], Stéphane Lanteri [Coordinator of the project], François Pellegrini [BACCHUS project-team, Inria Bordeaux - Sud-Ouest], Christian Perez [AVALON project-team, Inria Grenoble - Rhône-Alpes], Frédéric Vivien [ROMA project-team, Inria Grenoble - Rhône-Alpes].

Since January 2013, the team is participating to the C2S@Exa http://www-sop.inria.fr/c2s_at_exa Inria Project Lab (IPL). This national initiative aims at the development of numerical modeling methodologies that fully exploit the processing capabilities of modern massively parallel architectures in the context of a number of selected applications related to important scientific and technological challenges for the quality and the security of life in our society. At the current state of the art in technologies and methodologies, a multidisciplinary approach is required to overcome the challenges raised by the development of highly scalable numerical simulation software that can exploit computing platforms offering several hundreds of thousands of cores. Hence, the main objective of C2S@Exa is the establishment of a continuum of expertise in the computer science and numerical mathematics domains, by gathering researchers from Inria project-teams whose research and development activities are tightly linked to high performance computing issues

in these domains. More precisely, this collaborative effort involves computer scientists that are experts of programming models, environments and tools for harnessing massively parallel systems, algorithmists that propose algorithms and contribute to generic libraries and core solvers in order to take benefit from all the parallelism levels with the main goal of optimal scaling on very large numbers of computing entities and, numerical mathematicians that are studying numerical schemes and scalable solvers for systems of partial differential equations in view of the simulation of very large-scale problems.

8.2. European Initiatives

8.2.1. FP7 & H2020 Projects

8.2.1.1. SCORPIO

> Type: FP7
>
> Defi: Future and Emerging Technologies
>
> Instrument: Specific Targeted Research Project
>
> Objectif: Challenging current Thinking
>
> Duration: June 2013 - May 2016
>
> Coordinator: Nikolaos Bellas
>
> Partners: CERTH, Greece; EPFL, Switzerland; RWTH Aachen University, Germany; The Queen's University of Belfast, UK; IMEC, Belgium
>
> Inria contact: Frédéric Vivien
>
> Abstract: A new computing paradigm that exploits uncertainty to design systems that are energy-efficient and scale gracefully under hardware errors by operating below the nominal operating point, in a controlled way, without inducing massive or fatal errors.

8.3. International Initiatives

8.3.1. Inria International Labs

In 2014, the University of Illinois at Urbana-Champaign, Inria, the French national computer science institute, Argonne National Laboratory, Barcelona Supercomputing Center, and Jülich Supercomputing Centre formed the Joint Laboratory on Extreme Scale Computing (JLESC), a follow-up of the Inria-Illinois Joint Laboratory for Petascale Computing. The Joint Laboratory is based at Illinois and includes researchers from Inria, and the National Center for Supercomputing Applications, ANL, BSC, and JSC. It focuses on software challenges found in extreme scale high-performance computers.

Research areas include:

- Scientific applications (big compute and big data) that are the drivers of the research in the other topics of the joint-laboratory.
- Modeling and optimizing numerical libraries, which are at the heart of many scientific applications.
- Novel programming models and runtime systems, which allow scientific applications to be updated or reimagined to take full advantage of extreme-scale supercomputers.
- Resilience and Fault-tolerance research, which reduces the negative impact when processors, disk drives, or memory fail in supercomputers that have tens or hundreds of thousands of those components.
- I/O and visualization, which are important part of parallel execution for numerical silulations and data analytics
- HPC Clouds, that may execute a portion of the HPC workload in the near future.

Several members of the ROMA team are involved in the JLESC joint lab through their research on resilience. Yves Robert is the scientific representant of Inria in JLESC.

8.3.2. Inria Associate Teams

The ALOHA associate-team is a joint project of the ROMA team and of the Information and Computer science Department of the University of Hawai'i (UH) at Mānoa, Honolulu, USA. Building on a vast array of theoretical techniques and expertise developed in the field of parallel and distributed computing, and more particularly application *scheduling*, we tackle database questions from a fresh perspective. To this end, this proposal includes:

- a group that specializes in database systems research and who has both industrial and academic experience, the group of Lipyeow Lim (UH);
- a group that specializes in practical aspects of scheduling problems and in simulation for emerging platforms and applications, and who has a long experience of multidisciplinary research, the group of Henri Casanova (UH);
- a group that specializes in the theoretical aspects of scheduling problems and resource management (the ROMA team).

The research work focuses on the following three thrusts:

1. Online, multi-criteria query optimization
2. Fault-Tolerance for distributed databases
3. Query scheduling for distributed databases

8.4. International Research Visitors

8.4.1. Visits to International Teams

8.4.1.1. Research stays abroad

Yves Robert has been appointed as a visiting scientist by the ICL laboratory (headed by Jack Dongarra) at the University of Tennessee Knoxville. He collaborates with several ICL researchers on high-performance linear algebra and resilience methods at scale.

<p align="center" style="color:red">RUNTIME Team</p>

8. Partnerships and Cooperations

8.1. Regional Initiatives

REGION AQUITAINE   The Aquitaine Region Council is granting the PhD thesis of Andra Hugo about Composability of parallel software over hybrid architectures, from september 2011 to august 2014. REGION AQUITAINE

The Aquitaine Region Council is granting the PhD thesis of Bertrand Putigny about Performance Models for Heterogeneous Parallel Architectures.

REGION AQUITAINE - CEA   The Aquitaine Region Council together with CEA is funding PhD thesis of Marc Sergent (2013-2016) on Scalability for Task-based Runtimes (See also Section Bilateral Grants with Industry)

8.2. National Initiatives

8.2.1. ANR

ANR SOLHAR   (http://solhar.gforge.inria.fr/doku.php?id=start).

ANR MONU 2013 Program, 2013 - 2016 (36 months)

Identification: ANR-13-MONU-0007

Coordinator: Inria Bordeaux/LaBRI

Other partners: CNRS-IRIT, Inria-LIP Lyon, CEA/CESTA, EADS-IW

Abstract: This project aims at studying and designing algorithms and parallel programming models for implementing direct methods for the solution of sparse linear systems on emerging computers equipped with accelerators. The ultimate aim of this project is to achieve the implementation of a software package providing a solver based on direct methods for sparse linear systems of equations. Several attempts have been made to accomplish the porting of these methods on such architectures; the proposed approaches are mostly based on a simple offloading of some computational tasks (the coarsest grained ones) to the accelerators and rely on fine hand-tuning of the code and accurate performance modeling to achieve efficiency. This project proposes an innovative approach which relies on the efficiency and portability of runtime systems, such as the StarPU tool developed in the runtime team (Bordeaux). Although the SOLHAR project will focus on heterogeneous computers equipped with GPUs due to their wide availability and affordable cost, the research accomplished on algorithms, methods and programming models will be readily applicable to other accelerator devices such as ClearSpeed boards or Cell processors.

ANR Songs   Simulation of next generation systems (http://infra-songs.gforge.inria.fr/).

ANR INFRA 2011, 01/2012 - 12/2015 (48 months)

Identification: ANR-11INFR01306

Coordinator: Martin Quinson (Inria Nancy)

Other partners: Inria Nancy, Inria Rhône-Alpes, IN2P3, LSIIT, Inria Rennes, I3S.

Abstract: The goal of the SONGS project is to extend the applicability of the SIMGRID simulation framework from Grids and Peer-to-Peer systems to Clouds and High Performance Computation systems. Each type of large-scale computing system will be addressed through a set of use cases and lead by researchers recognized as experts in this area.

ANR MOEBUS   Scheduling in HPC (http://moebus.gforge.inria.fr/doku.php).

ANR INFRA 2013, 10/2013 - 9/2017 (48 months)

Coordinator: Denis Trystram (Inria Rhône-Alpes)

Other partners: Inria Bordeaux.

Abstract: This project focuses on the efficient execution of parallel applications submitted by various users and sharing resources in large-scale high-performance computing environments

8.2.2. ADT - Inria Technological Development Actions

ADT K'Star   (http://kstar.gforge.inria.fr/#!index.md)
Participants: Olivier Aumage, Nathalie Furmento, Samuel Pitoiset, Samuel Thibault.

Inria ADT Campaign 2013, 10/2013 - 9/2015 (24 months)

Coordinator: Thierry Gautier (team MOAIS, Inria Montbonnot) and Olivier Aumage (team RUNTIME, Inria Bordeaux - Sud-Ouest)

Abstract: The Inria action ADT K'Star is a joint effort from Inria teams MOAIS and RUNTIME to design the KLANG-OMP source-to-source OpenMP compiler to translate OpenMP directives into calls to the API of MOAIS and RUNTIME respective runtime systems (XKaapi for MOAIS, StarPU for RUNTIME).

8.2.3. IPL - Inria Project Lab

C2S@Exa - Computer and Computational Sciences at Exascale   **Participant:** Olivier Aumage.

Inria IPL 2013 - 2017 (48 months)

Coordinator: Stéphane Lantéri (team Nachos, Inria Sophia)

Since January 2013, the team is participating to the C2S@Exa http://www-sop.inria.fr/c2s_at_exa Inria Project Lab (IPL). This national initiative aims at the development of numerical modeling methodologies that fully exploit the processing capabilities of modern massively parallel architectures in the context of a number of selected applications related to important scientific and technological challenges for the quality and the security of life in our society. This collaborative effort involves computer scientists that are experts of programming models, environments and tools for harnessing massively parallel systems, algorithmists that propose algorithms and contribute to generic libraries and core solvers in order to take benefit from all the parallelism levels with the main goal of optimal scaling on very large numbers of computing entities and, numerical mathematicians that are studying numerical schemes and scalable solvers for systems of partial differential equations in view of the simulation of very large-scale problems.

MULTICORE - Large scale multicore virtualization for performance scaling and portability
Participants: Emmanuel Jeannot, Denis Barthou [RUNTIME project-team, Inria Bordeaux - Sud-Ouest].

Multicore processors are becoming the norm in most computing systems. However supporting them in an efficient way is still a scientific challenge. This large-scale initiative introduces a novel approach based on virtualization and dynamicity, in order to mask hardware heterogeneity, and to let performance scale with the number and nature of cores. It aims to build collaborative virtualization mechanisms that achieve essential tasks related to parallel execution and data management. We want to unify the analysis and transformation processes of programs and accompanying data into one unique virtual machine. We hope delivering a solution for compute-intensive applications running on general-purpose standard computers.

8.3. European Initiatives

8.3.1. FP7 & H2020 Projects

8.3.1.1. Mont-Blanc 2

Type: FP7

Defi: Special action

Instrument: Integrated Project

Objectif: Exascale computing platforms, software and applications

Duration: October 2013 - September 2016

Coordinator: Alex Ramirez (UPC)

Partner: UPC,Inria, Bull, ST, ARM, Gnodal, Juelich, BADW-LRZ, HLRS, CNRS, CEA, CINECA, Bristol, Allinea

Inria contact: Denis Barthou

Abstract: The Mont-Blanc project aims to develop a European Exascale approach leveraging on commodity power-efficient embedded technologies. The project has developed a HPC system software stack on ARM, and will deploy the first integrated ARM-based HPC prototype by 2014, and is also working on a set of 11 scientific applications to be ported and tuned to the prototype system. The rapid progress of Mont-Blanc towards defining a scalable power efficient Exascale platform has revealed a number of challenges and opportunities to broaden the scope of investigations and developments. Particularly, the growing interest of the HPC community in accessing the Mont-Blanc platform calls for increased efforts to setup a production-ready environment. The Mont-Blanc 2 proposal has 4 objectives:

- To complement the effort on the Mont-Blanc system software stack, with emphasis on programmer tools (debugger, performance analysis), system resiliency (from applications to architecture support), and ARM 64-bit support

- To produce a first definition of the Mont-Blanc Exascale architecture, exploring different alternatives for the compute node (from low-power mobile sockets to special-purpose high-end ARM chips), and its implications on the rest of the system

- To track the evolution of ARM-based systems, deploying small cluster systems to test new processors that were not available for the original Mont-Blanc prototype (both mobile processors and ARM server chips)

- To provide continued support for the Mont-Blanc consortium, namely operations of the original Mont-Blanc prototype, the new small scale prototypes and hands-on support for our application developers

Mont-Blanc 2 contributes to the development of extreme scale energy-efficient platforms, with potential for Exascale computing, addressing the challenges of massive parallelism, heterogeneous computing, and resiliency. Mont-Blanc 2 has great potential to create new market opportunities for successful EU technology, by placing embedded architectures in servers and HPC.

8.3.1.2. HPC-GA

Type: FP7

Defi: NC

Instrument: International Research Staff Exchange Scheme

Objectif: NC

Duration: January 2012 - December 2014

Coordinator: Jean-François Méhaut (UJF, France)

Partner: UFRGS, Inria, BRGM, BCAM et UNAM.

Inria contact: Jean-François Mehaut

Abstract: The design and implementation of geophysics applications on top of nowadays super-computers requires a strong expertise in parallel programming and the use of appropriate runtime systems able to efficiently deal with heterogeneous architectures featuring many-core nodes typically equipped with GPU accelerators. The HPC-GA project aims at evaluating the functionalities provided by current runtime systems in order to point out their limitations. It also aims at designing new methods and mechanisms for an efficient scheduling of processes/threads and a clever data distribution on such platforms. The HPC-GA project is unique in gathering an international, pluridisciplinary consortium of leading European and South American researchers featuring complementary expertise to face the challenge of designing high performance geophysics simulations for parallel architectures.

8.3.2. Collaborations in European Programs, except FP7 & H2020

Program: **ITEA2**

Project acronym: COLOC

Project title: The Concurrency and Locality Challenge

Duration: November 2014 - November 2017

Coordinator: BULL

Other partners: BULL SA (France); Dassault Aviation (France) ; Enfeild AB (Sweden); Scilab entreprise (France); Teratec (France); Inria (France); Swedish Defebnse Research Agency - FOI (France); UVSQ (France).

Abstract: The COLOC project aims at providing new models, mechanisms and tools for improving applications performance and supercomputer resources usage taking into account data locality and concurrency.

——

Program: **COST**

Project acronym: NESUS

Project title:Network for Ultrascale Computing

Duration: April 2014 - April 2018

Coordinator: University Carlos III de Madrid

Other partners: More than 35 European Countries.

Abstract: Ultrascale systems are envisioned as large-scale complex systems joining parallel and distributed computing systems that will be two to three orders of magnitude larger that today's systems. The EU is already funding large scale computing systems research, but it is not coordinated across researchers, leading to duplications and inefficiencies. The goal of the NESUS Action is to establish an open European research network targeting sustainable solutions for ultrascale computing aiming at cross fertilization among HPC, large scale distributed systems, and big data management. The network will contribute to glue disparate researchers working across different areas and provide a meeting ground for researchers in these separate areas to exchange ideas, to identify synergies, and to pursue common activities in research topics such as sustainable software solutions (applications and system software stack), data management, energy efficiency, and resilience. Some of the most active research groups of the world in this area are members of this proposal. This Action will increase the value of these groups at the European-level by reducing duplication of efforts and providing a more holistic view to all researchers, it will promote the leadership of Europe, and it will increase their impact on science, economy, and society.

8.4. International Initiatives

8.4.1. Inria International Labs

JLPC   Inria joint-Lab on Extreme Scale Computing:

>   Coordinators: Franck Cappello and Marc Snir.

>   Other partners: Argonne National Lab, Inria, University of Urbanna Champaign, Tokyo Riken, Jülich Supercomputing Center, Barcelona Supercomputing Center.

>   Abstract: The Joint Laboratory is based at Illinois and includes researchers from Inria, and the National Center for Supercomputing Applications, ANL, Riken, Jülich, and BSC. It focuses on software challenges found in extreme scale high-performance computers.

8.4.2. Inria Associate Teams

MORSE   Matrices Over Runtime Systems at Exascale

>   Inria Associate-Teams program: 2011-2016

>   Coordinator: Emmanuel Agullo (Hiepacs)

>   Parners: Inria (Runtime & Hiepacs), University of Tennessee Knoxville, University of Colorado Denver and KAUST.

>   Abstract: The Matrices Over Runtime Systems at Exascale (MORSE) associate team has vocation to design dense and sparse linear algebra methods that achieve the fastest possible time to an accurate solution on large-scale multicore systems with GPU accelerators, using all the processing power that future high end systems can make available. To develop software that will perform well on petascale and exascale systems with thousands of nodes and millions of cores, several daunting challenges have to be overcome both by the numerical linear algebra and the runtime system communities. With Inria Hiepacs, University of Tennessee, Knoxville and University of Colorado, Denver.

8.4.3. Inria International Partners

8.4.3.1. Informal International Partners

We collaborate with the following team.

- INESC-ID, Lisbon, Portugal on appplication moldeling.
- UWLAX (Wisconsin) works with us on network topology modeling;
- we collaborate with ICL at University of Tennessee on instrumenting MPI applications and modeling platforms (works on HWLOC take place in the context of the OPEN MPI consortium) and MPI and process placement
- On the industrial side collaborate with Cisco Systems about network topologies and platform models and Intel on modeling many-core platforms and BULL on memory hierarchy modeling.
- ETH Zurich (Switzerland), on topology mapping;
- PPL (U. Illinois at Urbana Champaign) on topology-aware load-balancing (through the Inria-Urbana-Argonne Joint Lab).
- University of Tokyo and Riken on the adaptation of MPI and runtime systems to MIC processors.
- Oak Ridge National Laboratory on high-performance network programming interfaces.

8.4.4. Participation In other International Programs

ANR-JST FP3C   Framework and Programming for Post Petascale Computing.

>   ANR-JST 2010 Program, 01/09/2010 - 31/03/2014

>   Identification: ANR-10-JST-002

>   Coordinator: Serge Petiton (Inria Saclay)

>   Other partners: CNRS IRIT, CEA DEN Saclay, Inria Bordeaux, CNRS-Prism, Inria Rennes, University of Tsukuba, Tokyo Institute of Technology, University of Tokyo, Kyoto University.

Abstract: Post-petascale systems and future exascale computers are expected to have an ultra large-scale and highly hierarchical architecture with nodes of many-core processors and accelerators. That implies that existing systems, language, programming paradigms and parallel algorithms would have, at best, to be adapted. The overall structure of the FP3C project represents a vertical stack from a high level language for end users to low level architecture considerations, in addition to more horizontal runtime system researches.

SEHLOC   Scheduling evaluation in heterogeneous systems with hwloc

STIC-AmSud 2012 Program, 01/2013 - 12/2014 (24 months)

Coordinator: Brice Goglin

Other Partners: Universidad Nacional de San Luis (Argentina), Universidad de la Repúpublica (Uruguay).

Abstract: This project focuses on the development of runtime systems that combine application characteristics with topology information to automatically offer scheduling hints that try to respect hardware and software affinities. Additionally we want to analyze the convergence of the obtained performance from our algorithms with the recently proposed Multi-BSP model which considers nested levels of computations that correspond to natural layers of nowadays hardware architectures.

NextGN   Preparing for Next Generation Numerical Simulation Platforms

PUF (Partner University Fund) - France USA, 01/2013 - 12-2016 (3 years)

Coordinator: Franck Capello, Marc Snir and Yves Robert

Other Partners: Inria, Argonne National Lab and University of Urbanna Chapaign

This PUF proposal builds on the existing successful joint laboratory between Inria and UIUC that has produced in past three years and half many top-level publications, some of which resulted in student awards; and several software packages that are making their way to production in Europe and USA. The proposal extends the collaboration to Argonne National Laboratory (ANL) and CNRS researchers who will bring their unique expertise and their skills to help addressing the scalability issue of simulation platforms.

8.5. International Research Visitors

8.5.1. Visits of International Scientists

8.5.1.1. Internships

- Malik Muhammad Zaki Murtaza Khan from Dept. of Computer and Information Science (IDI), Norwegian University of Science and Technology, Trondheim, Norway visited us for one week in October.

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

7. Partnerships and Cooperations

7.1. National Initiatives

7.1.1. Investissements d'avenir

CLAIRE

> Title: Community Learning through Adaptive and Interactive multichannel Resources for Education
>
> Call: Technologies for e-education
>
> Duration: March 2012 - February 2014
>
> Coordinator: OpenClassrooms, ex-SimpleIT
>
> Others partners: LIRIS
>
> See also: http://www.projet-claire.fr/
>
> Abstract: Project CLAIRE aims at developing an open-source tool for collaborative authoring in an e-learning environment (Learning Content Management System), targeting teachers and students in high-school and universities. Its innovative features include:
>
> - a platform for collaborative structured editing of rich media and "semantic" content, e.g.: tools for chaptering video, and for generating interactive evaluation tests
> - processes for continuous enhancement of content, e.g.: social annotation, behaviour analysis, accessible multi-support publishing, e.g.: web, PDF, ODT, LaTeX, smartphones, tablets.

Datalyse

> Title: Entrepôt Intelligent pour Big Data hétérogènes. Investissements d'Avenir Développement de l'Economie Numérique.
>
> Call: Cloud Computing, num 3 – Big Data.
>
> Duration: May 2013 - November 2016
>
> Coordinator: Business & Decision Eolas
>
> Others partners: Groupement des Mousquetaires, Inria Saclay (OAK EPC), LIG (Hadas and Erods teams), LIRMM (Montpellier), LIFL (Lille).
>
> See also: http://www.datalyse.fr/
>
> Abstract: Project Datalyse aims at designing and deploying an infrastructure for big data storage, collection, certification, integration, categorisation, enrichment and sharing over very large heterogeneous data sets. It relies on an industrial platform, to be made available on the cloud, and focuses on three flagship applications, showcasing three uses of big data over different data sets:
>
> - Data-Center Monitoring: The goal of this application is to provide features such as traceability, reporting, optimisation and analysis of abnormal behaviour regarding energy efficiency and security issues. The application will be built with an existing application called ScopeBR (Eolas) and will be deployed in two different green data centers, those of Eolas and GDF SUEZ.
> - "Territoire de données ouvertes et liées": This application aims at extracting and provisioning public open data collected from the city of Grenoble and its suburbs. The goal is to make public data available to third-party application developers and to federate local actors around a single platform.
> - Real-time Business Intelligence for the management and processing of points of sale: this application will focus on real-time data analytics and will be deployed within "Groupement des Mousquetaires" in support of their business intelligence platforms.

7.1.2. ANR

Typex

Title: Typeful certified XML: integrating language, logic, and data-oriented best practices
Call: Programme Blanc
Duration: January 2012 - December 2014
Coordinator: PPS (CNRS - Paris 7 Diderot)
Others partners: LRI (Orsay)
See also: http://typex.lri.fr
Abstract: The highly ambitious and final goal of this project is to produce a new generation of XML programming languages stemming from the synergy of integrating three approaches into a unique framework:

- a logical approach based on solvers
- a programming language (PL) approach
- a data-oriented approach

These languages will feature precise and polymorphic type systems that merge PL typing techniques with logical-solver-based type inference. They will be implemented efficiently using the latest research on tree automata and formally certified using modern theorem prover technology. They will offer the capacity to specify and formally verify invariants, business rules, and data integrity, and will have a direct and immediate impact on standardization processes.

7.2. European Initiatives

7.2.1. FP7 & H2020 Projects

VENTURI

Title: immersiVe ENhancemenT of User-woRld Interactions
Type: Cooperation (ICT)
Call: FP7-ICT-20111.5 Networked Media and Search Systems
Instrument: Specific Targeted Research Project (STREP)
Duration: October 2011 - September 2014
Coordinator: Fondazione Bruno Kessler (Italy)
Others partners: Fraunhofer Heinrich Hertz Institute (Germany), ST Microelectronics (Italy), ST-Ericsson (France), Metaio (Germany), e-Diam Interactive (Spain), Sony-Ericsson (Sweden)
See also: https://venturi.fbk.eu/
Abstract: Venturi aims to create a pervasive Augmented Reality paradigm, where available information will be presented in a user- rather than device-specific way. The goal is to create an experience that is always present whilst never obstructing. Venturi will exploit, optimize and extend current and next generation mobile platforms; verifying platform and QoE performance through life-enriching use cases and applications to ensure device-to-user continuity.

7.3. International Research Visitors

7.3.1. Visits of International Scientists

Prof. Boualem Benatallah, Professor at the School of Computer Science and Engineering (CSE), the University of New South Wales (UNSW) in Sydney, Australia, visited our group for one week in July 2014. The goal of this visit was to initiate common work on the formal verification of web services orchestration and verified API-driven web programming.

7.3.1.1. Internships

Martì Bosch Padros from Universitat Politècnica de Catalunya (UPC) Spain spent six months in the team to work on Automated Refactoring for Size Reduction of CSS Style Sheets.

Joel Ferreira Dos Santos from Universidade Federal Fluminense, UFF, Brasil is spending a one year sandwich PhD in the team to work on the formal verification of multimedia presentations.

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

8. Partnerships and Cooperations

8.1. Regional Initiatives

8.1.1. *Competitiveness cluster Images-et-Reseaux*

8.1.1.1. EcoCloud

Participant: Jean-Marc Menaud.

The project EcoCloud is a cooperative research project running for 2 years. Three other partners collaborate within the project that is coordinated by the company EasyVirt: the Ascola team and another company Pentasonic. The partners aim at developing an economically-valid and ecologic cloud platform in the context of micro and mono-site data centers (all resources are in the same physical location). A high SLA level must be provided with a specific focus on high availability satisfying strong redundancy and placement constraints.

8.2. National Initiatives

8.2.1. *CominLabs laboratory of excellence*

8.2.1.1. EPOC

Participants: Jean-Marc Menaud [coordinator], Thomas Ledoux.

The project EPOC (Energy Proportional and Opportunistic Computing system) is an (academic) Labex CominLabs project running for 4 years. Four other partners collaborate within the project that is coordinated by ASCOLA: Myriads team, and the three institutions ENIB, ENSTB and University of Nantes. In this project, the partners focus on energy-aware task execution from the hardware to application's components in the context of a *mono-site* data center (all resources are in the same physical location) which is connected to the *regular electric Grid and to renewable energy sources* (such as windmills or solar cells). Three major challenges are addressed in this context: Optimize the energy consumption of distributed infrastructures and service compositions in the presence of ever more dynamic service applications and ever more stringent availability requirements for services; Design a clever cloud's resource management which takes advantage of renewable energy availability to perform opportunistic tasks, then exploring the trade-off between energy saving and performance aspects in large-scale distributed system; Investigate energy-aware optical ultra high-speed interconnection networks to exchange large volumes of data (VM memory and storage) over very short periods of time.

One of the strengths of the project is to provide a systematic approach, and use a single model for the system (from hard to soft) by mixing constraint programming and behavioral models to manage energy consumption in data centers.

This year, we have proposed a Cloud energy broker [26], which can adjust the availability and price combination to buy Green energy dynamically from the market to make datacenter green.

8.2.1.2. SecCloud

Participants: Jacques Noyé [coordinator], Florent Marchand de Kerchove de Denterghem, Mario Südholt.

The high-level objective of the 3-year SecCloud (Secure Scripting for the Cloud) project is to enhance the security of devices on which web applications can be downloaded, i.e. to enhance client-side security in the context of the Cloud. In order to do so, the project relies on a language-based approach, focusing on three related issues:

- The definition of security policies for web architectures, especially on the client-side.
- Formally-proven analyses of web programming languages.
- Multi-level enforcement mechanisms for the security policies (based on static and dynamic analysis encompassing application-level and system-level software).

ASCOLA members are mainly interested in JavaScript as a programming language as well as the use of aspects as a seamless path from the definition of security policies and their composition to their implementation.

This year we have investigated how to extend real-world Javascript environments, such as Narcissus in a modular way.

8.2.2. ANR

8.2.2.1. MyCloud (ANR/ARPEGE)

Participants: Thomas Ledoux [coordinator], Jean-Marc Menaud, Yousri Kouki.

The MyCloud project is an ANR/ARPEGE project running for 42 months, starting in Nov. 2010. It was accepted in Jul. 2010 for funding amounting to 190 KEUR (ASCOLA only). MyCloud involves a consortium with three academic partners (Inria, LIP6, EMN) and one industrial partner (We Are Cloud).

Cloud Computing provides a convenient means of remote on-demand and pay-per-use access to computing resources. However, its ad-hoc management of quality-of-service (QoS) and SLA poses significant challenges to the performance, dependability and costs of online cloud services.

The objective of MyCloud (http://mycloud.inrialpes.fr) is to define and implement a novel cloud model: SLAaaS (SLA as a Service). The SLAaaS model enriches the general paradigm of Cloud Computing and enables systematic and transparent integration of SLA to the cloud. From the cloud provider's point of view, MyCloud proposes autonomic SLA management to handle performance, availability, energy and cost issues in the cloud. From the cloud customer's point of view, MyCloud provides SLA governance allowing cloud customers to be part of the loop and to be automatically notified about the state of the cloud, such as SLA violation and cloud energy consumption.

The project ended in April 2014. This year, our main contribution is a new system for the specification of service-level agreements in the Cloud presented at the IEEE/ACM CCGrid conference [27].

8.2.2.2. SONGS (ANR/INFRA)

Participants: Adrien Lebre [coordinator], Flavien Quesnel, Jonathan Pastor.

The SONGS project (Simulation of Next Generation Systems) is an ANR/INFRA project running for 48 months (starting in January 2012 with an allocated budget of 1.8MEuro, 95KEuro for ASCOLA).

The consortium is composed of 11 academic partners from Nancy (AlGorille, coordinator), Grenoble (MESCAL), Villeurbanne (IN2P3 Computing Center, GRAAL/Avalon - LIP), Bordeaux (CEPAGE, HiePACS, RUNTIME), Strasbourg (ICPS - LSIIT), Nantes (ASCOLA), Nice (MASCOTTE, MODALIS).

The goal of the SONGS project (http://infra-songs.gforge.inria.fr) is to extend the applicability of the SimGrid simulation framework from Grids and Peer-to-Peer systems to Clouds and High Performance Computation systems.

8.2.3. FSN

8.2.3.1. OpenCloudware (FSN)

Participants: Jean-Marc Menaud [coordinator], Thomas Ledoux, Yousri Kouki.

The OpenCloudware project is coordinated by France Telecom, funded by the French Fonds National pour la Société Numérique (FSN, call Cloud n°1) and endorsed by competitiveness clusters Minalogic, Systematic and SCS. OpenCloudware is developed by a consortium of 18 partners bringing together industry and academic leaders, innovative technology start-ups and open source community expertise. Duration: 36 months - 2012–2014.

The OpenCloudware project aims at building an open software engineering platform, for the collaborative development of distributed applications to be deployed on multiple Cloud infrastructures. It will be available through a self-service portal. We target virtualized multi-tier applications such as JavaEE - OSGi. The results of OpenCloudware will contain a set of software components to manage the lifecycle of such applications, from modelling(Think), developing and building images (Build), to a multi-IaaS compliant PaaS platform (Run).

The ASCOLA project-team is mainly involved in the sub-projects "Think" (SLA model across Cloud layers) and "Run" (virtual machine manager for datacenters and placement constraints). In 2013, the team has developed btrCloudStack, a private cloud based on the OpenSource CloudStack and integrating the work on placement rules and energy optimization.

8.3. European Initiatives

8.3.1. FP7 & H2020 Projects

8.3.1.1. ERC Starting Grant: The CoqHoTT project
Participant: Nicolas Tabareau [coordinator].

CoqHoTT stands for Coq for Homotopy Type Theory. The goal of this project is to go further in the correspondence between proofs and programs which has allowed in the last 20 years the development of useful proof assistants, such as Coq (developed by Inria). This project starts from the recent discovery by field medal Vladimir Voevosdky, of the strong link between homotopy theory (which studies the notion of continuous deformation in topology) and type theory (which is at the heart of the Coq proof assistant). The main goal of the CoqHoTT project is to provide a new generation of proof assistants based on this fascinating connection.

The CoqHoTT project should starts on March 2015 with a budget of 1,5M€.

8.3.1.2. A4Cloud (IP)
Participants: Mario Südholt [coordinator], Walid Benghabrit, Ronan-Alexandre Cherrueau, Rémi Douence, Hervé Grall, Jean-Claude Royer, Mohamed Sellami.

The integrated project "Accountability for the Cloud" (A4Cloud) is coordinated by HP Labs, UK, and fosters cooperation of a consortium of five industrial and eight academic partners. It has been started in Oct. 2012 for a duration of 42 months.

A4Cloud focuses on accountability properties for the cloud and other future internet services as the most critical prerequisite for effective governance and control of corporate and private data processed by cloud-based IT services. The research being conducted in the project will increase trust in cloud computing by devising methods and tools, through which cloud stakeholders can be made accountable for the privacy and confidentiality of information held in the cloud. These methods and tools will combine risk analysis, policy enforcement, monitoring and compliance auditing. They will contribute to the governance of cloud activities, providing transparency and assisting legal, regulatory and socio-economic policy enforcement. For further information, see http://www.a4cloud.eu. ASCOLA, whose financial support consists of 550 K€, is mainly involved in the sub-projects on the enforcement of accountability and security policies, as well as tool validation efforts.

This year we have proposed new logic-based and language-level means for the formal specification and implementation of accountability properties (see 6.3).

8.4. International Initiatives

8.4.1. Inria Associate Teams

8.4.1.1. REAL

Title: Reasoning about Aspect-oriented Programs and security In Distributed Systems

International Partner (Institution - Laboratory - Researcher):

Universidad de Chile (CHILI)

Duration: 2010-2016

See also: http://real.gforge.inria.fr

While Aspect-Oriented Programming offers promising mechanisms for enhancing the modularity of software, this increased modularity raises new challenges for systematic reasoning. This project studies means to address fundamental and practical issues in understanding distributed aspect-oriented programs by focusing on the issue of security. To this end, the project tackles three complementary lines of work: 1. Designing a core calculus to model distributed aspect-oriented programming languages and reason about programs written in these languages. 2. Studying how aspects can be used to enforce security properties in a distributed system, based upon guarantees provided by the underlying aspect infrastructure. 3. Designing and developing languages, analyses and runtime systems for distributed aspects based on the proposed calculus, therefore enabling systematic reasoning about security. These lines of work are interconnected and confluent. A concrete outcome of RAPIDS will be prototypes for two concrete distributed aspect-oriented extensions of languages increasingly used by current practitioners: Javascript and Java/Scala.

8.4.2. Inria International Partners

8.4.2.1. Informal International Partners

Apart from the Inria associate team rapids with the Pleiad group (Prof. Éric Tanter) at U. Chile, the Ascola team has formalized cooperations, notably in the context of co-financed and co-supervised PhD theses with the PROG group (Prof. Wofgang de Meuter) at VU Brussel, Belgium, and the Software Technology group (Prof. Mira Mezini) at TU Darmstadt, Germany.

Furthermore, the Ascola team has long-term cooperations that resulted in common results in 2014, typically joint publications or common software artifacts, with partners from the AIST research institute (Dr. Takahiro Hirofuchi) and U. of Bogota, Colombia (Prof. Rubby Casallas).

8.5. International Research Visitors

8.5.1. Visits of International Scientists

8.5.1.1. Internships

Gustavo Soto Ridd has done an Inria master internship advised by Nicolas Tabareau from August to November 2014. The goal of the internship was to go beyond the work on aspectual session types 6.4 .

8.5.1.2. Researchers

Dr. Takahiro Hirofuchi, Researcher at AIST (Japan) spent one week in June 2014 to prepare a journal submission related to the Virtualization extensions we made in 2013 in Simgrid. The article is under review.

<p style="text-align:center;color:red;font-weight:bold;">DIVERSE Project-Team</p>

8. Partnerships and Cooperations

8.1. Regional Initiatives

We obtained a grant from the Britany region, within the plan of action SAD (for "Stratégie d'attractivité durable"). The VIP project (for "Visualisation Interactive de produits dans les configurateurs") aims to investigate software product line techniques. We have recruited Dr. Jin Kin (post-doc for a duration of 18 months, starting in december 2014) in collaboration with the ESTASYS team.

8.2. National Initiatives

8.2.1. ANR

8.2.1.1. ANR GEMOC

- Coordinator: Inria (DIVERSE)
- Other partners: ENSTA Bretagne, Inria, IRIT, I3S, Obeo, Thales
- Dates: 2012-2016
- Abstract: GEMOC focuses on a generic framework for heterogeneous software model execution and dynamic analysis. This work has the ambition to propose an innovative environment for the design of complex software-intensive systems by providing: a formal framework that integrates state-of-the-art in model-driven engineering (MDE) to build domain-specific modeling languages (DSMLs), and models of computation (MoC) to reason over the composition of heterogeneous concerns; an open-source design and modeling environment associated to a well-defined method for the definition of DSMLs, MoCs and rigorous composition of all concerns for execution and analysis purposes.

  This requires addressing two major scientific issues: the design and verification of a formal framework to combine several different DSMLs relying on distinct MoCs; the design and validation of a methodology for DSMLs and MoC development. GEMOC aims at participating in the development of next generation MDE environments through a rigorous, tool-supported process for the definition of executable DSMLs and the simulation of heterogeneous models.

8.2.1.2. ANR INFRA-JVM

- Coordinator: Université Paris 6
- Other partners: Université Bordeaux 1, Université Rennes 1 (DIVERSE), Ecole des Mines de Nantes
- Dates: 2012-2015
- Abstract: INFRA-JVM is an ANR project whose goal is to design and provide a new Java Virtual Machine dedicated to pervasive environments. This project focuses on designing a Java Virtual Machine for embedded computing platform offering dynamic reconfiguration capabilities. In this context, DIVERSEaddresses the problem of efficiently identifying faulty software components running simultaneously in a virtual machine without isolation. Current solutions that perform permanent and extensive monitoring to detect anomalies induce very high overhead on the system, and can, by themselves, make the system unstable. Our main objective is to investigate an optimistic adaptive monitoring system using models@runtime to determine the faulty components of an application.

8.2.1.3. SOPRANO

- Coordinator: CEA
- CEA, University of Paris-Sud, Inria Rennes, OcamlPro, Adacore

- Dates: 2014-2017
- Abstract: Today most major verification approaches rely on automatic external solvers. However these solvers do not fill the current and future needs for verification: lack of satisfying model generation, lack of reasoning on difficult theories (e.g. floating-point arithmetic), lack of extensibility for specific or new needs. The SOPRANO project aims at solving these problems and prepare the next generation of verification-oriented solvers by gathering experts from academia and industry. We will design a new framework for the cooperation of solvers, focused on model generation and borrowing principles from SMT (current standard) and CP (well-known in optimisation). These ideas will be implemented in an open-source platform, with regular evaluations from the industrial partners.

8.2.2. BGLE / LEOC

8.2.2.1. BGLE2 CONNEXION

- Coordinator: EDF
- Other partners: Atos WorldGrid, Rolls-Royce Civil Nuclear, Corys TESS, Esterel Technologies, All4Tec, Predict, CEA, Inria, CNRS / CRAN, ENS Cachan, LIG, Telecom ParisTech
- Dates: 2012-2016
- Abstract: The cluster CONNEXION (*digital command CONntrol for Nuclear EXport and renovatION*) aims to propose and validate an innovative architecture platforms suitable control systems for nuclear power plants in France and abroad. In this project the Triskell team investigates methods and tools to (i) automatically analyze and compare regulatory requirements evolutions and geographical differences; (ii) automatically generate test cases for critical interactive systems.

8.2.2.2. LEOC CLARITY

- Coordinator: Obéo
- Other partners: AIRBUS, Airbus Defence and Space, All4tec, ALTRAN Technologies, AREVA, Artal, C.E.S.A.M.E.S., Eclipse Foundation Europe, Inria Sophia Antipolis Méditerranée, PRFC, Scilab Enterprises, Thales Global Services, Thales Alenia Space, Thales Research & Technology, Thales Systèmes Aéroportés, Université de Rennes 1.
- Dates: 2014-2017
- Abstract: The CLARITY project aims to establish an international dimension ecosystem around Melody/Capella modeling workbench for systems engineering (MBSE) and engineering architectures (system, software, hardware).

8.2.2.3. Occiware

- Coordinator: Open Wide
- Open Wide, ActiveEon SA, CSRT - Cloud Systèmes Réseaux et Télécoms, Institut Mines-Télécom/Télécom SudParis, Inria, Linagora, Obeo, OW2 Consortium, Pôle Numérique, Université Joseph Fourier,
- Dates: 2014-2017
- Abstract: The Occiware project aims to establish a formal and equipped framework for the management of all cloud resource based on the OCCI standard.

8.2.3. DGA

8.2.3.1. DGA-RAPID MOTIV

- Coordinator: InPixal
- Other partners: Bertin, DGA, Inria
- Dates: 2012-2014

- Abstract: This project investigates innovative software test generation and management solutions to handle the very high degrees of variability in video processing algorithmic chains. The objective is to provide systematic criteria to qualify the testing activity when developing video processing software and to tailor these criteria to the variability dimensions that emerge in the context of visible images.

8.2.3.2. DGA FPML

- Coordinator: DGA
- Partners: DGA MI, Inria
- Dates: 2014-2016
- Abstract: in the context of this project, DGA-MI and the Inria team DiverSE explore the existing approaches to ease the development of formal specifications of domain-Specific Languages (DSLs) dedicated to paquet filtering, while guaranteeing expressiveness, precision and safety. In the long term, this work is part of the trend to provide to DGA-MI and its partners a tooling to design and develop formal DSLs which ease the use while ensuring a high level of reasoning.

8.3. European Initiatives

8.3.1. FP7 & H2020 Projects

8.3.1.1. FP7 FET STREP DIVERSIFY

- Coordinator: Inria (DIVERSE)
- Other partners: SINTEF, Université de Rennes 1, Trinity College Dublin
- Dates: 2013-2016
- Abstract: DIVERSIFY explores diversity as the foundation for a novel software design principle and increased adaptive capacities in CASs. Higher levels of diversity in the system provide a pool of software solutions that can eventually be used to adapt to unforeseen situations at design time. The scientific development of DIVERSIFY is based on a strong analogy with ecological systems, biodiversity, and evolutionary ecology. DIVERSIFY brings together researchers from the domains of software-intensive distributed systems and ecology in order to translate ecological concepts and processes into software design principles.

8.3.1.2. FP7 NoE NESSoS

- Coordinator: CNR - Consiglio Nazionale delle Ricerche (Italy)
- Others partners: ATOS (Spain), ETH (Switzerland), Katholieke Universiteit Leuven (Belgium), Ludwig-Maximilians-Universitaet Muenchen (Germany), IMDEA (Spain), Inria (France), University of Duisburg-Essen (Germany), University of Malaga (Spain), University of Trento (Italy), SIEMENS (Germany), SINTEF (Norway)
- Dates: 2010-2014
- Abstract: The Network of Excellence on Engineering Secure Future Internet Software Services and Systems (NESSoS) aims at constituting and integrating a long lasting research community on engineering secure software-based services and systems. In light of the unique security requirements the Future Internet will expose, new results will be achieved by means of an integrated research, as to improve the necessary assurance level and to address risk and cost during the software development cycle in order to prioritize and manage investments. NESSoS will also impact training and education activities in Europe to grow a new generation of skilled researchers and practitioners in the area. NESSoS will collaborate with industrial stakeholders to improve the industry best practices and support a rapid growth of software-based service systems in the Future Internet.

  Three Inria EPIs are involved in NeSSoS: ARLES, CASSIS and Triskell. Triskell leads the research workpackage on design and architecture for secured future internet applications.

8.3.1.3. FP7 Marie-Curie Relate

- Coordinator: Karlsruhe Institute of Technology
- Other partners: Université de Rennes, IRISA (France); King's College (UK); South East European Research Center, SEERC (Greece); Charles University (Czech Republic); CAS Software (Germany); Singular Logic (Greece)
- Dates: 2011-2015
- Abstract: The RELATE Initial Training Network aims to establish a network of international academic and industrial partners for a joint research training effort in the area of engineering and provisioning service-based cloud applications. The training is intended to not only shape high-level academic researchers, but also educate next generation experts and innovators in the European software industry. Through an integrative and multidisciplinary research approach, RELATE aims to promote the advancement of the state of the art in the related areas of model-driven engineering and formal methods, service-based mash-ups and application integration, security, performance, and trust in service-based cloud applications, and quality management and business model innovation.

8.3.1.4. FP7 STREP HEADS

- Coordinator: SINTEF
- Other partners: Inria, Software AG, ATC, Tellu, eZmonitoring
- Dates: 2013-2016
- Abstract: The idea of the HEADS project is to leverage model-driven software engineering and generative programming techniques to provide a new integrated software engineering approach which allow advanced exploitation the full range of diversity and specificity of the future computing continuum. The goal is to empower the software and services industry to better take advantage of the opportunities of the future computing continuum and to effectively provide new innovative services that are seamlessly integrated to the physical world making them more pervasive, more robust, more reactive and closer (physically, socially, emotionally, etc.) to their users. We denote such services HD-services. HD-services (Heterogeneous and Distributed services) characterize the class of services or applications within the Future Internet whose logic and value emerges from a set of communicating software components distributed on a heterogeneous computing continuum from clouds to mobile devices, sensors and/or smart-objects.

8.3.2. Collaborations in European Programs, except FP7 & H2020

8.3.2.1. ICT COST Action MPM4CPS (IC1404)

- Chair of the Action: Prof Hans Vangheluwe (BE)
- Dates: 2014-2018
- Abstract: Truly complex, designed systems, known as Cyber Physical Systems (CPS), are emerging that integrate physical, software, and network aspects. To date, no unifying theory nor systematic design methods, techniques and tools exist for such systems. Individual (mechanical, electrical, network or software) engineering disciplines only offer partial solutions. Multi-paradigm Modelling (MPM) proposes to model every part and aspect of a system explicitly, at the most appropriate level(s) of abstraction, using the most appropriate modelling formalism(s). Modelling languages' engineering, including model transformation, and the study of their semantics, are used to realize MPM. MPM is seen as an effective answer to the challenges of designing CPS. This COST Action promotes the sharing of foundations, techniques and tools, and provide educational resources, to both academia and industry. This is achieved by bringing together and disseminating knowledge and experiments on CPS problems and MPM solutions.

8.3.3. Industry-driven EU projects

8.3.3.1. ITEA MERGE

- Coordinator: Thales Research and Technology

- Other partners: Thales Global Services, Thales Communications and Security, OBEO, ALL4TEC, Onera, Inria, Université Paris VI, Codenomicon, STUK - Radiation and Nuclear Safety Authority, POHTOnSense Oy, University of Oulu, University of Jyvaskyla, Space Applications Services NV, Melexis, E2S, Katholieke Universiteit Leuven
- Dates: 2012-2015
- Abstract: MERgE stands for "Multi-Concerns Interactions System Engineering". Within the "Engineering support" theme of ITEA2 roadmap, the purpose of this project is to develop and demonstrate innovative concepts and design tools addressing in combination the "Safety" and "Security" concerns, targeting the elaboration of effective architectural solutions. MERgE will provide tools and solutions for combining safety and security concerns in systems development in a holistic way. It will provide academically solid and practice proven solutions and models for system developers and system owners to tackle the challenges of designing seamless optimal cost effective safe and secure solutions conformant to the model driven engineering paradigm. This will be done by tightly integrating the following paradigms: requirement engineering, safety, security and risk management in an over-all design process which is supported by adequate tools and methods. MERgE aims to bring a system engineering solution for Combined Safe & Secure system design. The main technical innovation of the project is the application of state of the art design tools tailorisation capabilities and "multi concern engineering" core technologies to the issue of interactions of "Safety" and "Security" concerns as well as other concerns like "Performance" or "Timing" in the design process.

8.3.4. Collaborations with Major European Organizations

SINTEF, ICT (Norway): Model-driven systems development for the construction of distributed, heterogeneous applications. We collaborate since 2008 and are currently in two FP7 projects together.

Université du Luxembourg, (Luxembourg): Models@runtime for dynamic adaptation and multi-objective elasticity in cloud management; model-driven development.

Open University (UK): models@runtime for the Internet of Things.

8.4. International Initiatives

8.4.1. Inria International Partners

8.4.1.1. Declared Inria International Partners

8.4.1.1.1. Inria International Chair

Prof. Robert B. France [0] was granted by an Inria international chair for the period 2013-2017. Prof. France collaborate intensively with many members of DIVERSE on various joint work, e.g., the Familiar project and the GEMOC initiative. The Inria International Chair allows Prof. France to visit once a year the team along the period.

8.4.1.2. Informal International Partners

- Université de Montréal (Canada)
- McGill University (Canada)
- University of Alabama (USA)

8.4.2. International initiative GEMOC

The GEMOC initiative (cf. http://www.gemoc.org) is an open and international initiative launched in 2013 that coordinate research partners worldwide to develop breakthrough software language engineering (SLE) approaches that support global software engineering through the use of multiple domain-specific languages. GEMOC members aim to provide effective SLE solutions to problems associated with the design and implementation of collaborative, interoperable and composable modeling languages.

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[0]Colorado State University, USA. See. http://www.cs.colostate.edu/~france/

The GEMOC initiative aims to provide a framework that facilitates collaborative work on the challenges of using of multiple domain-specific languages in software development projects. The framework consists of mechanisms for coordinating the work of members, and for disseminating research results and other related information on GEMOC activities. The framework also provides the required infrastructure for sharing artifacts produced by members, including publications, case studies, and tools.

The governance of the GEMOC initiative is ensured by the Advisory Board. The role of the Advisory Board is to coordinate the GEMOC work and to ensure proper dissemination of work products and information about GEMOC events (e.g., meetings, workshops).

Benoit Combemale is the co-founder and currently acts as principal coordinator of the GEMOC initiative. Benoit Combemale and Jean-Marc Jézéquel are part of the Advisory Board, and 9 DIVERSE members are part of the GEMOC initiative.

8.5. International Research Visitors

8.5.1. Visits of International Scientists

8.5.1.1. Internships

- Victor Vranceanu: Inria, Intern, from Mar 2014 until Jul 2014
- Eric Manzi: Inria, Intern, from Jun 2014 until Aug 2014

<p align="center">**FOCUS Project-Team**</p>

7. Partnerships and Cooperations

7.1. National Initiatives

- AEOLUS (Mastering the Cloud Complexity) is an ANR-ARPEGE project started on December 2010 that finished on December 2014. AEOLUS studies the problem of installation, maintenance and update of package-based software distributions in cloud-based distributed systems. The problem consists of representing the dependencies of packages and the inter-relationships among the services, in such a way that starting from a declarative description of the application to be deployed on the cloud, it is possible to automatically compute the resources (ie. virtual machines) to be acquired, and the allocation of such resources to the software services needed to run the application. Main persons involved: Gabbrielli, Lienhardt, Mauro, Zavattaro.

- REVER (Programming Reversible Recoverable Systems) is an ANR project that started on 1st December 2011 and with a 48-month duration. REVER aims to study the possibility of defining semantically well-founded and composable abstractions for dependable computing on the basis of a reversible programming language substrate, where reversibility means the ability to undo any distributed program execution, possibly step by step. The critical assumption behind REVER is that by adopting a reversible model of computation, and by combining it with appropriate notions of compensation and modularity, one can develop systematic and composable abstractions for recoverable and dependable systems. Main persons involved: Giachino, Lienhardt, Lanese, Laneve, Zavattaro.

- PACE (Processus non-standard: Analyse, Coinduction, et Expressivité) is an ANR project that started in 2013. The project targets three fundamental ingredients in theories of concurrent processes, namely coinduction, expressiveness, and analysis techniques. The project aims at processes that are beyond the realm of "traditional" processes. Specifically, the models studied exhibit one or more of the following features: probabilities, higher-order, quantum, constraints, knowledge, and confidentiality. These models are becoming increasingly more important for today's applications. Coinduction is intended to play a pivotal role. Indeed, the approaches to expressiveness and the analysis techniques considered in the project are based on coinductive equalities. Main persons involved: Hirschkoff (project coordinator), Dal Lago, Lanese, Sangiorgi, Zavattaro.

- ELICA (Expanding Logical Ideas for Complexity Analysis) is an ANR project which started on October 2014 and that we will finish on September 2018. ELICA is a project about methodologies for the static analysis of programs as for their resource consumption. The project's aim is to further improve on logical methodologies for complexity analysis (type systems, rewriting, etc.). More specifically, one would like to have more powerful techniques with less false negatives, being able at the same time to deal with nonstandard programming paradigms (concurrent, probabilistic, etc.). Main persons involved: Avanzini, Cappai, Dal Lago, Hirschkoff, Martini, Sangiorgi.

7.2. European Initiatives

7.2.1. FP7 & H2020 Projects

- ENVISAGE (Engineering Virtualized Services) is a EU FP7 project, with starting date October 1st, 2013, and with a 3-year duration. The project is about model-based development of virtualized services, including tool support for resource analysis. Most Focus members are involved.

7.2.2. Collaborations in European Programs, except FP7

- The ICT COST Action BETTY (Behavioural Types for Reliable Large-Scale Software Systems), initiated in October 2012 and with a four-year duration, uses behavioural type theory as the basis for new foundations, programming languages, and software development methods for communication-intensive distributed systems. Behavioural type theory encompasses concepts such as interfaces, communication protocols, contracts, and choreography. Main persons involved: Bravetti, Giachino, Hirschkoff, Lanese, Laneve, Mauro, Sangiorgi, Zavattaro.

7.2.3. Collaborations with Major European Organizations

Simone Martini is a member of the Executive Board of EQANIE (European Quality Assurance Network for Informatics Education), from October 2014.

We list here the cooperations and contacts with other groups, without repeating those already listed in previous sections.

- ENS Lyon (on concurrency models and resource control). Contact person(s) in Focus: Dal Lago, Martini, Sangiorgi, Vignudelli. Some visit exchanges during the year, in both directions. One joint PhD supervision (J.-M. Madiot).
- Inria EPI Spades (on models and languages for components, reversibility). Contact person(s) in Focus: Lanese. Some visit exchanges during the year, in both directions.
- Laboratoire d'Informatique, Université Paris Nord, Villetaneuse (on implicit computational complexity). Contact person(s) in Focus: Dal Lago, Martini. An Italian PhD student (Marco Solieri) is working on his PhD thesis with joint supervision (Martini, Guerrini).
- Institut de Mathématiques de Luminy, Marseille (on lambda-calculi, linear logic and semantics). Contact person(s) in Focus: Dal Lago, Martini. One joint PhD supervision (Michele Alberti).
- Team PPS, University of Paris-Diderot Paris 7 (on logics for processes, resource control). Contact person(s) in Focus: Dal Lago, Martini, Sangiorgi. Some short visits in both directions during the year.
- IRILL Lab, Paris (on models for the representation of dependencies in distributed package based software distributions). Contact person(s) in Focus: Mauro, Zavattaro. Some short visits in both directions during the year.
- EPI Carte, Inria-Nancy Grand Est and LORIA (on implicit computational complexity). Contact person(s) in Focus: Dal Lago.
- LMU Munich (M. Hofmann) (on Implicit computational complexity and IntML). Contact person(s) in Focus: Dal Lago.
- IMDEA Software, Madrid (G. Barthe) (on Implicit computational complexity for cryptography). Contact person(s) in Focus: Dal Lago, Sangiorgi. Some visits during 2014.
- Facultad de Informatica, Universidad Complutense de Madrid (on web services). Contact person(s) in Focus: Bravetti. Bravetti is an external collaborator in the project "ESTuDIo: ESpecificacion y Testing de sistemas altamente DIstribuidos" (Specification and Testing of Highly Distributed Systems) January 1, 2013 - December 31, 2015 (3 years), funded by the Spanish Ministerio de Economia y Competitividad.

7.3. International Research Visitors

7.3.1. Visits of International Scientists

The following researchers have visited Focus for short periods; we list them together with the title of the talk they have given during their stay, or the topic discussed during their stay.

- Luca Padovani (Turin) "Deadlock and lock freedom in the linear pi-calculus".
- Jean-Bernard Stefani (Inria Grenoble), "Strong isolation in actor systems".
- Mauro Caporuscio (Milan): "Prime: A middleware support for fluid distributed systems".

- Fabrizio Montesi (Copenhagen): "Choreographic Programming".
- Marco Carbone (Copenhagen): "Behavioural types for adaptable service composition".
- Sandro Etalle (Eindhoven), "Signature-Less Network Intrusion Detection: from the research table to the production environments."
- Wolf Zimmermann (Halle, Germany), "Automatic Protocol Conformance Checking in Component-Based and Service-Oriented Systems."
- Lars Kotthoff (Cork, Ireland), "Towards an algorithm selection standard: data format and tools."
- Herbert Wiklicky (London), "Quantitative Aspects in Program Synthesis."
- Naoki Kobayashi (Tokyo), "Model checking higher-order programs".
- Benoit Valiron and Claudia Faggian (Paris), "Geometry of Synchronization"
- Marc Bagnol (Marseille), "On the Resolution Semiring"
- Irek Ulidowski (Leicester), on the topic of reversibility.

7.3.1.1. Internships

Raphaelle Crubille, from ENS Lyon, has begun a stage in Focus during 2014, under the supervision of Ugo Dal Lago.

<p style="text-align:center; color:red; font-weight:bold;">INDES Project-Team</p>

7. Partnerships and Cooperations

7.1. National Initiatives

7.1.1. ANR DEFIS PWD

The PWD project (Programmation du Web diffus) has been funded by the ANR Défis programme for 4 years, starting November 2009. The partners of this project are the teams INDES (coordinator), LIP6 at University Pierre et Marie Curie and PPS at University Denis Diderot. The PWD project has been elected as one the projects "phare" by the ANR.

7.1.2. ANR AJACS

The AJACS project (Analyses of JavaScript Applications: Certification & Security) has been funded by the ANR for 42 months, starting December 2014. The goal of AJACS project is to provide strong security and privacy guarantees on the client side for web application scripts. The Indes members are involved in the tasks WP2 Certified Analyses and WP3 Security of JavaScript Applications. The partners of this project include Inria teams Celtique (coordinator), Toccata, and Prosecco.

7.1.3. FUI X-Data

Broadly available big and open data open new perspectives in terms of use and applications. The X-Data project aims at validating this claim by using actual data sets for building realistic applications. The goal is to combine a large variety of data sets coming from different partners (Data Publica, Orange, EDF, La Poste, social networks, ...) to build innovative applications. The Indes team designs and implements new programming language constructs that help programming these applications. Our contribution to this project ended in November 2014.

7.1.4. FUI UCF

The 3 years long UCF project aims at developing a reactive Web platforms for delivering multimedia contents. The partners of the project are the startups Alterway, OCamlPro, and XWiki, and the academic research laboratories of University Pierre et Marie Curie and Denis Diderot.

7.2. European Initiatives

7.2.1. FP7

7.2.1.1. RAPP

Program: http://rapp-project.eu

Title: Robot App Store

Collaborator: Inria Hephaistos

Abstract: RAPP is a 36 months pan-european FP7 project, started in December 2013. Hop is used in the development of prototypes of the Coprin Ang rollator transfer device, for mobility assistance and activity monitoring.

7.2.1.2. MEALS

Type: FP7

Title: Mobility between Europe and Argentina applying Logics to Systems

Instrument: International Research Staff Exchange Scheme

Duration: October 2011 - September 2015

Coordinator: Pedro D'Argenio

Partner: University of Córdoba, University of Buenos Aires, University of Twente

Inria contact: Castuscia Palamidessi

Abstract:The MEALS project (Mobility between Europe and Argentina applying Logics to Systems) goals cover three aspects of formal methods: specification (of both requirement properties and system behavior), verification, and synthesis. The Indes members are involved in the task of Security and Information Flow Properties (WP3). The partners in this task include University of Buenos Aires, University of Córdoba, Inria (together with Catuscia Palamidessi, Kostas Chatzikokolakis, Miguel Andrés) and University of Twente. The web page of the project can be found at http://www.meals-project.eu.

7.2.2. Collaborations in European Programs, except FP7 & H2020

Program: **ICT Cost Action IC1201**

Project acronym: BETTY

Project title: Behavioural Types for Reliable Large-Scale Software Systems

Duration: October 2012 - October 2016

Coordinator: Simon Gay, University of Glasgow

Other partners: Several research groups, belonging to 22 european countries

Abstract: The aim of BETTY is to investigate and promote behavioural type theory as the basis for new foundations, programming languages, and software development methods for communication-intensive distributed systems. Behavioural type theory encompasses concepts such as interfaces, communication protocols, contracts, and choreography.

Program: **ICT Cost Action IC1405**

Project title: Reversible computation - extending horizons of computing

Duration: November 2014 - November 2018

Coordinator: Irek Ulidowski, University of Leicester

Abstract: Reversible computation is an emerging paradigm that extends the standard forwards mode of computation with the ability to execute in reverse. It aims to deliver novel computing devices and software, and to enhance traditional systems. The potential benefits include the design of reversible logic gates and circuits - leading to low-power computing and innovative hardware for green ICT, new conceptual frameworks and language abstractions, and software tools for reliable and recovery-oriented distributed systems.

This Action is the first European network of excellence aimed at coordinating research on reversible computation.

7.3. International Research Visitors

7.3.1. Visits of International Scientists

7.3.1.1. Internships

Vineet Rajani

Date: 10/12/2014 - 10/03/2015

Institution: Max Planck Institute (MPI), Germany

Collaborator: Tamara Rezk

7.3.1.2. Research stays abroad

Atuya Okudaira

Date: 1/1/2014 - 31/08/2014

Institution: International University of Kagoshima, Japan

Collaborator: Manuel Serrano

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

7. Partnerships and Cooperations

7.1. Regional Initiatives

7.1.1. *HomeAssist: Platform for Assisted Living*

The objective of this project is to provide an open platform of digital assistance dedicated to aging in place. This project is in collaboration with researchers in Cognitive Science (Bordeaux University) and the UDCCAS Gironde (Union Départementale des Centres Communaux d'Action Sociale) managing elderly care. This project includes a need analysis, the development of assistive applications and their experimental validation.

This work is funded by CARSAT Aquitaine ("Caisse d'Assurance Retraite et de la Santé au Travail"), Aquitaine Region and Conseil Général de la Gironde.

7.1.2. *Cognitive Assistance for Supporting the Autonomy of Persons with Intellectual Disabilities*

The objective of this project is to develop assistive technologies enabling people with intellectual disabilities to gain independence and to develop self-determined behaviors, such as making choices and taking decisions. This project is in collaboration with the "Handicap et Système Nerveux" research group (EA 4136, Bordeaux University), the TSA Chair of UQTR (Université du Québec à Trois-Rivières) in Psychology and the Association Trisomie 21 Gironde (Down Syndrome). The TSA chair has recently designed and built a smart apartment that is used to conduct experimental evaluation of our assistive technologies in realistic conditions.

7.1.3. *Certification of an open platform*

The purpose of this project is to define concepts and tools for developing certifying open platforms. This certification process must ensure a set of critical properties (e.g., safety, confidentiality, security) by certifying each tier application. These guarantees are essential to ensure that openness does not come at the expense of the user's well-being. To preserve the innovation model of open platforms, this certification process should also be as automatic as possible. Indeed, the success of open platforms is mainly due to the low development cost of a new application. The case study of this thesis will be the domain of home automation. The results of this thesis will be put into practice in the DiaSuiteBox open platform.

This project is funded by Aquitaine Region.

7.1.4. *ANDDI*

Five percent of the population have Intellectual Disabilities (ID). Individuals with ID have significant socio-adaptive limitations in a variety of daily activities, at home (task planification and execution, medication, home safety, etc.) as well as outside (route planning, itinerary in public transportation, etc.). Individuals with ID, their families, health institutions, caregiving services, and dedicated organizations strive to find ways in which these individuals can live as independently as possible, while promoting their social inclusion in every respect of their life (housing, professional training, employment, leisure, culture, etc.).

The research project ANDDI leverages the abilities of individuals with ID and the recent technological advances to develop a variety of assistive services addressing their daily needs. These services draw on our expertise in cognitive science and computer science, dedicated to assisting users with technologies. In particular, we use our platform, named HomeAssist, dedicated to the independently living of older adults. This platform relies on DiaSuite, our suite of tools for developing applications that orchestrate networked objects, and DiaSuiteBox, our platform that runs an open-ended set of applications, sensors, actuators and web services.

ANDDI addresses users with Down syndrome aiming to live independently; it pursues the following goals:

1. determining the key obstacles to perform daily activities autonomously and collecting the needs in assistive support expressed by individuals with ID and their family and caregivers;
2. developing and adapting assistive services available in HomeAssist across an iterative assessment (period of 6 months) of experiences of each individual;
3. evaluating the efficacy of our developed assistive services across the stages experienced by individuals progressively becoming independent in their daily life (pre-post comparison after 12 months of HomAssist intervention).

This project is funded by the "Conseil Régional d'Aquitaine" and "Trisomie 21".

7.2. National Initiatives

7.2.1. *Objects' World: design-driven development of large-scale smart spaces*

The goal of this project is to develop an innovative communication technology, allowing the emergence of a new economic sector for large-scale smart spaces. Our objective is to propose concepts and tools for developing reliable applications orchestrating large-scale smart spaces of networked entities. The industrial partners of the Objects' World project will provide us with real-size case studies in various application domains (e.g., smart cities, tracking of vehicles, healthcare, energy management).

This work is funded by the OSEO national agency.

7.2.2. *School Inclusion for Children with Autism*

The objective of this project is to provide children with assistive technologies dedicated to the school routines. This project is in collaboration with the "Handicap et Système Nerveux" research group (EA 4136, Bordeaux University), the PsyCLÉ research center (EA 3273, Provence Aix-Marseille University) and the "Parole et Langage" research laboratory (CNRS, Provence Aix-Marseille University).

This work is funded by the French Ministry of National Education.

7.3. International Initiatives

7.3.1. *Inria Associate Teams*

7.3.1.1. OPALI

Title: OPen Assistive-technology platform for independent LIving

International Partner (Institution - Laboratory - Researcher):

Université du Québec à Trois Rivières (CANADA)

Duration: 2013 - 2015

See also: http://phoenix.inria.fr/opali

The goal of the OPALI project is to develop an Open Platform for Assisted Living targeting users with cognitive disabilities. It is a cross-disciplinary project combining expertise in (1) Computer Science focusing in development of applications orchestrating networked devices and (2) Psychology focusing in assistive technologies for users with cognitive disabilities. Furthermore, this project will leverage a unique research vehicle created by the University of Trois-Rivières consisting of a full-fledged apartment equipped with a range of networked devices and dedicated to experimental studies. The outcome of the project will include a large catalog of assistive applications allowing to match each user's project life.

7.4. International Research Visitors

7.4.1. *Visits of International Scientists*

Catherine Plaisant visited the Phoenix team during the month of November 2014. Catherine Plaisant is a Senior Research Scientist at the University of Maryland Institute for Advanced Computer Studies and Associate Director of the Human-Computer Interaction Lab.

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

8. Partnerships and Cooperations

8.1. Regional Initiatives

We have signed a convention with the CAR team led by Noury Bouraqadi of Ecole des Mines de Douai. In such context we co-supervized two PhD students (Mariano Martinez-Peck, Nick Papoylias). Two co-supervisions are ongoing (Guillermo Polito, Max Mattone). The team is also an important contributor and supporting organization of the Pharo project.

8.2. National Initiatives

8.2.1. ANR

8.2.1.1. Cutter

Participants: Stéphane Ducasse [Correspondant], Nicolas Anquetil, Damien Pollet, Muhammad Bhatti, Andre Calvante Hora.

This partnership is done with the following members from the LIRMM-D'OC-APR: Marianne Huchard, Roland Ducournau, Jean-Claude König, Rodolphe Giroudeau, Abdelhak-Djamel Seriai, and Rémi Watrigant.

CUTTER is a Basic Research project that addresses the problems of object-oriented system remodularization by developing, combining, and evaluating new techniques for analyzing and modularizing code. In particular, it will: (i) use concurrently and collaboratively four package decomposition techniques; and (ii) take into account different levels of abstractions (packages, classes).

The project started in march 2011 and ended this year in November just after the defense of PhD student André Hora

8.3. European Initiatives

8.3.1. FP7 & H2020 Projects

MEALS FP7 Marie Curie Research Staff Exchange Scheme

MEALS (Mobility between Europe and Argentina applying Logics to Systems) is a mobility project financed by the 7th Framework programme under Marie Curie's International Research Staff Exchange Scheme. It involves seven academic institutions from Europe and four from Argentina, and a total of about 80 researchers to be exchanged. The project started on the 1st of October, 2011, and it has a duration of 4 years. Nr: FP7-PEOPEL-2011-IRSES

http://www.meals-project.eu

8.3.2. Collaborations in European Programs, except FP7 & H2020

8.3.2.1. ERCIM Software Evolution

We are involved in the ERCIM Software Evolution working group since its inception. We participated at his creation when we were at the University of Bern.

8.4. International Initiatives

8.4.1. Inria International Labs

CIRIC Chile and Pleiad Team of University of Chile at Santiago

We are collaborating with ObjectProfile, a startup company which is hosted at Inria Chile. ObjectProfile is a collaborator within the PLOMO2 Associated Team and a contributor to both Pharo and Moose. http://objectprofile.com

The DeepIntoPharo book is a collaboration with the Pleiad Team of University of Chile at Santiago.

8.4.2. Inria Associate Teams

8.4.2.1. PLOMO2

Title: Infrastructure for a new generation of development tools

International Partner:

Universidad de Chile (Chile), DCC.

Duration: 2014 - 2016

See also: http://pleiad.cl/research/plomo2

Performing effective software development and maintenance are best achieved with effective tool support. Provided by a variety of tools, each one presenting a specific kind of information supporting the task at hand. The goal of the first PLOMO was to develop new meta tools to improve and bring synergy in the existing infrastructure of Pharo (for software development) and the Moose software analysis platform (for maintenance). With Plomo2, we want to build on top of this work and invent a new generation of tools to navigate and profile programs.

The hypotheses that Plomo2 will seek to verify are:

- Use of reflection enables new profiling techniques
- Use of visualization in a programming environment improves programmer performance

The overall objectives of Plomo2 are:

- Infrastructure for profiling programs and recording programmer activity.
- Visual software maps defined in a flexible and agile fashion
- Combining dynamic information with visualization to improve the development environment
- Empirical evaluation of this environment
- All the efforts will be performed on Pharo and Moose, two platforms heavily used by the RMoD and Pleiad teams.

The detailed work plan and the results of the first year can be found in the PLOMO2 report at http://pleiad.cl/research/plomo2.

8.4.3. Inria International Partners

8.4.3.1. Uqbar - Argentina

Participants: Marcus Denker [correspondant], Stéphane Ducasse [RMoD], Nicolas Anquetil [RMoD], Diego Garbervetsky [UBA,LAFHIS], Gabriela Arevalo [Universidad Nacional de Quilmes)], Nicolas Passerini [Uqbar].

Uqbar is a foundation of researchers teaching in several universities of the Buenos Aires area. Universidad Tecnologica Nacional (FRBA) Universidad Nacional de Quilmes, Universidad Nacional de San Martin,Universidad Nacional del Oeste. LAFHIS is a research laboratory from the University of Buenos Aires. More information at (http://www.uqbar-project.org).

8.4.3.2. Informal International Partners

Pharo in Research: We are building an ecosystem around Pharo with international research groups, universities and companies. Several research groups (such as Software Composition Group – Bern, and Pleiad – Santiago) are using Pharo. Many universities are teaching OOP using Pharo and its books. Several companies worldwide are deploying business solutions using Pharo.

8.4.4. Participation In other International Programs

8.4.4.1. STIC AmSud

Participants: Damien Cassou [correspondant], Gustavo Santos [RMoD], Martin Martin [RMoD], David Röthlisberger [UDP - Universidad Diego Portales, Santiago, Chile], Marcelo Almeida Maia [UFU - Federal University of Uberlândia, Brasil], Romain Robbes [Departamento de Ciencias de la Computación (DCC), Universidad de Chile, Santiago, Chile], Martin Monperrus [Spirals].

Project Partners: Inria RMOD, Inria Spirals, DCC Universidad de Chile, Universidad Diego Portale Chile, Federal University of Uberlândia, Brasil.

This project aims at facilitating the usage of frameworks and application programming interfaces (APIs) by mining software repositories. Our intuition is that mining reveals how existing projects instantiate these frameworks. By locating concrete framework instantiations in existing projects, we can recommend to developers the concrete procedures for how to use a particular framework for a particular task in a new system. Our project also tackles the challenge of adapting existing systems to new versions of a framework or API by seeking repositories for how other systems adapted to such changes. We plan to integrate recommendations of how to instantiate a framework and adapt to changes directly in the development environment. Those points taken together, considerably distinguish our approach from existing research in the area of framework engineering.

8.4.4.2. European Lab with Delft

We have a Lille Nord Europe European Lab with A. Bachelli from Delft University. We are working on infrastructure and tools for code reviewing. We have exchange of staff and got a paper accepted to SANER 2015.

8.5. International Research Visitors

8.5.1. Visits of International Scientists

In the context of the PLOMO2 associated Team with the University of Chile:

- Ronie Saldago: 24/08/2014 until 07/09/2014. Subject was FFI and OSWindow.
- Miguel Campusano: 16/08/2014 until 11/09/2014. Subject was Slots and visual representation of code.
- Alexandre Bergel: 13/12/2014 until 01/01/2015. Subject: system support for advanced profiling.
- Juraj Kubelka: 06/12/2014 until 19/12/2014. First visit to RMoD to plan future collaboration.

In the context of MEALS:

- Guido Chari visited RMoD from November 2014.

Other visitors:

- Laurence Tratt, Software Development Team, King's College London (15-16/05/14)
- Johan Fabry, University of Chile, November 2014.
- Max Leske, University of Bern, Mar 2014.
- Miao Fang, Siemens, from Jun 2014 until Jul 2014.
- Alain Plantec, Univ. Bretagne Occidentale, Jan 2014

8.5.1.1. Internships

Pablo Herrero, Universidad de Buenos Aires (Argentina): *Compressed ASTs for Pharo*, from Oct 2013.

Lucas Godoy, Universidad de Buenos Aires (Argentina):*Tracking depeendencies between code changes.*, May 2014 - Oct 2014.

Baptiste Quide, Polytech Lille: *Package dependencies analysis*, from May 2014 until Aug 2014.

Hayatou Oumarou, Universite de Maroua, Cameroun:*Cost of Rules*, frome June 2014 to Oct 2014.

Clara Allende, Universidad Tecnológica Nacional, Buenos Aires (Argentina): *BreakPoints for Pharo*, from May 2014 until Oct 2014.

Max Mattone, École des Mines Douai: *VirtualCPU for Pharo*. From May 2014 until Oct 2014.

Mark Rizun, Ivan Franko National University of Lviv, Ukraine: *Refactoring Improvements*, from July 2014 until Aug 2014.

Kevin Lanvin, University Lille: *A web front-end for Moose*, from Jan until Apr 2014.

Leo Perard, University Lille: *Telescope: a new way to describe visualizations*, from Mar 2014 until Aug 2014.

8.5.2. Visits to International Teams

- Stéphane Ducasse visited LAM Research, Inc, USA for one week in December 2014.

- Stéphane Ducasse visited the University of Delft, 3 days, July 2014

- Stefan Marr visited the Software Composition Group at Universität Bern in Switzerland for two days in December 2014

- Stefan Marr visited the Institut für Systemsoftware at the JKU University Linz in Austria for three days in July 2014

- Stefan Marr visited the Software Development Team of Laurence Tratt at King's College London for two days in May 2014

- Martín Dias visited the University of Technology of Delft for one week in September, 2014.

- Martín Dias visited the University of Buenos Aires in January 2014.

<p align="center">**TACOMA Team**</p>

7. Partnerships and Cooperations

7.1. National Initiatives

7.1.1. Pervasive_RFID

- Partner: IETR
- Starting: July 2013; ending: July 2016

Pervasive_RFID is a joint effort (within the CominLabs initiative, see http://www.cominlabs.ueb.eu/) started in July 2013 with IETR (institut d'électronique et de télécommunications de Rennes) to study and design innovative RFID reading protocols in the context of pervasive computing applications. Some limitations of existing RFID technology become challenging: unlike standard RFID application scenarios, pervasive computing often involves uncontrolled environment for RFID, where tags and reader have to operate in much more difficult situations that those usually encountered or expected for classical RFID systems.

7.1.2. GLIE - Guidage Lumineux par l'Intelligence de l'Environnement

- Partner: OyaLight
- Starting: December 2014; ending: December 2015

GLIE is a collaborative projet with OYALIGT and TACOMA group. The objective of the project is to design and demonstrate a new service combining connected LEDs provided by OYALIGHT and a software tool developed by TACOMA. By integrating and analyzing data transmitted by the sensors integrated into LEDs , the service must be able to detect a given context and to react accordingly.

<p align="center">**COATI Project-Team**</p>

8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. ANR

8.1.1.1. ANR Blanc STINT, 2014-2017

Participants: Jean-Claude Bermond, David Coudert, Frédéric Havet, Luc Hogie, Ana Karolinna Maia de Oliveira, Nicolas Nisse, Stéphane Pérennes, Michel Syska.

The STINT projet (*STructures INTerdites*) is leaded by the MC2 group (LIP, ENS-Lyon) and involves the G-SCOP laboratory (Grenoble).

The aim of STINT is to answer the following fondamental question: *given a (possibly infinite) family ψ of graphs, what propoerties does a ψ-free graph have?*. To this end, it will firstly establish bounds on some classical graph parameters (e.g., clique number, stability number, chromatic number) for ψ-free graphs. Then, it will design efficient algorithms to recognize ψ-free graphs and to determine or approximate some parameters for those graphs. These studies shall result in the development of new proof techniques.

(http://www.ens-lyon.fr/LIP/MC2/STINT/)

8.1.2. GDR Actions

8.1.2.1. Action ResCom, ongoing (since 2006)

Réseaux de communications, working group of GDR ASR, CNRS.

(http://rescom.asr.cnrs.fr/)

8.1.2.2. Action Graphes, ongoing (since 2006)

Action Graphes, working group of GDR IM, CNRS.

(http://gtgraphes.labri.fr/)

8.2. European Initiatives

8.2.1. FP7 & H2020 Projects

8.2.1.1. EULER

Participants: David Coudert, Luc Hogie, Aurélien Lancin, Bi Li, Nicolas Nisse.

> Title: EULER (Experimental UpdateLess Evolutive Routing)
>
> Type: COOPERATION (ICT)
>
> Defi: Future Internet Experimental Facility and Experimentally-driven Research
>
> Instrument: Specific Targeted Research Project (STREP)
>
> Duration: October 2010 - June 2014
>
> Partners: Alcatel-Lucent Bell (leader) (Antwerp, Belgique), iMind (Ghent, Belgium), UCL (Louvain, Belgium), RACTI (Patras, Grece), UPC (Barcelona, Spain), UPMC (ComplexNetworks, Paris 6), Inria (COATI, GANG, CEPAGE). Coordinator: ALCATEL-LUCENT (Belgium)
>
> STREP EULER (Experimental UpdateLess Evolutive Routing) is part of FIRE (Future Internet Research and Experimentation) objective of FP7. It aims at finding new paradigms to design, develop, and validate experimentally a distributed and dynamic routing scheme suitable for the future Internet and its evolution. COATI is the leader of WP3 on Topology Modelling and Routing scheme experimental analysis.
>
> See also: http://www-sop.inria.fr/mascotte/EULER/wiki/

8.2.2. Collaborations with Major European Organizations

Participants: David Coudert, Alvinice Kodjo, Truong Khoa Phan.

Discrete Optimization group : Lehrstuhl II für Mathematik, RWTH Aachen (Germany)

Robust optimization in backbone networks for energy efficient designs, and chance-constrained programming in backhaul networks subject to link capacity variations.

8.2.3. COLOR Inria Sophia Antipolis-méditerranée DIT University of Athens

Participants: Jean-Claude Bermond, David Coudert, Frédéric Giroire, Nicolas Nisse, Stéphane Pérennes.

Title : Algorithms Design and Games for Location, Placement and Infrastructure Leasing (AlGa-LoP)

Duration: June 2013- September 2014

COATI and DIT University of Athens (responsible Vassilis Zissimopoulos)

8.3. International Initiatives

8.3.1. Inria Associate Teams

8.3.1.1. AlDyNet

Title: Algorithm for large and Dynamic Networks

Inria principal investigator: Nicolas Nisse

International Partner (Institution - Laboratory - Researcher):

> Universidad Adolfo Ibañez, Santiago, Chile
> Facultad de Ingeniería y Ciencias
> Karol Suchan

Duration: 2013 - 2015

See also: http://team.inria.fr/coati/projects/aldynet/

The main goal of this Associate Team is to study the structure of networks (modeled by graphs) to design both efficient distributed algorithms and reliable network topologies suitable to applications. We are interested both in large-scale (Facebook, Internet, etc.) and in smaller networks (e.g., WDM) that handle heavy traffic. More precisely, we aim at designing new techniques of distributed and localized computing to test structural properties of networks and to compute structures (e.g., decompositions) to be used in applications. Concerning the applications, we will first focus on routing and subgraph packing problems.

There are two main objectives:

- Find efficient localized algorithms to test certain graph properties or to prove that no such algorithms exist. We will formalize several distributed computing models and analyze which properties can and which cannot be tested in them.
- Define graph properties , computable or approximable in distributed systems , such as structures/decompositions/representations. The driving idea is to combine several well studied graph properties in order to obtain more specific structures which we hope to be more easily computable.

To verify the practical efficiency of our results, the designed algorithms will be implemented and compared to existing ones. For this purpose, a particular effort will be put to design and implement algorithms to generate graphs that satisfy properties of interest, in order to use them to test the algorithms.

The originality of the proposal is to combine powerful tools of graphs theory (e.g., FPT complexity) and of combinatorial optimization (Mixed Integer Programming) with distributed computing. One challenge here is to balance between the degree of locality of desired algorithms and the relevance of properties that may be computed.

8.3.2. Participation In other International Programs

Action ECOS-SUD: ALgorithmes Distribués pour le calcul de la structure des réseaux, with Chile, 2013-2015.

GAIATO : Graphs And Algorithms Applied To Telecommunications, International Cooperation FUNCAP/FAPs/Inria/INS2i-CNRS, no. INC-0083-00047.01.00/13, with Federal University of Ceara, Brasil, 2014-2016.

8.4. International Research Visitors

8.4.1. Visits of International Scientists

8.4.1.1. Professors / Researchers

Xavier Défago

Date: until Jan 31 2014

Institution: JAIST, Japan

Michele Flammini

Date: Jun 30 - Jul 13 2014

Institution: Univ. L'aquila, Italy

Brigitte Jaumard

Date: Dec 15-21, 2014

Institution: Concordia Univ., Montréal, Canada

Mejdi Kaddour

Date: Oct 13-19 2014

Institution: Univ. Oran, Algeria

Takako Kodate

Date: Mars 21 - Apr 3 2014

Institution: Tokyo Woman's Christian Univ., Suginami-ku, Tokyo, Japan

Arie M. C. A. Koster

Date: Jun 10-13, 2014

Institution: RWTH Aachen Univ., Germany

Gianpiero Monaco

Date: Jul 9-17, 2014

Institution: Univ. L'aquila, Italy

Gabriele Muciaccia

Date: Jan 10-16, 2014

Institution: Royal Holloway, University of London, UK

Jean-Sébastien Sereni

Date: Fev 2-7, 2014

Institution: LORIA, Nancy, France

Julio-Cesar Silva Araújo

Date: Jun 23 - Jul 25 2014

Institution: Univ. Federal do Ceara, Fortaleza, Brazil

Karol Suchan

Date: Sep 7-28 2014

Institution: Univ. Adolfo Ibanez, Santiago, Chile

Joseph Yu

Date: Mar 1 - Apr 18, 2014

Institution: Abbotsford and SFU, Vancouver, Canada

Vassilis Zissimopoulos

Date: Jul 4-12 2014

Institution: NKUA, Athens, Greece

8.4.1.2. PhD students

Marthe Bonamy

Date: Jan 27 - Fev 7, 2014

Institution: LIRMM, Montpellier, France

Akram Kout

Date: Sep 1 - Oct 25, 2014

Institution: Univ. Mentouri, Constantine, Algeria,

Esteban H. Roman Catafau

Date: May 8 - Jul 23 2014

Institution: Univ. Adolfo Ibanez, Santiago, Chile

8.4.1.3. Internships

Claudio Carvallho

Date: Dec 2013-Feb 2014

Institution: Federal University of Ceara, Brasil

Supervisor: Frédéric Havet

Renan Dantas

Date: Dec 2013-Feb 2014

Institution: Federal University of Ceara, Brasil

Supervisor: Frédéric Havet

Doldan Juan

Date: Apr 2014 - Aug 2014

Institution: Universidad de Buenos Aires (Argentina)

Supervisor: Nicolas Nisse

8.4.2. Visits to International Teams

8.4.2.1. Research stays abroad

Jean-Claude Bermond

Department of Informatics and Telecommunications of the National and Kapodistrian University of Athens, Greece, May 31 -June 14, 2014

David Coudert

Research Unit 1 (RU1) of the Computer Technology Institute and Press "Diophantus" (CTI), Patras, Greece, March 12-16, 2014

Department of Informatics and Telecommunications of the National and Kapodistrian University of Athens, Greece, March 16-22, 2014

Univ. Adolfo Ibañez, Santiago, Chile, November 17-30, 2014

Frédéric Giroire

LIAFA, Paris, France, March 19, 2014

PARGO, Federal University of Ceará, Fortaleza, Brazil, June 9-20, 2014

Frédéric Havet

LIP, ENS Lyon, France, December 15-17, 2014

Nicolas Nisse

JAIST, Kanazawa, Japan, July 22 - August 8, 2014

Univ. Adolfo Ibañez, Santiago, Chile, November 17 - December 12, 2014

DANTE Team

8. Partnerships and Cooperations

8.1. Regional Initiatives

8.1.1. IXXI

8.1.1.1. Linguistic usage and social networks: agent based models and direct observation of verbal interactions. (ULMMA)
Participants: Éric Fleury, Márton Karsai.

8.1.1.2. A sociolinguistics of Twitter : social links and linguistics variation
Participants: Éric Fleury, Márton Karsai.

8.2. National Initiatives

8.2.1. ANR

8.2.1.1. Equipex FIT (Futur Internet of Things)
Participant: Éric Fleury.

FIT is one of 52 winning projects in the Equipex research grant program. It will set up a competitive and innovative experimental facility that brings France to the forefront of Future Internet research. FIT benefits from 5.8€¨ million grant from the French government Running from 22.02.11 – 31.12.2019. The main ambition is to create a first-class facility to promote experimentally driven research and to facilitate the emergence of the Internet of the future.

8.2.1.2. ANR INFRA DISCO (DIstributed SDN COntrollers for rich and elastic network services)
Participants: Thomas Begin [correspondant], Anthony Busson, Isabelle Guérin Lassous.

The DANTE team will explore the way SDN (Software Designed Network) can change network monitoring, control, urbanisation and abstract description of network resources for the optimisation of services. More specifically, the team will address the issues regarding the positioning of SDN controllers within the network, and the implementation of an admission control that can manage IP traffic prioritization.

8.2.1.3. ANR REFLEXION (REsilient and FLEXible Infrastructure for Open Networking)
Participants: Thomas Begin [correspondant], Anthony Busson, Isabelle Guérin Lassous.

The DANTE team will work on the monitoring of NFV proposing passive and light-weight metrology tools. They will then investigate the modeling of low-level resources consumptions and finally propose methods to dynamically allocate these resources taking into account performance constraints.

8.2.1.4. ANR CONTINT CODDDE
Participants: Éric Fleury [correspondant], Christophe Crespelle, Márton Karsai.

It is a collaborative project between the ComplexNetwork team at LIP6/UPMC; Linkfluence and Inria Dante. The CODDDE project aims at studying critical research issues in the field of real-world complex networks study:

- How do these networks evolve over time?
- How does information spread on these networks?
- How can we detect and predict anomalies in these networks?

In order to answer these questions, an essential feature of complex networks will be exploited: the existence of a community structure among nodes of these networks. Complex networks are indeed composed of densely connected groups of that are loosely connected between themselves.

The CODDE project will therefore propose new community detection algorithms to reflect complex networks evolution, in particular with regards to diffusion phenomena and anomaly detection.

These algorithms and methodology will be applied and validated on a real-world online social network consisting of more than 10 000 blogs and French media collected since 2009 on a daily basis (the dataset comprises all published articles and the links between these articles).

8.2.1.5. ANR RESCUE

Participants: Thomas Begin, Isabelle Guérin Lassous [correspondant].

In the RESCUE project, we investigate both the underlying mechanisms and the deployment of a substitution network composed of a fleet of dirigible wireless mobile routers. Unlike many projects and other scientific works that consider mobility as a drawback, in RESCUE we use the controlled mobility of the substitution network to help the base network reduce contention or to create an alternative network in case of failure. The advantages of an on-the-fly substitution network are manifold: Reusability and cost reduction; Deployability; Adaptability.

The RESCUE project addresses both the theoretical and the practical aspects of the deployment of a substitution network. From a theoretical point of view, we will propose a two-tiered architecture including the base network and the substitution network. This architecture will describe the deployment procedures of the mobile routing devices, the communication stack, the protocols, and the services. The design of this architecture will take into account some constraints such as quality of service and energy consumption (since mobile devices are autonomous), as we want the substitution network to provide more than a best effort service. From a practical point of view, we will provide a proof of concept, the architecture linked to this concept, and the necessary tools (*e.g.*, traffic monitoring, protocols) to validate the concept and mechanisms of on-the-fly substitution networks. At last but not least, we will validate the proposed system both in laboratory testbeds and in a real-usage scenario.

8.2.1.6. ANR FETUSES

Participant: Paulo Gonçalves.

The goals of this ANR project consist in the development of statistical signal processing tools dedicated to per partum fetal heat rate characterization and acidosis detection, and are organized as follows: *(i)* construction of a large dataset of per partum fetal heart rate recordings, which is well documented and of significant clinical value; *(ii)* Developments of adaptive (*e.g.* data driven) algorithms to separate data into trend (deceleration induced by contractions) and fluctuation (cardiac variability) components; *(iii)* Developments of algorithms to characterize the non stationary and multifractal properties of per partum fetal heart rate ; *(iv)* Acidosis detection and assessment using the large datasets; *(v)* Algorithm implementation for performing tests in real clinical situations. ANR is a joint project between DANTE, the Physics Lab of ENS de Lyon (SiSyPhe team) and the *Hôpital Femme-Mère-Enfant* of Bron (Lyon). Fetuses started in january 2012 and will end in june 2015.

8.3. European Initiatives

8.3.1. Collaborations with Major European Organizations

University of Namur: Department of Mathematics/Naxys (Belgium). Collaboration with Renaud Lambiotte on dynamical processes on dynamical networks and communities detections.

Aalto University: Department of Biomedical Engineering and Computational Science (Finland). Collaboration with Jari Saramaki on modeling temporal networks and community like modular structure

Central European University (Hungary). Collaboration with János Kertész on modeling complex contagion phenomena.

ISI Foundation (Italy). Collaboration with Laetitia Gauvin on multiplex networks and transportation systems

UPC (Spain): Department of Telematic Engineering. Collaboration with Monica Aguilar Igartua and Luis J. de la Cruz Llopis on vehicular and community networks.

University of Bergen: Institute of Computer Science (Norway). Collaboration with Pinar Heggernes on graph editing problems for analysis and modeling of complex networks.

Ecole Polytechnique Fédérale de Lausanne (Switzerland). Collaboration with Pierre Vandergheynst on Graph Signal Processing

8.4. International Initiatives

8.4.1. Inria International Partners

8.4.1.1. Declared Inria International Partners

- Taiwan, ACADEMIA SINICA & IIIS. Signature of a MoU in the framework of IoT-LAB.

8.4.2. Participation in other International Programs

8.4.2.1. STIC AMSUD

- Understanding and predicting human demanded COntent and mObiLity (UCOOL). To define solutions for the identification and modeling of correlations between the user mobility – describing changes in the user positioning and the current environment he/she is in – and the traffic demand he/she generates. Partners are: LNNC Brasil, Facultad de Ingenieri´a, Universidad de Buenos Aires (FI/UBA), Universidad Tecnica Federico Santa Maria (USM) Chile,

8.5. International Research Visitors

8.5.1. Visits of International Scientists

8.5.1.1. Invited professors

Ha Duong PHAN (invited professor of ENS Lyon and UCBL)

Date: March 2014 - April 2014

Institution: Institute of Mathematics of the Vietnam Academy of Science and Technology (Vietnam).

Alexandre BRANDWAJN (Invited Inria Researcher Program)

Date: September 29, 2014 - October 29, 2014

Institution: University of California, Santa Cruz (USA).

8.5.1.2. Invited researchers

Laetita Gauvin

Date: one week each month, February 2014 - December 2014

Institution: ISI Foundation (Italy)

Tommaso Panini (PhD Student)

Date: from Oct 2014 until Jan 2014

Institution: Collegio Carlo Alberto (Italy)

Andres Marcelo Vazquez Rodasi (PhD Student)

Date: from un 2014 until Sep 2014

Institution: UPC (Spain)

8.5.1.3. Internships

Karathanos Christos

Date: Apr 2014 - Jul 2014

Institution: Université Nationale Capodistrienne d'Athènes (Greece)

8.5.2. Visits to International Teams

8.5.2.1. Research stays abroad

- Thomas Begin, 2 weeks in Spring 2014, University of California Santa Cruz, Jack Baskin School of Engineering, USA.

- Christophe Crespelle, 1 week in December 2014, Institute of Computer Science of the University of Bergen, Norway.

- Christophe Crespelle is in CNRS delegation for 1 year (2014-2015) at the Institute of Mathematics, Vietnam Academy of Science and Technology, Hanoï.

- Christophe Crespelle, 2 months in June-July 2014, Vietnam Institute for Advanced Study in Mathematics (VIASM), Hanoï.

- Christophe Crespelle, 2 months in January-February 2014, Institute of Mathematics, Vietnam Academy of Science and Technology, Hanoï.

- Márton Karsai, 2 times 2 weeks in March and July 2014, Department of Biomedical Engineering and Computational Science, Aalto University, Finland

- Márton Karsai, 1 week June 2014, ISI Foundation Torino, Italy

- Márton Karsai, 1 week December 2014, Central European University, Hungary

<p style="text-align:center">**DIANA Team**</p>

7. Partnerships and Cooperations

7.1. Regional Initiatives

Plate-forme Télécom (PFT) (2011-2014) is a DGCIS funded project, in the context of the competitivity cluster SCS, that aims at providing to PACA region industrials wishing to develop or validate new products related to future mobile networks and services and M2M application, a networking infrastructure and tools helpful for development, test and validation of those products. Other partners : 3Roam, Audilog Groupe Ericsson, Ericsson, Eurecom, Inria, iQsim, MobiSmart, Newsteo, OneAccess, Orange Labs, Pôle SCS, ST Ericsson, Telecom Valley. Our contribution is centred around providing a test methodology and tools for wireless networks experimentation.

7.2. National Initiatives

7.2.1. ANR

- **ANR FIT** (2011-2018): FIT (Future Internet of Things) aims at developing an experimental facility, a federated and competitive infrastructure with international visibility and a broad panel of customers. It will provide this facility with a set of complementary components that enable experimentation on innovative services for academic and industrial users. The project will give French Internet stakeholders a means to experiment on mobile wireless communications at the network and application layers thereby accelerating the design of advanced networking technologies for the Future Internet. FIT is one of 52 winning projects from the first wave of the French Ministry of Higher Education and Research's "Équipements d'Excellence" (Equipex) research grant programme. The project will benefit from a 5.8 million euro grant from the French government. Other partners are UPMC, IT, Strasbourg University and CNRS. See also http://fit-equipex.fr/.

- **ANR DISCO** (2013-2016): DISCO (DIstributed SDN COntrollers for rich and elastic network services) aims at exploring the way how Software Defined Networking changes network monitoring, control, urbanisation and abstract description of network resources for the optimisation of services. The project works throughout experimentations and application use cases on the next generation of Software-Defined Networking solutions for large and critical distributed systems. The project will study the distribution of the current SDN control plane and the optimization of network operations that the integrated system view of cloud computing-based architectures allows.

- **ANR REFLEXION** (2015-2016): REFLEXION (REsilient and FLEXible Infrastructure for Open Networking) research project will study the robustness and scalability of the current SDN architectures and the flexibility leveraged by SDN for provisioning resources and virtualized network functions (VNF). The project will address four main scientific objectives: (1) Fault and disruption management for virtualized services, (2) Robust and scalable control plane for next generation SDN, (3) Dynamic performance management of low level resources in SDN/NFV environments and (4) Distribution and optimization of virtual network functions in SDN environments. Our contribution in this project will be focused on fault and disruption management for virtualized services.

7.3. European Initiatives

7.3.1. FP7 & H2020 Projects

Program: FP7 FIRE programme

Project acronym:

Project title: Fed4Fire

Duration: mois October 2012 - October 2016

Coordinator: iMinds (Belgium)

Other partners: 17 european partners including iMinds (Belgium), IT Innovation (UK), UPMC (Fr), Fraunhofer (Germany), TUB (Germany), UEDIN (UK), NICTA (Australia), etc.

Web site: http://www.fed4fire.eu/

Abstract: Fed4FIRE will deliver open and easily accessible facilities to the FIRE experimentation communities, which focus on fixed and wireless infrastructures, services and applications, and combinations thereof. The project will develop a demand-driven common federation framework, based on an open architecture and specification. It will be widely adopted by facilities and promoted internationally. This framework will provide simple, efficient, and cost effective experimental processes built around experimenters' and facility owners' requirements. Insight into technical and socio-economic metrics, and how the introduction of new technologies into Future Internet facilities influences them, will be provided by harmonized and comprehensive measurement techniques. Tools and services supporting dynamic federated identities, access control, and SLA management will increase the trustworthiness of the federation and its facilities. A FIRE portal will offer brokering, user access management and measurements. Professional technical staff will offer first-line and second-line support to make the federation simple to use. The project will use open calls to support innovative experiments from academia and industry and to adapt additional experimentation facilities for compliance with Fed4FIRE specifications. A federation authority will be established to approve facilities and to promote desirable operational policies that simplify federation. A Federation Standardization Task Force will prepare for sustainable standardization beyond the end of the project. The adoption of the Fed4FIRE common federation framework by the FIRE facilities, the widespread usage by both academic and industrial experimenters, and the strong links with other national and international initiatives such as the FI-PPP, will pave the way to sustainability towards Horizon 2020.

7.3.2. EIT KIC funded activities

Program: **FNS Future Networking Solutions Action Line**

Project acronym: **NFMD**

Project title: Networks for Future Media Distribution (14082)

Duration: January 2014 to December 2014

Coordinator: Acreo, Sweden

Other partners: VTT (Finland), Ericsson, Lund University, SICS (Sweden).

Abstract: The EIT ICT Labs' Networks for Future Media Distribution (NFMD) activity 14082 has as a specific innovation object set out in the application: "Information centric networking is a novel approach of distributing content based on information rather than traditional host routing. The impact foreseen is novel content distribution networks. This is high risk but gives potentially very high impacts. Solutions for media distribution, based on caching in the network and with advanced tools for quality of experience monitoring, as well as optimization for user demand content patterns as monitored in live services, will be considered." The expected outcomes envisioned also in the application were seen over the total length of the project of 2-3 years and would give:

- Building blocks for high performance media service distribution at low cost
- Optimized caching strategies
- Information centric networking solutions
- Quality of Experience tools
- Prototypes, standardization and open source
- Greater mobility, better performance of media services and reduced cost
- Sharing of experience; increased cooperation; new or extended partnerships

Program: **FNS Future Networking Solutions Action Line**

Project acronym: **SDN**

Project title: Software Defined Networking (13153)

Duration: January 2014 to December 2014

Coordinator: Aalto University, Finland

Other partners: Helsinky University (Finland), Thales (France), Deutsche Telecom, Fraunhofer, TU München, TU Berlin (Germany).

Abstract: SDN still requires improvements to be used in mobile networks considering aspects such as security, resilience/robustness and efficient usage of resources in the mobile access. This activity addresses the design of security in mobile access networks (Distributed FW for attack detection and mitigation), Efficient resource usage in mobile access networks (redistribution of traffic based on congestion, mobility patterns) and Resilient control-plane (supporting high speed carrier mobile networks). The expected outcomes are the following:

- Security outcome: Dynamically allocate resources to countermeasure the cyber attack. Isolation of the part of the network under attack so rest is not compromised.

- Efficient resource usage in mobile access networks outcome: Optimal redirection of flows following optimized caching policy and pattern based mobility.

- Resilient control-plane outcome: Understand QoS and make that information available in routing to ensure resiliency.

7.4. International Initiatives

7.4.1. Inria International Labs

We collaborate with Javier Bustos from Inria Chile and his group on the measurements of users' quality of experience and its interpretation in terms of measurements carried on within the devices of the end-users. This collaboration comes to extend Adkintun Mobile with experience-level measurements, and to leverage the results to obtain for the analysis and calibration of users' experience new models and to develop network troubleshooting techniques in case of service degradation. This collaboration fits within our project ACQUA on predicting quality of user experience at Internet access. In 2014, we started integrating the feedback of users revealing their experience into Adkintun Mobile, and the work is currently focusing on obtaining the targeted measurements.

7.4.2. Inria Associate Teams

7.4.2.1. SIMULBED

Title: SIMULBED: Large-Scale Simulation Testbed for Realistic Evaluation of Network Protocols and Architectures

International Partner (Institution - Laboratory - Researcher):

NICT and University of Tokyo (Japan), Hitoshi Asaeda and Yuji Sekiya.

Duration: 2012 - 2014

Participants from Inria in 2014: Walid Dabbous, Emilio Mancini, Alina Quereilhac, Hardik Soni, Julien Tribino and Thierry Turletti.

Participants from NICT in 2014: Hitoshi Asaeda, Ruidong Li and Kazuhisa Matsuzono.

Participants from Univeristy of Tokyo in 2014: Yuji Sekiya and Hajime Tazaki.

Web site: http://planete.inria.fr/Simulbed/

Abstract: Simulators and experimental testbeds are two different approaches for the evaluation of network protocols and they provide a varying degree of repeatability, scalability, instrumentation and realism. Network simulators allow fine grained control of experimentation parameters, easy instrumentation and good scalability, but they usually lack realism. However, there is a growing need to conduct realistic experiments involving complex cross-layer interactions between many layers of the communication stack and this has led network researchers to evaluate network protocols on experimental testbeds.

The use of both simulators and testbeds to conduct experiments grants a better insight on the behavior of the evaluated network protocols and applications. In this project, we focus on the design of SIMULBED, an experimentation platform that aims at providing the best of both worlds. Our project builds on the following state-of-the-art tools and platforms: the open source ns-3 network simulator and the PlanetLab testbed. ns-3 is the first network simulator that includes a mechanism to execute directly within the simulator existing real-world Linux protocol implementations and applications. Furthermore, it can be used as a real-time emulator for mixed (simulation-experimentation) network scenarios. PlanetLab is the well-known international experimental testbed that supports the development and the evaluation of new network services. It is composed of nodes connected to the Internet across the world, and uses container-based virtualization to allow multiple experiments running independently on the same node while sharing its resources.

The overall objective of the project is to make available to networking research community, the SIMULBED platform that will: (1) allow to conduct easily mixed simulation-experimentation evaluation of networking protocols and (2) scale up the size of the PlanetLab experimental testbed, while maintaining a high degree of realism and increasing controllability and reproducibility. We will use the NEPI unified programming environment recently developed in the Planète project-team to help in simplifying the configuration, deployment and run of network scenarios on the platform. See the 2014 Update on the Simulbed web site.

7.4.2.2. Community

Title: COMMUNITY: Message delivery in heterogeneous networks

International Partner (Institution - Laboratory - Researcher):

> University of California Santa Cruz (United States) - School of Engineering - Katia Obraczka

Duration: 2009 - 2014

Participants from Inria in 2014: Thierry Turletti, Chadi Barakat, Damien Saucez, Xuan Nam Nguyen, Hardik Soni and Bruno Nunes.

Participants from USCS in 2014: Katia Obraczka and Mateus Santos, PhD Student, USP (research intern at UCSC in 2014).

Participants from USP in 2014: Cintia Borges Margi.

Web site: http://inrg.cse.ucsc.edu/community/

Abstract: This Inria - UC Santa Cruz Team investigates a number of research challenges raised by message delivery in environments consisting of heterogeneous networks that may be subject to episodic connectivity.

During the first three years of the COMMUNITY associate team, we have explored solutions to enable efficient delivery mechanisms for disruption-prone and heterogeneous networks (i.e. challenged networks). In particular, we have designed the MeDeHa framework along with the Henna naming scheme, which allow communication in infrastructure and infrastructure-less networks with varying degrees of connectivity. We have also proposed efficient routing strategies adapted to environment with episodic connectivity that take into account the utility of nodes to relay messages. The various solutions have been evaluated using both simulations and real experimentations in testbeds located at Inria and UCSC. These solutions have demonstrated good performance in challenged networks.

However, the ossification of the Internet prevents the deployment of such solutions in large scale. So, in 2012 we decided to extend our collaboration in two research directions: (1) The exploration of the software-defined networking paradigm to facilitate the implementation and large scale deployment of new network architectures to infrastructure-less network environments, and (2) the design of innovative information-centric communication mechanisms adapted to challenged networks. In particular, we are designing mechanisms to p rovide flexible, efficient, and secure capacity sharing solutions by leveraging SDN in hybrid networked environments, i.e., environments that consist of infrastructure-based as well as infrastructureless networks. We are also investigating solutions to optimize caching in infrastructure and infrastructureless networks using SDN. We have also designed a content-optimal delivery algorithm, called CODA, for distributing named data over challenged networks. See the 2014 Update on the Community web site.

7.5. International Research Visitors

7.5.1. Visits of International Scientists

7.5.1.1. Visiting PhDs

> PhD Student: Sahar Hoteit
> Date: from May 12th 2014 until May 21st 2014
> Subject: On ICN Cache Allocation to Content Providers
> Institution: LIP6, University of Pierre and Marie Curie

7.5.1.2. Internships

> Student: Salim Afra
> Date: from March 2014 until August 2014
> Institution: Polytech Nice Sophia, Ubinet Master

> Student: Nicolas Aguilera Miranda
> Date: from October 2014 February 2015
> Subject: Measurements of users' quality of experience over Adkintun Mobile
> Institution: University of Chile

> Student: Lelio Renard-Lavaud
> Date: from April 2014 until July 2014
> Subject: Popularity and placement of content in Delay Tolerant Networks
> Institution: Ecole Polytechnique - Palaiseau

> Student: Hardik Soni
> Date: from March 2014 until August 2014
> Subject: On managing wireless mesh networks using an SDN architecture
> Institution: Polytech Nice Sophia, Ubinet Master

> Student: Mahdi Shoja
> Date: from March 2014 until August 2014
> Subject: Evaluation of network protocols with Direct Code Execution
> Institution: Polytech Nice Sophia, Ubinet Master

> Student: Phuong Tran Huu
> Date: from May 2014 until October 2014
> Subject: A Future Internet Technologies benchmark
> Institution: Polytech Nice Sophia

7.5.2. Visits to International Teams

Bruno Astuto A. Nunes and Thierry Turletti, visited UCSC in March in the context of the Community associated team.

Hardik Soni and Thierry Turletti, visited NICT and Univ. of Tokyo in november in the context of the Simulbed associated team.

DIONYSOS Project-Team

7. Partnerships and Cooperations

7.1. National Initiatives

7.1.1. ANR

- Adlen Ksentini is participating at 20% of his time to the IRT BCOM granted by the ANR.
- Yassine Hadjadj-Aoul is participating at 20% of his time to the IRT BCOM granted by the ANR.

7.2. European Initiatives

7.2.1. Collaborations in European Programs, except FP7 & H2020

7.2.1.1. QuEEN project

Program: CELTIC

Project acronym: QuEEN

Project title: Quality of Experience Estimators in Networks

Duration: October 2011 - January 2015

Coordinator: Orange Labs

Other partners: 24 partners in many European partners

Abstract: QuEEN is a large 3-year Celtic project going from end 2011 to January 2015. Its objectives are to develop automatic QoE measurement modules for Web services and applications, and to organize these measurement modules as a network of cooperative agents in order to allow each agent to take advantage of the measurements done by the others. Dionysos was involved in most of the activities of the project, and QuEEN partners have benefit from our experience in developing the PSQA technology. QuEEN involved many companies and academic institutions (24 European partners); the project leader was Orange Labs, in Sophia Antipolis.

For more details, visit http://celtic-queen.inria.fr/dokuwiki/doku.php?id=start

7.2.1.2. DPDM1

Program: IT for Knowledge Management, IT4 Innovations, National Supercomputing Center, Ostrava, Czech Republic

Project acronym: DPDM1

Project title: Database of Performance and Dependability Models 1

Duration: October 2014 – March 2015

Coordinator: Technical University of Ostrava

Other partners: Inria (G. Rubino, Dionysos)

Abstract: the project consists in using the supercomputing facilities at Ostrava to build very large models with known numerical solutions, that will serve as a benchmark to many types of techniques designed to compute numerically exact values, bounds, estimations, etc., under research efforts all over the world (areas: Markovian models, rare event problems, neural networks, etc.).

7.2.2. Collaborations with Major European Organizations

Partner 1: FTW, Vienna (Austria)

We work with FTW on network economics.

Partner 2: VTT, Oulu, Finland

We work with VTT on Quality of Experience estimation and use.

7.3. International Initiatives

7.3.1. Inria International Labs

7.3.1.1. CIRIC

In the context of CIRIC, we cooperate with the team of Reinaldo Vallejos, professor at the UTFSM, Valparaíso, Chile, on different topics related to networking and modeling issues. Specifically, these activities are organized around two collaborative projects, 7.3.2.1 and 7.3.4.1 , where one can find the scientific details. We start to work also with Javiera Barrera's team at the University Adolfo Ibañez, Santiago de Chile, on stochastic optimization problems.

7.3.2. Inria Associate Teams

7.3.2.1. MANAP

Title: MANAP (Markovian ANalysis and APplications)

International Partner (Institution - Laboratory - Researcher):

Universidad Técnica Federico Santa María (Valparaíso, Chile)

Duration: 2013 - · · ·

See also: http://people.rennes.inria.fr/Gerardo.Rubino/RESEARCH/MANAP/manap.html

This project has two goals. The main one is to develop techniques allowing to accelerate solving techniques for Markov models, both in equilibrium and in their transient phases. The applications behind these efforts are the evaluation of performance, dependability and performability properties of complex communication systems. The second goal is to apply these solving techniques to specific problems in networking, concerning optical and wireless infrastructures. On both cases there is some emphasis on dependability aspects: fault tolerance routing schemes in the first case, complex dependability characteristics and their analysis in the second one. A third explicit objective is to produce a software tool implementing the techniques coming from the main research direction of the project, designed to be used both by engineers and researchers.

7.3.3. Inria International Partners

7.3.3.1. MOCQUASIN

Title: Monte Carlo and Quasi- Monte Carlo for rare event simulation

International Partner (Institution - Laboratory - Researcher):

University of Montreal (Canada)

Duration: 2013 - · · ·

See also: http://www.irisa.fr/dionysos/pages_perso/tuffin/MOCQUASIN/

The goal of this team is to compute integrals, sums or to solve equations or optimization problems by means of Monte Carlo methods, which are statistical tools used when the models have a high complexity (for instance a large dimension). They are unavoidable tools in areas such as finance, electronics, seismology, computer science, engineering, physics, transport, biology, social sciences... Nonetheless, they have the reputation of being slow, i.e. to require a large computational time to reach a given precision. The goal of the project is to work on acceleration techniques, meaning methods allowing to reach the targeted precision in a shorter computational time. A typical framework is that of rare event simulation for which getting even only one occurrence of the event could require a very long time. In this case, there are two main acceleration techniques: importance sampling and splitting, on which we work.

7.3.4. Participation In other International Programs

7.3.4.1. Stic AmSud with UDELAR, Uruguay, and UTFSM, Chile

Program: Stic AmSud

Title: Accelerating Markov Models for analysis and design of dynamic WDM optical networks (AMMA)

Inria principal investigator: Gerardo Rubino

International Partners (Institution - Laboratory - Researcher):

> University of the Republic (UDELAR), Montevideo, Uruguay – Computer Science at the Engineering Faculty – prof. Héctor Cancela

> Technical University Federico Santa María (UTFSM), Valparaíso, Chile – Electronics Department – Prof. Reinaldo Vallejos

Duration: 2 years, Jan. 2013 – Dec. 2014

This project has two main scientific goals: (i) to develop methods capable of solving Markov models faster than with state-of-the-art techniques, and (ii) to apply these techniques to the design of fault-tolerant optical networks. The rationale behind (i) is that the group has ideas and some preliminary promising unpublished results that makes it expect that its approach will be effective in producing new nice solving procedures. Concerning (ii), we have already produced results in simpler cases (without taking into account failures), and we also have results on all the associated areas (dependability analysis, combinatorial optimization, etc.). These main research lines are completed with other goals all concerned with the quantitative analysis of such complex communication systems.

7.3.4.2. Math AmSud with UDELAR, Uruguay, and UV, Chile

Program: Math AmSud

Title: Stochastic Analysis, Statistics Inference, Numerical Analysiss (SIN)

Inria principal investigator: Gerardo Rubino

Main International Partners (Institution - Laboratory - Researcher):

> University of the Republic (UDELAR), Montevideo, Uruguay – Computer Science at the Engineering Faculty – prof. Paola Bermolen

> University of Valparaíso, Chile — Prof. Soledad Torres

Duration: 2 years, Jan. 2013 – Dec. 2014

Stochastic calculus with respect to the standard Brownian motion or more generally with respect to semi-martingales is currently one of the most important components of international research in probability theory. The applications of this theory largely exceed the original probabilistic framework and have repercussions in various fields, including differential geometry, differential partial equations, theoretical physics, modeling in finance, hydrology, telecommunications and biology. Recently, many authors have been interested in developing a stochastic calculus with respect to Gaussian processes which are not necessarily semi-martingales, as for instance the well known fractional Brownian motion. This research project is articulated around the analysis and the applications of stochastic differential equations driven by long memory processes.

SIN is a large project with many partners. Our team participates in looking at differential equations and stocastic differential equations as limits of discrete Markov processes.

7.4. International Research Visitors

7.4.1. Visits of International Scientists

- Professor Héctor Cancela

  > Subject: network reliability (see 7.3.4.1 , 7.3.2.1)

  > Institution: UDELAR, Montevideo, Uruguay

  > Duration: December 14 to December 31

- Professors Reinaldo Vallejos and Marta Barría

    Subject: network modeling and Markov chain analysis (see 7.3.4.1 , 7.3.2.1 , 7.3.1.1)

    Institutions: UTFSM and UV, Valparaíso, Chile

    Duration: October 17 to October 27

- Leslie Murray

    Subject: Monte Carlo methods (see 5.6)

    Institution: University of Rosario, Argentina

    Duration: November 21 to December 19

- Assistant Professor Pablo Romero

    Subject: network modeling and network reliability (see 7.3.4.1 , 7.3.2.1)

    Institutions: UDELAR, Montevideo, Uruguay

    Duration: September 4 to November 14

- Luis Gutiérrez Begovich

    Subject: neural networks

    Institution: IPN (Instituto Politécnico Nacional), Mexico DF, Mexico

    Duration: December 6, 2013, to February 28, 2014

- Assistant Professor Jorge Graneri

    Subject: neural networks and human memory modeling (preparation for a future PhD work)

    Institutions: UDELAR, Montevideo, Uruguay

    Duration: October 1 to November 21

7.4.2. Visits to International Teams

7.4.2.1. Research stays abroad

Gerardo Rubino

Date: Jan 6 - Jan 10

Institution: Kaust, Saudi Arabia

G. Rubino visited the Center for Uncertainty Quantification in Computational Science and Engineering, Kaust, Saudi Arabia, one week in January, where he gave a seminar. He also served at the international Advisory Board of this Center

Gerardo Rubino

Date: Jun 25 - Jun 28

Institution: National Supercomputing Center, Technical University of Ostrava, Czech Republic

This was a research visit, which included a tutorial on rare event analysis using Monte Carlo techniques, and the preparation of a project

<p style="text-align:center">**DYOGENE Project-Team**</p>

8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. GdR GeoSto

Members of Dyogene participate in Research Group GeoSto (Groupement de recherche, GdR 3477) http://gdr-geostoch.math.cnrs.fr/ on Stochastic Geometry led by Pierre Calka [Université de Rouen]. This is a collaboration framework for all French research teams working in the domain of spatial stochastic modeling, both on theory development and in applications.

8.1.2. ANR

8.1.2.1. ANR GAP

Graphs, Algorithms and Probability - PI: Marc Lelarge; started in Jan 2012 - 48 months. http://www.di.ens.fr/~lelarge/ANR-GAP.html

Over the last few years, several research areas have witnessed important progress through the fruitful collaboration of mathematicians, theoretical physicists and computer scientists. One of them is the cavity method. Originating from the theory of mean field spin glasses, it is key to understanding the structure of Gibbs measures on diluted random graphs, which play a key role in many applications, ranging from statistical inference to optimization, coding and social sciences.

The objective of this project is to develop mathematical tools in order to contribute to a rigorous formalization of the cavity method:

- From local to global, the cavity method on diluted graphs. We will study the extent to which the global properties of a random process defined on some graph are determined by the local properties of interactions on this graph. To this end, we will relate the cavity method to the analysis of the complex zeros of the partition function, an approach that also comes from statistical mechanics. This will allow us to apply new techniques to the study of random processes on large diluted graphs and associated random matrices.

- Combinatorial optimization, network algorithms, statistical inference and social sciences. Motivated by combinatorial optimization problems, we will attack long-standing open questions in theoretical computer science with the new tools developed in the first project. We expect to design new distributed algorithms for communication networks and new algorithms for inference in graphical models. We will also analyze networks from an economic perspective by studying games on complex networks.

8.1.2.2. ANR MARMOTE

Markovian Modeling Tools and Environments - coordinator: Alain Jean-Marie (Inria Maestro); local coordinator (for partner Inria Paris-Rocquencourt): A. Bušić; Started: January 2013; Duration: 48 months; partners: Inria Paris-Rocquencourt (EPI DYOGENE), Inria Sophia Antipolis Méditerranée (EPI MAESTRO), Inria Grenoble Rhône-Alpes (EPI MESCAL), Université Versaillese-St Quentin, Telecom SudParis, Université Paris-Est Creteil, Université Pierre et Marie Curie.

The aim of the project is to realize a modeling environment dedicated to Markov models. One part will develop the Perfect Simulation techniques, which allow to sample from the stationary distribution of the process. A second one will develop parallelization techniques for Monte Carlo simulation. A third one will develop numerical computation techniques for a wide class of Markov models. All these developments will be integrated into a programming environment allowing the specification of models and their solution strategy. Several applications will be studied in various scientific disciplines: physics, biology, economics, network engineering.

8.1.2.3. ANR MAGNUM

A. Bušić was a participant (within partner LIP6) of the national project ANR MAGNUM (Methodes Algorithmiques pour la Generation aleatoire Non Uniforme: Modeles et applications) (2010–2014), partners: LIP6, LIAFA, IGM. http://www-apr.lip6.fr/anrMagnum/.

8.2. International Initiatives

8.2.1. *Inria Associate Teams*

IT-SG-WN is an Associate Team between the Inria project-team DYOGENE of Inria Paris-Rocquencourt, and the EECS department of UC Berkeley in the USA, funded from 2011 to 2014. This Associate Team participates in the Inria@SiliconValley initiative. The last visit within this program was the one month visit of Prof. Venkat Anantharam (EECS, UC Berkeley). The research work focused on network information theory, and more precisely on error exponents for Gaussian MAC Channels [38] and led to an ISIT submission lately.

8.3. International Research Visitors

8.3.1. *Visits of International Scientists*

Prof. Pawel Lorek from Wroclaw University (Poland) visited DYOGENE for one week.

Prof. Venkat Anantharam (EECS, UC Berkeley) visited DYOGENE in June 2014, within IT-SG-WN Inria Associate Team.

Prof. A. Rybko and Prof. A. Vladimirov (IITP RAS) visited DYOGNE in June - July 2014.

8.3.2. *Visits to International Teams*

Ana Bušić visited MIT (2 months) and University of Florida (4 months) from March to August 2014.

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

7. Partnerships and Cooperations

7.1. Regional Initiatives

7.1.1. Tracaverre

Participants: Nathalie Mitton [correspondant], Gabriele Sabatino.

Title: Tracaverre

Type: FUI

Duration: November 2012 - Avril 2015

Coordinator: Saver Glass

Others partners: Inria FUN IEMN Courbon Camus La Grande Marque LIRIS DISP

Abstract: Tracaverre studies the use of RFID for traceability of prestigious bottles. Tracaverre has yielded to the implementation of the T-Scan software.

7.2. National Initiatives

7.2.1. ANR

7.2.1.1. RESCUE

Participants: Nathalie Mitton, Karen Miranda, Tahiry Razafindralambo [correspondant].

Title: Reseau Coordonne de substitution mobile

Type: VERSO

Duration: December 2010 - April 2014

Coordinator: Inria FUN

Other partners: LAAS UPMC France Telecom ENS Lyon

See also: http://rescue.lille.inria.fr/

Abstract: In RESCUE, we propose to exploit the controlled mobility of mobile routers to help a base network in trouble provide a better service. The base network may be any access network or metropolitan network (including wired and wireless technologies). Troubles may come from an increase of unplanned traffic, a failure of an equipment, or a power outage.

When no backup networks are available, it would be interesting to deploy, for a limited time corresponding to the period of the problem (i.e., failure or traffic overload), a substitution network to help the base network keep providing services to users. In the RESCUE project, we will investigate both the underlying mechanisms and the deployment of a substitution network composed of a fleet of dirigible wireless mobile routers. Unlike many projects and other scientific works that consider mobility as a drawback, in RESCUE we use the controlled mobility of the substitution network to help the base network reduce contention or to create an alternative network in case of failure.

7.2.1.2. BinThatThinks

Participant: Nathalie Mitton [correspondant].

Title: BinThatThinks

Type: ECOTECH

Duration: November 2010 - March 2014

Coordinator: Inria ACES (Rennes)

Other partners: Etineo Veolia

See also: http://binthatthink.inria.fr/

Abstract: Efficient dust sorting is a main challenge for the current society. BinThatThinks is a research project that aims to propose a system that makes the collect and sorting easier through the use of RFID and sensors. Publications in 2014 in the framework of this project are: [12], [13].

7.2.2. ADT

7.2.2.1. MiAOU

Participants: Ibrahim Amadou, Rim Driss, Nathalie Mitton [correspondant], Loic Schmidt, Julien Vandaele.

Title: Middleware Application to Optimal Use (MiAOU)

Type: ADT

Duration: December 2012 - November 2014

Coordinator: Inria FUN

Abstract: Miaou is an ADT that aims to promote the AspireRFID middleware to a new level of manageability and usability. Miaou has yielded to a software module.

7.2.2.2. ARUNTA

Participants: Emilio Compagnone, Valeria Loscri [correspondant], Julien Vandaele, Sonja Nienaber.

Title: Arduino-based Robots for Ubiquitous Network (ARUNTA)

Type: ADT

Duration: September 2014 - August 2016

Coordinator: Inria FUN

Abstract: This ADT focuses on the use of Arduino, an open-source electronics prototyping platform, really flexible and easy-to-use [1] to allow a fleet of robots to perform specific tasks. The goal of the ADT is to make experiments on Arduino-based robotic platforms, by implementing two robot cooperation algorithms that have been already tested through simulation tools. In order to extend the users' community and to allow more people to benefit from this research on robot cooperation, this ADT will output a tutorial and a test-bed will be developed. Moreover, the final project will be shared with the Arduino community and every interested user.

7.2.3. Equipements d'Excellence

7.2.3.1. FIT

Participants: Raymond Borenstein, Nathalie Mitton [correspondant], Anne-Sophie Tonneau, Julien Vandaele, Roberto Quilez.

Title: Future Internet of Things

Type: EquipEx

Duration: March 2010 - December 2019

Coordinator: UPMC

See also: http://fit-equipex.fr/

Abstract: FIT (Future Internet of Things) aims to develop an experimental facility, a federated and competitive infrastructure with international visibility and a broad panel of customers. It will provide this facility with a set of complementary components that enable experimentation on innovative services for academic and industrial users. The project will give French Internet stakeholders a means to experiment on mobile wireless communications at the network and application layers thereby accelerating the design of advanced networking technologies for the Future Internet.

FIT is one of 52 winning projects from the first wave of the French Ministry of Higher Education and Research's "Equipements d'Excellence" (Equipex) research grant program. Coordinated by Professor Serge Fdida of UPMC Sorbonne Universités and running over a nine-year period, the project will benefit from a 5.8 million euro grant from the French government.

7.3. European Initiatives

7.3.1. FP7 & H2020 Projects

7.3.1.1. VITAL

Participants: Nathalie Mitton [correspondant], Valeria Loscri, Riccardo Petrolo.

Type: FP7

Defi: Pervasive and Trusted Network and Service Infrastructure

Instrument: Specific Targeted Research Project

Objectif: A reliable, smart and secure Internet of Things for Smart Cities

Duration: September 2013 - August 2016

Coordinator: DERI

Partner: National University of Ireland (NUI), Inria, Reply (Italy), Silo (Greece), Atos (Spain), AIT (Greece), IMAGES (UK), Camden Town Unlimited (UK), ITU (Turkey), Istanbul Metropolitan Municipality (Turkey)

Inria contact: Nathalie Mitton

Abstract: Internet-of-Things (IoT) applications are currently based on multiple architectures, standards and platforms, which have led to a highly fragmented IoT landscape. This fragmentation is evident in the area of smart cities, which typically comprise several technological silos (i.e. IoT systems that have been developed and deployed independently). Nowadays there is a pressing need to remove these silos in order to allow cities to share data across systems and coordinate processes across domains, thereby essentially improving sustainability and quality of life. In response to this need, VITAL will realize a radical shift in the development, deployment and operation of IoT applications, through introducing an abstract virtualized digital layer that will operate across multiple IoT architectures, platforms and business contexts. Specifically, VITAL will provide platform and business context agnostic access to Internet-Connected-Objects (ICO). Moreover, it will research virtualized filtering, complex event processing (CEP) and business process management mechanisms, which will be operational over a variety of IoT architectures/ecosystems. The mechanisms will compromise the diverse characteristics of the underlying ecosystems, thereby boosting interoperability at the technical and business levels. VITAL will also provide development and governance tools, which will leverage the project's interfaces for virtualized access to ICOs. VITAL will allow solution providers to (re)use a wider range of data steams, thereby increasing the scope of potential applications. It will also enable a more connected/integrated approach to smart city applications development, which will be validated in realistic deployments in London and Istanbul. The partners will contribute and adapt a host of readily available urban infrastructures, IoT platforms and novel IoT applications, which will ease the accomplishment of the project's goals based on an optimal value for EC money.

Publications in 2014 in the framework of this project are: [6], [7], [11], [21], [22].

7.4. International Initiatives

7.4.1. Inria International Labs

7.4.1.1. PREDNET

Participants: Nathalie Mitton [correspondant], Viktor Toldov, Julien Vandaele, Cesar Marchal.

Title: Predator network

Type: LIRIMA

Duration: January 2013 - December 2016

See also: https://iww.inria.fr/prednet/en/

Abstract: PREDNET (PREDator adhoc NETwork) proposes to do research on the most suitable topology and subsequent deployment of a wireless sensor network for sparsely populated outlying rural and wilderness areas, for effective monitoring and protection of resources and ecosystems. This collaboration gave birth to joint project submission, joint conference organization and several publications, among them for 2014: [36]

7.4.1.2. CIRIC Chile

Participant: Tahiry Razafindralambo.

Tahiry Razafindralambo is in leave at Inria Chile since August 2013 until April 2014. Tahiry's project within Inria Chile is linked to a project developed by NIC research Labs - Chile (Dr. Javier Bustos, Ms. Carolina Sandoval, Mr. Felipe Lema and Ms. Karina Ventura) regarding Quality of Experience, the Universidad de Chile (Pr. Nelson Baloian and Pr. Gustavo Zurita Alarcon) regarding data display, Psicomedica regarding the clinical aspect regarding the wireless sensor networks aspect. The proposed project tries to evaluate the user perception regarding a wearable monitoring system. The Wearable monitoring system will be installed on patients with mental diseases to monitor their body temperatures, heart rate, ...

7.4.1.3. Declared Inria International Partners

Title: Palmares

International Partner (Institution - Laboratory - Researcher):

Université Mediterranea di Reggio Calabria (UNIC) (Italy)

Duration: 2014 - 2016

See also: http://www.palmares.unirc.it

Objective of this collaboration is the design of an innovative architecture that enables autonomic and decentralized fruition of the services offered by the network of smart objects in many heterogeneous and dynamic environments, in a way that is independent of the network topology, reliable and flexible. The result is an 'ecosystem' of objects, self-organized and self-sustained, capable of making data and services available to the users wherever and whenever required, thus supporting the fruition of an 'augmented' reality thanks to a new environmental and social awareness. This collaboration gave birth to the PALMARES project (see section International programs), students and researchers exchanges (see section international visits) and joint publications, among them for 2014: [1], [2], [28], [29], [23], [13].

7.4.1.4. Informal International Partners

Southern University, China

The purpose of this collaboration is to study the green (or energy-efficient) communication problem in vehicular ad hoc networks (VANETs) and the application of vehicular network communication in green transportation. It gave birth to joint project submission, joint conference organization and several publications, among them for 2014: [26], [27].

7.4.1.5. PhD co-supervision

PhD co-supervision with Sfax University

Since January 2013, Nathalie Mitton co-supervises Mouna Rekik as a PhD student with Pr Zied Chtourou from Université de Sfax, Tunisia. Her topic is about swarm intelligence based multi-path geographic routing for wireless sensor and actuator networks.

7.5. International Research Visitors

7.5.1. *Visits of International Scientists*

Several researchers have visited our group in 2014, mainly from our partner universities but not only:

- Marthinus Johannes Booysen, Univ. Stellenbosch, South Africa, July 2014
- Zied Chtourou, Univ. Sfax, Tunisia, June and December 2014
- Riaan Wolhuter, Univ. Stellenbosch, South Africa, March and June 2014
- Willem Smit, Univ. Stellenbosch, South Africa, July 2014
- OP Vyas, Indian Institute of Information Technology, India July 2014

In addition, 2 ERCIM fellows have visited us for a week : Andrea Hess and Matthew Orlinski.

7.5.1.1. Internships

We have hosted and supervised several master students. Some came to run their master internship in our lab, like

Christos Katsikiotis from Athenes University, Greece (6 months), Abdoul-Aziz Mbacke from Université Anta Diop in Senegal (6 months), Siavash Mohamadabadi from UPMC (4 months), Basile Mona from Université Jules Vernes (4 months)/.

Other students have visited us from our partner universities in the framework of the joint project we run together. This is the case for Sonja Nienaber (4 months) and Adriaan Zeeman (4 months) who came from Stellenbosch university, South Africa, in the framework of the Prednet program and Nicola Zema from our International partner University of Reggio Calabria, Italy (6 months).

7.5.2. Visits to International Teams

- Roudy Dagher visited University of Brno, Czech Republic a week in May 2014.
- Roudy Dagher visited University of Santanders, Spain in July 2014.
- Viktor Toldov visited Stellenbosch University, South Africa for 2 months (Oct-dec 2014).

7.5.2.1. Research stays abroad

Tahiry Razafindralambo spent 20 months in Chile (See other section).

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

7. Partnerships and Cooperations

7.1. National Initiatives

7.1.1. ANR Displexity

Participants: Carole Gallet Delporte, Hugues Fauconnier, Pierre Fraigniaud, Amos Korman, Adrian Kosowski, Laurent Viennot.

Managed by University Paris Diderot, C. Delporte and H. Fauconnier lead this project that grants 1 Ph. D.

Distributed computation keep raising new questions concerning computability and complexity. For instance, as far as fault-tolerant distributed computing is concerned, impossibility results do not depend on the computational power of the processes, demonstrating a form of undecidability which is significantly different from the one encountered in sequential computing. In the same way, as far as network computing is concerned, the impossibility of solving certain tasks locally does not depend on the computational power of the individual processes.

The main goal of DISPLEXITY (for DIStributed computing: computability and ComPLEXITY) is to establish the scientific foundations for building up a consistent theory of computability and complexity for distributed computing.

One difficulty to be faced by DISPLEXITY is to reconcile the different sub-communities corresponding to a variety of classes of distributed computing models. The current distributed computing community may indeed be viewed as two not necessarily disjoint sub-communities, one focusing on the impact of temporal issues, while the other focusing on the impact of spatial issues. The different working frameworks tackled by these two communities induce different objectives: computability is the main concern of the former, while complexity is the main concern of the latter.

Within DISPLEXITY, the reconciliation between the two communities will be achieved by focusing on the same class of problems, those for which the distributed outputs are interpreted as a single binary output: yes or no. Those are known as the yes/no-problems. The strength of DISPLEXITY is to gather specialists of the two main streams of distributed computing. Hence, DISPLEXITY will take advantage of the experience gained over the last decade by both communities concerning the challenges to be faced when building up a complexity theory encompassing more than a fragment of the field.

In order to reach its objectives, DISPLEXITY aims at achieving the following tasks:

- Formalizing yes/no-problems (decision problems) in the context of distributed computing. Such problems are expected to play an analogous role in the field of distributed computing as that played by decision problems in the context of sequential computing.

- Formalizing decision problems (yes/no-problems) in the context of distributed computing. Such problems are expected to play an analogous role in the field of distributed computing as that played by decision problems in the context of sequential computing.

- Revisiting the various explicit (e.g., failure-detectors) or implicit (e.g., a priori information) notions of oracles used in the context of distributed computing allowing us to express them in terms of decidability/complexity classes based on oracles.

- Identifying the impact of non-determinism on complexity in distributed computing. In particular, DISPLEXITY aims at a better understanding of the apparent lack of impact of non-determinism in the context of fault-tolerant computing, to be contrasted with the apparent huge impact of non-determinism in the context of network computing. Also, it is foreseen that non-determinism will enable the comparison of complexity classes defined in the context of fault-tolerance with complexity classes defined in the context of network computing.

- Last but not least, DISPLEXITY will focus on new computational paradigms and frameworks, including, but not limited to distributed quantum computing and algorithmic game theory (e.g., network formation games).

The project will have to face and solve a number of challenging problems. Hence, we have built the DISPLEXITY consortium so as to coordinate the efforts of those worldwide leaders in Distributed Computing who are working in our country. A successful execution of the project will result in a tremendous increase in the current knowledge and understanding of decentralized computing and place us in a unique position in the field.

7.1.2. *Laboratory of Information, Networking and Communication Sciences (LINCS)*

Participants: François Durand, The-Dang Huynh, Leonardo Linguaglossa, Laurent Viennot.

Gang is participating to the LINCS, a research centre co-founded by Inria, Institut Mines-Télécom, UPMC and Alcatel-Lucent Bell Labs, dedicated to research and innovation in the domains of future information and communication networks, systems and services. Gang contributes to work on online social networks, content centric networking and forwarding information verification.

7.2. International Initiatives

7.2.1. *Inria International Partners*

7.2.1.1. Informal International Partners

- Carole Delporte and Hugues Fauconnier collaborate with Sam Toueg (Univ. of Toronto) and Rachid Guerraoui (EPFL) on distributed computing and synchronization.
- Carole Delporte, Hugues Fauconnier and Pierre Fraigniaud collaborate on distributed computing with Eli Gafni (UCLA) and Sergio Rajsbaum (Univ. of Mexico).
- Pierre Fraigniaud collaborates with Zvi Lotker (Ben-Gurion Univ.) on social networks.
- Amos Korman collaborates with Ofer Feinerman (Weizmann Institute) on the application of distributed algorithm analysis to ant behaviors.

7.3. International Research Visitors

7.3.1. *Visits of International Scientists*

- Eli Gafni, UCLA, June - July 2014
- Sergio Rajsbaum, Univ. of Mexico, June - July 2014
- Zvi Lotker, Ben-Gurion Univ., September 2014 - July 2015 (Junior chair of the FSMP)

<p align="center">**HIPERCOM2 Team**</p>

8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. ANR

8.1.1.1. GETRF

Participants: Paul Muhlethaler, Pascale Minet, Cédric Adjih, Emmanuel Baccelli, Philippe Jacquet.

Period: 2012 - 2014.

Partners: DGA/MI, Inria (coordinator), Alcatel-Lucent.

The GETRF project aims at improving the effectiveness of communications mechanisms and technologies capable of functioning in extreme conditions and GETRF also aims at opening ways for solutions that are close to the optimum. The following areas will be addressed:

- Compromise time / maximum efficiency for coloring (TDMA), which can be used to take into account the asymmetry of traffic delays to optimize routing.
- Significant energy savings for opportunistic routing (in power saving mode) even where traffic control is limited and where the nodes are idle most of the time ("low-duty cycle")
- From a completely different point of view, the finding optimal network capacity for opportunistic routing variants when designed for mobile networks
- Robustness to mobility and to changes in network conditions (difficult connectivity, foes, ...) extreme network coding - which is moreover an innovative technology in itself applied here in MANETs, at the network and/or application layer, rather than at the physical/or theoretical level as in other proposals.

The project focuses on four technical approaches which are:

- Coloring for the development of a TDMA system for energy saving and delay control,
- Cross-layer (MAC/routing) mechanism for "low-duty-cycle" mode
- Network coding,
- Opportunistic routing and mobile mobility to use relays to minimize retransmissions of packets with a target time.

The first two approaches are intended to provide energy efficient sensor networks. The second two approaches try to provide mechanisms for building ad hoc networks capable of handling high node mobility.

In this last year of the project we finalize our studies on the four main mechanism of the GETRF project:

- energy saving mechanisms using synchronous techniques,
- energy saving mechanisms using asynchronous techniques,
- network coding,
- mobile routing.

In the last deliverable of the project, we study how these techniques can be combined. We also present how to improve asynchronous techniques for energy saving and how to adapt mobile routing to other assumptions.

8.1.2. Competitivity Clusters

8.1.2.1. SAHARA

Participants: Pascale Minet, Ridha Soua, Erwan Livolant.

Period: 2011 - 2014.

Partners: EADS (coordinator), Astrium, BeanAir, CNES, ECE, EPMI, Eurocopter, GlobalSys, Inria, LIMOS, Oktal SE, Reflex CES, Safran Engineering Systems.

SAHARA is a FUI project, labelled by ASTECH and PEGASE, which aims at designing a wireless sensor network embedded in an aircraft. The proposed solution should improve the embedded mass, the end-to-end delays, the cost and performance in the transfers of non critical data.

During year 2014, we provided support to the SMEs in the SAHARA project for the implementation of network algorithms and protocols.

8.1.2.2. CONNEXION

Participants: Pascale Minet, Ines Khoufi, Erwan Livolant.

Period: 2012 - 2016.

Partners: EDF (coordinator), All4Tec, ALSTOM, AREVA, Atos WorldGrid, CEA, CNRS / CRAN, Corys TESS, ENS Cachan, Esterel Technologies, Inria, LIG, Predict, Rolls-Royce Civil Nuclear, Telecom ParisTech.

The Cluster CONNEXION (Digital Command Control for Nuclear EXport and renovation) project aims to propose and validate an innovative architecture platforms suitable control systems for nuclear power plants in France and abroad. This architecture integrates a set of technological components developed by the academic partners (CEA, Inria, CNRS / CRAN, ENS Cachan, LIG, Telecom ParisTech) and based on collaborations between major integrators such as ALSTOM and AREVA, the operator EDF in France and "techno-providers" of embedded software (Atos WorldGrid, Rolls-Royce Civil Nuclear, Corys TESS, Esterel Technologies, All4Tec, Predict). With the support of the competitiveness clusters System@tic, Minalogic and Burgundy Nuclear Partnership,the project started in April 2012. The key deliverables of the project covered several topics related demonstration concern-driven engineering models for the design and validation of large technical systems, design environments and evaluation of HMI, the implementation of Wireless Sensor Network context-nuclear, buses business object or real-time middleware facilitating the exchange of heterogeneous data and distributed data models standardized to ensure consistency of digital systems.

The HIPERCOM2 team is focuses more particularly on the interconnection of the OCARI wireless sensor network with the industrial facility backbone and deployment algorithms of wireless sensors. In November 2014, we contributed with our Connexion partners to a demonstration showing that OCARI:

- supports wireless sensors of various types (e.g. temperature sensor PT100, smoke detector produced by CEA, fire alarm produced by ADWAVE);
- can be interconnected via a gateway to the industrial facility backbone OPC/UA ROSA developed by Telecom ParisTech to reach the KASEM system in charge of predictive maintenance developed by Predict.

All the chain ranging from the physical sensors, the OCARI wireless network, the OPC/UA bus to the KASEM software was integrated to allow information originated from wireless sensor nodes to be displayed on the KASEM console.

We also focus on deployment algorithms for mobile wireless sensor networks in a temporary worksite or after a disaster. These deployments must ensure coverage and network connectivity. In 2013 we studied solutions to ensure full coverage of the area to monitor as well as network connectivity. We proposed solutions in a first step for autonomous mobile wireless sensor nodes and in a second step for static ones. In May 2014, we showed in a Connexion demonstration a tool displaying the deployment of wireless static sensor nodes in an indoor environment. Since these static nodes are deployed by a mobile robot, we studied how to optimize the exposition duration of a robot in an hostile environment. We also focused on network connectivity, more particularly on how to ensure a reliable connectivity to the sink of sensor nodes located at some points of interest. Our goal is to find the best trade-off between the number of relay nodes deployed and the length of the paths connecting each PoI to the sink.

8.1.2.3. SWAN

Participants: Cédric Adjih, Claudio Greco.

Period: 2011 - 2014

Partners: CNRS, Supélec, Université Paris-Sud (L2S), LTCI, LRI, Inria and IEF.

SWAN, Source-aWAre Network coding, is a DIMLSC DIGITEO project. It deals with network coding for multimedia.

8.2. European Initiatives

8.2.1. FP7 & H2020 Projects

Paul Muhlethaler was reviewer of the projects:

- E3NETWORK (Energy Efficient E-band transceiver for backhaul of the future networks)
- TROPIC (Distributed computing, storage and radio resource allocation over cooperative femtocells)

8.3. International Initiatives

8.3.1. Participation In other International Programs

8.3.1.1. AWSN 2014

Program: Euromediterranean 3+3

Title: Auto-adaptivity in Wireless Sensor Networks

Inria principal investigator: Pascale Minet

International Partners (Institution - Laboratory - Researcher):

University of Catania (Italy) - DIEEI - Lucia Lo Bello

Ecole Nationale Supérieure d'Informatique et d'Analyse des Systèmes (Morocco) - ND-SRG - Mohamed Erradi

Ecole Nationale des Sciences de l'Informatique (Tunisia) - CRISTAL - Leila Azouz Saidane

Duration: Jan 2012 - Dec 2015

See the Web site: http://hipercom.inria.fr/euromed/

Wireless sensor networks (WSNs) allow the development of numerous applications in various domains, such as security and surveillance, environment protection, precision agriculture, intelligent transportation, homecare of elderly and disabled people...

Communication in such WSNs has to cope with limited capacity resources, energy depletion of sensor nodes, important fluctuations of traffic in the network, changes in the network topology (radio link breakage, interferences ...) or new application requirements. In the AWSN project, we focus on the different techniques to be introduced in the WSNs to make them auto-adaptive with regard to these various changes, while meeting the application requirements. Thus, we address:

- network deployment and redeployment in order to fulfill the application requirements,
- QoS (Quality of Service) optimization taking into account real-time traffic and dynamic bandwidth allocation,
- energy efficiency and replacement of failed sensor node,
- component generation and dynamic adaptation of the application.

In 2014, the AWSN project organized two workshops reserved to AWSN teams:

- Workshop in Rabat in October 2014.
- Workshop in Rocquencourt in December 2014.

The AWSN project organized also open workshops and conferences:

- the RAWSN 2014 workshop in Marrakech in May 2014 organized by the Moroccan team: see the program on http://www.netys.net/rawsn2014/, workshop held in conjunction with NETYS 2014.
- the PEMWN 2014 conference in Sousse in November 2014, organized by the Tunisian and French teams, see the program on https://sites.google.com/site/pemwn2014/final-program

8.4. International Research Visitors

8.4.1. Visits of International Scientists

- **Leila Saidane**, ENSI, Tunis, Tunisia, February and September 2013,
- **Mohammed Erradi**, ENSIAS, Rabat, Morocco, September 2013,
- **Abdellatif Kobbane**, ENSIAS, Rabat, Morocco, September 2013.

<p style="text-align:center">**INFINE Team**</p>

8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. *Equipex FIT*

Participants: Cedric Adjih, Emmanuel Baccelli, Ichrak Amdouni, Alaeddine Weslati, Vincent Ladeveze.

Partners: Inria (Lille, Sophia-Antipolis, Grenoble), INSA, UPMC, Institut Télécom Paris, Institut Télécom Evry, LSIIT Strasbourg.

FIT (Future Internet of Things) aims to develop an experimental facility, a federated and competitive infrastructure with international visibility and a broad panel of customers. It provides this facility with a set of complementary components that enable experimentation on innovative services for academic and industrial users. The project gives french internet stakeholders a means to experiment on mobile wireless communications at the network and application layers thereby accelerating the design of advanced networking technologies for the future internet. FIT was one of 52 winning projects from the first wave of the French Ministry of Higher Education and Research's "Équipements d'Excellence" (Equipex) research grant program, in 2011.

One component of the FIT platform is the sets of IoT-LAB testbeds (voir le site IoT-LAB). These were motivated by the observation that the world is moving towards an "Internet of Things", in which most communication over networks will be between objects rather than people.

The Infine team is now managing the FIT IoT-LAB site currently at Rocquencourt whose development has been started in 2010 (in the Hipercom team).

8.2. European Initiatives

8.2.1. *EU CHIST-ERA MACACO*

Participants: Aline Carneiro Viana, Emmanuel Baccelli, Eduardo Mucelli.

Program: EU CHIST-ERA, topic Context- and Content-Adaptive Communication Networks

Project acronym: MACACO

Project title: Mobile context-Adaptive CAching for COntent-centric networking

Duration: 2013-2016

Coordinator: Aline Carneiro Viana

Other partners: INPT-ENSEEIHT at University of Toulouse, University of Birmingham (UK), SUPSI (Switzerland), CNR (Italy) and Federal University of Minas Gerais (Brazil)

Abstract:

MACACO (Mobile context-Adaptive CAching for COntent-centric networking) is a 3-year CHIST-ERA European Project addressing the topic Context- and Content-Adaptive Communication Networks. It is funded by ANR in France, SNSF in Switzerland, and ESPRC in UK. It focus on data offloading mechanisms that take advantage of context and content information. Our intuition is that if it is possible to extract and forecast the behaviour of mobile network users in the threedimensional space of time, location and interest (i.e. 'what', 'when' and 'where' users are pulling data from the network), it is possible to derive efficient data offloading protocols. Such protocols would pre-fetch the identified data and cache it at the network edge at an earlier time, preferably when the mobile network is less charged, or offers better quality of service. This project has officially started in November 2013. The first annual report will be delivered before January 25, 2015.

8.2.2. Collaborations in European Programs, except FP7 & H2020

Participants: Emmanuel Baccelli, Cedric Adjih, Oliver Hahm.

Program: ANR/BMBF French-German partnership within CSOSG Framework

Project acronym: SAFEST

Project title: Social Area Framework for Early Security Triggers

Duration: 2012-2015

Coordinators: Emmanuel Baccelli (France), Jochen Schiller (Germany)

Other partners: Freie Universitat Berlin, Fraunhofer, Hamburg University, Sagem, Daviko, FOS

Abstract: Public spaces, such as airports, railway stations, or stadiums bring together large numbers of people on limited space to use security-sensitive infrastructure. These spaces pose two distinct challenges to public security: (a) detecting unauthorized intrusions and (b) monitoring large crowds in order to provide guidance in case of unexpected events (e.g., mass panic). To ensure the safety of the general public as well as individuals, we thus require a flexible and intelligent method for area surveillance. One example in which current monitoring systems proved to be dangerously inefficient is the Love Parade music festival in Duisburg, Germany, July 2010. Crowd control failed to provide guidance to a large crowd, resulting in a mass panic with 21 deaths and several hundred injured. In this particular case, overloaded communication infrastructure led to a lack of information about the density and the movement of the crowd, which in turn resulted in misjudgments on appropriate strategies to resolve the situation. This incident highlights the need for more sophisticated and reliable methods for area surveillance. The SAFEST project aims to analyse the social context of area surveillance and to develop a system that can fulfill this task, both in terms of technology as well as acceptance by the general public. The system will operate in distributed way, collect anonymised data, securely transfer this data to a central location for evaluation, and if necessary notify the operator and/or issue alerts directly to the general public. SAFEST addresses the following topics: (i) it proposes a solution for crisis management, addressing social, technical, and economic issues, (ii) it enhances the protection of the population against risks and dangers, including the evaluation of acceptance of said solution, and (iii) it addresses the protection of critical infrastructures by the means of a comprehensive technical solution.

8.3. International Initiatives

8.3.1. Participation In other International Programs

8.3.1.1. STIC AmSud UCOOL

Participants: Aline Carneiro Viana, Eduardo Mucelli.

Program: STIC AmSud

Project acronym: UCOOL

Project title: Understanding and predicting human demanded COntent and mObiLity

Duration: 2013-2015

Coordinator: Aline Carneiro Viana

Other partners: National Laboratory for Scientific Computing (Brazil), Facultad de Ingeniería, Universidad de Buenos Aires (Argentina), Universidad Tecnica Federico Santa Maria (Chile), Telecom Sud Paris, and Inria (with INFINE at Saclay and DANTE at Rhone-Alpes)

Abstract: The UCOOL (Understanding and predicting human demanded COntent and mObiLity, https://macaco.inria.fr/) project is granted by STIC-AmSUD, it is a 2-year project, and has officially started in January 2014. The main goal of this project is to define solutions for the identification and modelling of correlations between the user mobility – describing changes in the user positioning and the current environment he/she is in – and the traffic demand he/she generates.

8.3.1.2. STIC Asie URSA
Participant: Aline Carneiro Viana.

Program: STIC Asie

Project acronym: URSA

Project title: Urban Sensing for Ads Networks

Duration: 2012-2014

Coordinator: Stephane MAag (Telecom SudParis)

Other partners: Telecom SudParis, Inria, Fu Jen Catholic University (Taiwan), Institute for Infocomm Research (Singapore), and IFI (Vietnam).

Abstract: The URSA (Urban Sensing for Ads Networks, http://www-public.tem-tsp.eu/ maag/URSA/) project was granted by STIC-Asie. It was a 2-year project which has started in January 2013 and has just finished. URSA aims at defining an urban sensing network based on the mobility of users and the diffusion of advertisings by fixed elements.

8.4. International Research Visitors

8.4.1. *Visits of International Scientists*

Artur Ziviani, National Laboratory for Scientific Computing (LNCC), Brazil, October 2014.

José Ignacio Alvarez-Hamelin, Facultad de Ingeniería, Universidad de Buenos Aires, Argentina, October 2014.

Jorge Brea, GranData and Universidad de Buenos Aires, Argentina, October 2014.

Anelise Munaretto, Federal Technological University of the Parana (UTFPR), Brazil, October 2014.

Carlos Sarraute, GranData, Argentina, October 2014.

Don Towsley, University of Massachusetts - Amherst, USA, June 2014.

8.4.1.1. Internships

Lavanya Addepalli, Universidad Politecnica de Valencia, Spain, from Jun 2014 to Nov 2014.

8.4.2. *Visits to International Teams*

8.4.2.1. Research stays abroad

Emmanuel Baccelli has been visiting Freie Universitaet (FU) Berlin in 2014, within the context of the SAFEST project. The closer collaboration enabled by this stay allowed the initial development of the RIOT community http://www.riot-os.org, and the development of new activities around Information-centric networking in the Internet of Things. During his stay, Emmanuel Baccelli also taught a course on Computer Networking for graduate level. More details in the corresponding sections of this document.

<p style="text-align:center">**MADYNES Project-Team**</p>

8. Partnerships and Cooperations

8.1. Regional Initiatives

8.1.1. *Satelor AME Lorraine regional project*

Participants: Mandar Harshe, Bernardetta Addis, Evangelia Tsiontsiou, Ye-Qiong Song [contact].

MADYNES is involved in Satelor, a regional research and development project funded by the AME (Agence de Mobilisation Economique) of Lorraine (October 2013 – September 2016). The consortium includes academic (Univ. of Lorraine, Inria), medical (OHS) and industrial (Diatelic-Pharmagest, ACS, Kapelse, Salendra, Neolinks) partners. It aims at developing innovative and easily deployable ambient assisted living solutions for their effective use in the tele-homecare systems. Madynes team is mainly involved in the data collection system development based on wireless sensors networks and IoT technology. The first topic consists in defining the basic functions of the future SATEBOX – a gateway box for interconnecting in-home sensors to the medical datacenter, based on our previously developed MPIGate software. A first specification for achieving a beta-version prototype of the future Satebox gateway has been made. It is intentionally limited to only using Zigbee wireless sensors for providing a low-cost and easily deployable solution for the daily activity monitoring. Its first real-world deployment at a OHS hospital room has also bee carried out.Through this deployment, a lot of important lessons have been learn that enable us to improve the reliability, robustness and the accuracy of our system. The second topic is related to improving the data transfer reliability while still keeping minimum energy consumption. This has led us to focus on the multi-hop mesh network topology with multi-constrained QoS routing problem (PhD thesis of Evangelia Tsiontsiou). A state of the art study has shown the need to look for new routing algorithms and the interest of the newly developed operator calculus approach.

8.1.2. *Hydradrone R&D Lorraine UL project*

Participants: Adrien Guenard, Laurent Ciarletta [contact].

Funded by the Region Lorraine under the R&D program.

The Madynes team has been working on the Hydradrone project since July 2014. It is starting as a collaborative R&D regional research and development project, funded by Region Lorraine. This project is a joint work between Madynes and PEMA (Pedon Environnement et Milieux aquatiques), an SME/VSE (small and medium size Entreprise, PEM/TPE). The company is providing the use cases and terrain (and business) validation.

It consists in developing a new solution for the surveillance of aquatic environment, the Hydradrone :

- based on an hybrid UxV (Unmanned Air, Surface, Ground Vehicle),
- some Cyber Physical bricks in coherence with the Alerion concept
- and an integration in the Information System of the company

The first year is dedicated to the development of a couple hydradrone proofs of concept (the UxV) for both hardware and software (embedded / remote) and for the sensor payload "cyber physical" bricks.

The Alerion spinoff will join the consortium upon creation.

8.1.3. *6PO Research Region Lorraine and UL project*

Participants: Emmanuel Nataf, Ye-Qiong Song, Yael Kolasa, Laurent Ciarletta [contact].

Funded by Region Lorraine and Université de Lorraine since 2013. Vincent Chevrier is the point of contact for the dep. 5 at Loria. Adel Belkadi (CRAN & LORIA) is co-directed by L. Ciarletta and Didier Theilliol (CRAN correspondant).

6PO ("Systèmes Cyber-Physiques et Commande Coopérative Sûre de Fonctionnement pour une Flotte de Véhicules sans Pilote") is a joint research project between the Loria and CRAN laboratories. It aims at researching solutions for safe formation flying of collaborative UAVs seen as part of a collection of Cyber Physical Systems. This led to a common publication and the organisation of a workshop in 09/2014. It is reinforced by a PhD grant from the Federation Charles Hermite that started in october 2014. Efforts will be pursued in 2015.

The project provides common use cases and scientific challenges that serve as catalysts for collaboration between teams from different research topics :

- Cyber Physical Systems, Real Time, Quality of service, Performance and Energy in Wireless Sensors and Activator Networks
- Collaborative, communicating autonomous systems and Unmanned Vehicles
- Safety, Dependabilty, Reliability, Diagnosis, Fault-Tolerance

8.2. National Initiatives

8.2.1. *Quasimodo*

Participants: François Despaux, Abdelkader Lahmadi, Ye-Qiong Song [contact].

The QUASIMODO ANR Blanc international project (http://quasimodo.loria.fr/) is a fundamental research project coordinated by Prof. Ye-Qiong SONG at LORIA - University of Lorraine in France and by Prof. Youxian SUN at SKLICT of Zhejiang University in China. The project started on March 2011 and will be completed at the end of 2014. It is funded by ANR grant (ANR 2010 INTB 0206 01) and NSFC grant (NSFC 61061130563). The main objective of the project is to specify, develop and evaluate algorithms and mechanisms to provide the self-adaptive QoS support for real-time applications using wireless sensor networks (WSN). This year, the iQueue-MAC has been extended (see section 6.5.2) and we presented a method to estimate the e2e delay for a multi-hop scenario (section 6.5.2)

8.2.2. *ANR Doctor*

Participants: Thomas Silverston [contact], Thibault Cholez [contact], Elian Aubry, Jérôme François, Abdelkader Lahmadi, Olivier Festor.

The DOCTOR project is an applied research project funded by the French National Research Agency (ANR), grant <ANR-14-CE28-000>, and supported by the french Systematic cluster. The project officially started on October 2014 with a effective beginning of the scientific work on December 2014. It involves five partners specialized in network architectures, network monitoring and network security: three industrial partners (Orange Labs, Thales and Montimage) and two academic partners (Université de technologie de Troyes, LORIA).

Information-Centric Networking (ICN), a novel promising networking paradigm that allows adapting networks to current content-centric usage patterns, raises many deployment issues. The DOCTOR project advocates the use of virtualized network equipment (Network Functions Virtualization), enabling the co-existence of such IP and ICN stacks and the progressive migration of traffic from one stack to the other while guaranteeing the good security and manageability of the network that are primary operator requirements that need to be assured before deploying new solutions. Therefore in DOCTOR, the main goals of the project are: (1) the efficient deployment of emerging networks functions or protocols in a virtualized networking environment; (2) the monitoring and security of virtually deployed networking architectures.

This year, we mainly prepared the kickoff meeting that took place the 10th of December in Orange Labs, Issy-les-Moulineaux. We also started a joint work with UTT to write a survey on Named-Data Networking with an emphasis on the deployment and security questions.

8.2.3. *ANR LAR*

Participants: Kévin Roussel, Ye-Qiong Song [contact].

LAR (Living Assistant Robot) is a national project getting together Inria (MAIA and MADYNES teams), Credit Agricole, Diatelic and Robotsoft. The aim is to develop an ambient assisted living system for elderly including both sensors and assistant robots. The task of our team is the development of a WSN based system integrating both sensors of the environment and sensors and actuators embedded on a mobile robot. The research issues include the QoS, energy and mobility management. This year we identified RIOT OS as our software platform for developing both protocols and IoT applications. We also evaluated and fixed three hardware platforms (Zolertia MSP430 Z1, AVR ATmega256RFR2 and Arduino DUE) for the development of the project. We have improved the robustness of the existing ports of RIOT OS on MSP430-based motes. Two MAC protocols (S-CoSenS and iQueue-MAC) have been implemented on RIOT-OS (see section 6.5.2).

8.2.4. PEPS Humain - CNRS Project TrustSourcing

Participants: Thomas Silverston [contact], Vassili Rivron, Isabelle Chrisment.

Crowdsourcing relies on the participation of users collecting information in order to perform complex tasks. The participating users and the collected data should be of high quality for offering a trustable service to all the users. In the Trustsourcing project, we propose to design a Trust mechanism adapted to the crowdsourcing paradigm. Based on the current work initiated by the Metroscope/PRACTIC initiative, whose main goal is to study the usage of smartphone by measuring users' activity, we will propose to classify smartphone users and deduce some categories of trustable users. According to their "fingerprint" usage of their smartphone (time spent with phone, number of applications, messages etc.), we could estimate if an user will more probably belong to a category of trustable users or not. Our predictive mechanism will rely on the measurement of realistic users' activity and could help limiting drastically the impact of malicious users and the deterioration of the crowdsourcing service.

8.2.5. Action de Développement Technologique

8.2.5.1. ADT Métroscope

This ADT is linked to the consortium Metroscope [0], whose goal is to understand the behavior of the Internet and its uses within a mobile environment. Through this ADT, funded by Inria, an engineer (Mohammad-Irfan Khan) was hired for 2 years (2013-2015). He is participating in the design and deployment of a distributed platform. This platform is composed of a services providing measurement tools that collect a set of data and interact with probes located at various points of the network.

8.2.5.2. ADT SEA

The goal of this ADT is to provide an novel security solution for Android platforms where the users will be able to evaluate the security level of their devices. The solution relies on the analysis and collection of logs and network activities of running Android applications to detect malicious activities and also the detection of vulnerable configurations of the device using an OVAL-based approach. Through, this ADT, funded by Inria, an engineer (Eric Finickel) was hired for 2 years (2013-2015). He is working on the development of Android devices embedded probes to export logs and network activities. He will also design and setup the collector and the analysis applications using a Hadoop based framework. It is currently deployed in the High Security Lab.

8.2.5.3. ADT R2D2

The goal of this ADT is to provide assistance in developing the Aetournos platform. Through this ADT, funded by Inria, an engineer (Ceilidh Hoffmann) was hired for the year (2014). She has been helping maintaining the Aetournos platform, coordinating students work on the platform and tutoring the Aetournos team for the Outback Joe Search and Rescue Challenge. She is also developing tools for UAV localization using visual cues.

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[0] http://metroscope.eu/

8.2.6. Inria Project Lab PAL

The Inria Large-scale initiative action IPL PAL project (http://pal.inria.fr) aims at providing technologies and services for improving the autonomy and quality of life for elderly and fragile persons. Communication is one of the key components for ensuring real-time data gathering and exchange between heterogeneous sensors and actuators (robots). Within PAL project and using LORIA's smart apartment platform (http://infositu.loria.fr), we extended MPIGate (http://mpigate.loria.fr) functionalities by adding EnOcean sensors and defining a unified data format in JSON to ease the exchange with other data servers. The adoption of ROS (Robotic Operating System) as middleware also facilitates the interoperability of our services with the services of the other PAL partners since the new PALGate is based on ROS.

8.3. European Initiatives

8.3.1. FP7 & H2020 Projects

8.3.1.1. FI-WARE

        Type: COOPERATION Future Internet Core Platform

        Instrument: Integrated Project

        Objective/Topic: PPP FI - Technology Foundation: Future Internet Core Platform

        Duration: September 2011 - May 2014

        Coordinator: Telefonica (Spain)

        Partners: Thales, SAP, Inria

        Inria contact: Olivier Festor

        See also: http://www.fi-ware.eu

        Abstract: FI-WARE will deliver a novel service infrastructure, building upon elements (called Generic Enablers) which offer reusable and commonly shared functions making it easier to develop Future Internet Applications in multiple sectors. This infrastructure will bring significant and quantifiable improvements in the performance, reliability and production costs linked to Internet Applications, building a true foundation for the Future Internet.

The goal of the FI-WARE project is to advance the global competitiveness of the EU economy by introducing an innovative infrastructure for cost-effective creation and delivery of services, providing high QoS and security guarantees. The key deliverables of FI-WARE will be an open architecture and a reference implementation of a novel service infrastructure, building upon generic and reusable building blocks developed earlier.

The MADYNES contributions to the FI-WARE project are:

- Sicslowfuzzer, a fuzzing framework for the Internet of Things, that allows to assess the robustness of IoT OSes and applications, networkwise.
- Flowoid, a netflow probe for Android-based devices, which also provides a netflow location template to convey location information of the device;
- XOvaldi4Android, an OVAL interpreter for Android-based devices, that is able to retrieve OVAL definitions using a web service, use them to check the current status of the system, and publish a result, using a second web service;
- the coordination between the Security Work Package and the Inria teams involved in it. This includes the attending to weekly audio conferences, face to face meetings, and making sure deliverables and tasks were addressed in a timely manner.

During 2014, all the contributions of the Madynes team including the developed tools and their respective documentation have been delivered and validated by the Work Package leader.

8.3.1.2. Flamingo

Type: FP7

Instrument: Network of Excellence

Objective/Topic: Management of the Future Internet

Duration: November 2012 - October 2016

Coordinator: University of Twente (Netherlands)

Partners: University of Twente, Inria, University of Zurich, Jacobs University of Bremen, University des Bundeswehr Munich, Polytechnic University of Catalonia, Interdisciplinary Institute for Broadband Technology, University of Ghent, University College London

Inria contact: Olivier Festor

See also: http://www.fp7-flamingo.eu

Abstract: The FP7 FLAMINGO Network of Excellence is composed of 8 partner universities, with complementary knowledge and strong ties to industry. It covers the entire spectrum of network management core functions and application domains, which are required for building, integrating, and disseminating the knowledge of the management plane for the Future Internet.

The objectives of FLAMINGO are (a) to strongly integrate the research of leading European research groups in the area of network and service management, (b) to strengthen the European and worldwide research in this area, and (c) to bridge the gap between scientific research and industrial application. To achieve these goals, FLAMINGO performs a broad range of activities, such as to develop open source software, establish joint labs, exchange researchers, jointly supervise Ph.D. students, develop educational and training material, interact with academia and industry, organize event, and strongly contribute to (IETF and IRTF) standardization.

Our work on network and service monitoring has focused on security for mobile and low power networks. We have proposed a strategy for addressing DODAG-based attacks [25], jointly with Jacobs University of Bremen. We have also designed a distributed monitoring architecture in the context of advanced measurement infrastructures. These results are presented in section 6.3.5 . In addition, we have continued efforts with University of Twente on extending IP flow-based network monitoring with location information. These ones have been centered on additional use cases, applicability of associating IP Flows with metering processes location, and implementation guidelines from both metering process and collector sides.

We have also pursued activities on automated configuration and repair, with a particular focus on safe configuration and service orchestration issues, which are covered in section 6.3.1 .

8.4. International Initiatives

8.4.1. Inria International Labs

- LIRIMA (Laboratoire international de recherche en informatique et mathématiques appliquées): MADYNES is associated with the MASECNESS research team of the Yaoundé University in Cameroun. The collaboration is about wireless sensors networks and was the support for funding student mobility (3 months this year). The LIRIMA has also supported the purchase of thirty sensors used in our common work.

8.4.2. Inria International Partners

8.4.2.1. Declared Inria International Partners

- JFLI (CNRS UMI 3527) in Tokyo: Thomas Silverston is currently in this lab (délégation) in Tokyo. The main goal of his research work is to anticipate the evolution of the Internet and to focus on the design of new architectures for the Future Internet. His research program at the JFLI (CNRS, UMI 3527) focus on the use of SDN to allow deploying new network architecture and functionalities in virtualized environment (e.g., ICN) as well as providing a management plane to help network operators monitoring novel network architecture for the Future Internet.

- University of Luxembourg: we have several active cooperations with the university of Luxembourg around network security, Information Centric Networking and Software Defined Networking. Especially, we have one ongoing Ph.D. candidate (Samuel Marchal) and Jérôme François is a Fellow at SnT (Interdisciplinary Center for Security, Reliability and Trust) to empower these collaborations. Besides S. Marchal, we are working particularly with Radu State, Thomas Engel and Salvatore Signorello.

8.4.2.2. Informal International Partners

- University of Twente, The Netherlands, joint work with Professor Aiko Pras on large scale network monitoring and attack detection

- Jacobs University Bremen, joint PhD. with Professor Schoenwaelder on security management in wireless sensor networks

- Federal University of Rio Grande do Sul (UFRGS), joint work with Professor Granville on autonomic management systems

- University of the Federal Armed Forces, Munich Germany, joint work with Professor Gabi Dreo on cloud and mobile cloud security management

- Politecnico di Milano, Italy, joint work with Professor Antonio Capone and Giuliana Carello on energy-aware network management and cloud infrastructures

- Polytecnique de Montrèal, Canada, joint work with Professor Brunilde Sansò on energy-aware network management

- IASI-CNR (National Italian Center of Research), Italy, joint work with Sara Mattia on optimization methods for energy-aware survivable networks

- Zhejiang University (China), joint ANR-NSFC Quasimodo project with professors Youxian Sun, Jiming Chen and Zhi Wang on the adaptive QoS in WSN and multi-target tracking.

8.5. International Research Visitors

8.5.1. Visits of International Scientists

8.5.1.1. Internships

Pedro Paulo Martins Dos Santos

>> Subject: Flow-based malware signatures

>> Date: from Jun 2014 to Aug 2014

>> Institution: Universidade de Brasília, Brazil

8.5.1.2. Scientific visits

Participant: Raouf Boutaba.

>> Visiting Professor

>> Network and cloud managements

>> Date: from Jul to Aug 2014

>> University of Waterloo, Canada

Participant: Lamia Fourati-Chaari.

>> Visiting Assistant Professor

>> Content Centric Networks

>> Date: from mid-June to end June 2014

>> Institut d'Informatique et de Multimédia de Sfax (Tunisie)

Participant: Celia Ouanteur.

Visiting PhD student

Markov modeling of Low Latency Deterministic Networks (LLDN) of IEEE802.15.4e

Date: from May to June 2014

University A/Mira of Bejaia, Algeria

Participant: Xiufang Shi.

Visiting PhD student

ANR-NSFC Quasimodo joint project: multi-target location algorithm design

Date: from March to June 2014

Zhejiang University, China

Participant: Shuguo Zhuo.

Visiting PhD student

ANR-NSFC Quasimodo joint project: implementation of iQueue-MAC protocol on RIOT OS

Date: from May to August 2014

Zhejiang University, China

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

8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. ANR Marmote

Participants: Alain Jean-Marie, Issam Rabhi.

ANR Program: Modèles Numériques (MN) 2012, number ANR-12-MONU-0019

Project title: MARkovian MOdeling Tools and Environments

Duration: January 2013 - December 2016

Coordinator: Alain Jean Marie (Inria)

Partners: Inria (project-teams DYOGENE, MAESTRO and MESCAL), Univ. Versailles-Saint-Quentin (PRiSM lab.), Telecom SudParis (SAMOVAR lab.), Univ. Paris-Est Créteil (LACL), and Univ. Pierre-et-Marie-Curie (LIP6)

Abstract: ANRMARMOTE aims at realizing the prototype of a software environment dedicated to modeling with Markov chains. It brings together seven partner teams, expert in Markovian analysis, who will develop advanced solution algorithms and applications in different scientific domains: reliability, distributed systems, biology, physics and economics.

https://wiki.inria.fr/MARMOTE/Welcome

8.2. European Initiatives

8.2.1. FP7 & H2020 Projects

8.2.1.1. CONGAS

Participants: Eitan Altman, Konstantin Avrachenkov, Ilaria Brunetti, Yonathan Portilla, Alexandre Reiffers, Vikas Singh.

Project title: Dynamics and coevolution in multi level strategic interaction games

Type: FP7

Challenge: Future and Emerging Technologies

Instrument: Specific Targeted Research Project

Objective: FET Proactive: Dynamics of Multi-Level Complex Systems (DyM-CS)

Duration: October 2012 - September 2015

Coordinator: Francesco De Pellegrini (CREATE-NET)

Scientific Coordinator: Eitan Altman (Inria)

Other partners: Center for Research and Telecommunication Experimentation for Network Communities (Italy), Univ. d'Avignon et des Pays de Vaucluse (France), Technische Univ. Delft (The Netherlands), Imperial College of Science, Technology and Medicine (United Kingdom), Univ. di Pisa (Italy) and Technion - Israel Institute of Techonology (Israel)

Inria contact: Konstantin Avrachenkov

Abstract: CONGAS will develop new mathematical models and tools, rooted in game theory, for the analysis, prediction and control of dynamical processes in complex systems. It will provide a coherent theoretical framework for understanding the emergence of structure and patterns in these systems, accounting for interactions spanning various scales in time and space, and acting at different structural and aggregation levels.

MAESTRO's task is to develop game theoretic models to model (a) the formation of technological and social network; (b) the routing for competing agents; and (c) the competition of information in social networks.

http://www.congas-project.eu/

8.2.2. Collaborations in European Programs, except FP7 & H2020

Program: COST
Project acronym: ACROSS
Project title: Autonomous Control for a Reliable Internet of Services
Duration: November 2013 - November 2017
Coordinator: Rob Van Der Mei (CWI) and J.L. Van Den Berg (TNO), The Netherlands
Abstract: Currently, we are witnessing a paradigm shift from the traditional information-oriented Internet into an Internet of Services (IoS). This transition opens up virtually unbounded possibilities for creating and deploying new services. Eventually, the ICT landscape will migrate into a global system where new services are essentially large-scale service chains, combining and integrating the functionality of (possibly huge) numbers of other services offered by third parties, including cloud services. At the same time, as our modern society is becoming more and more dependent on ICT, these developments raise the need for effective means to ensure quality and reliability of the services running in such a complex environment. Motivated by this, the aim of this Action is to create a European network of experts, from both academia and industry, aiming at the development of autonomous control methods and algorithms for a reliable and quality-aware IoS.
Keywords: Service oriented internet, cloud services, autonomous control, reliability, pricing.
Website: http://www.cost-across.nl/

8.2.3. Collaborations with Major European Organizations

European Space Operations Centre: European Space Agency, Darmstadt (Germany)
Application of a BitTorrent-like data distribution model to mission operations. In the framework of this project with ESA we cooperate with Thales-Alenia Space (France) and with Teletel S.A. (Greece).

8.3. International Initiatives

8.3.1. Inria Associate Teams

8.3.1.1. THANES

Participants: Eitan Altman, Konstantin Avrachenkov, Jithin Kazhuthuveettil Sreedharan, Philippe Nain, Giovanni Neglia, Alexandre Reiffers.

Title: THeory and Application of NEtwork Science
Inria principal investigator: Giovanni Neglia
International Partner (Institution - Laboratory - Researcher):
  Univ. Federal do Rio de Janeiro (Brazil) - Department of Computer and Systems Engineering - Daniel Ratton Figueiredo
Duration: 2014 - 2016
See also: https://team.inria.fr/thanes/
Our goal is to study how services in Online Social Networks (OSN) can be efficiently designed and managed. This research requires to answer 3 main questions: 1) How can the topology of an OSN be discovered? Many services need or can take advantage of some knowledge of the network structure that is usually not globally available and in any case changes continuously due to structural dynamics. 2) How does services adoption spread across the OSN? On the one hand the popularity of a service is determined by word-of-mouth through the links of the OSN and, on the other end, the service may contribute to reshape the structure of the OSN (e.g. by creating new connections). 3) How do different services compete for the finite attention and money of OSN users? In particular our purpose is to provide analytical models (corroborated by simulations and experiments on real networks) to understand such complex interactions.

8.3.1.2. GANESH

Participants: Eitan Altman, Konstantin Avrachenkov.

Title: GAmes, OptimizatioN and Analysis of NEtworkS THeory and Applications

Inria principal investigator: Eitan Altman

International Partners (Institution - Laboratory - Researcher):

IISc Bangalore (India) - Electrical Communication Engineering - Anurag Kumar

IIT Mumbai (India) - Department of Electrical Engineering - Vivek Borkar

IIT Madras (India) - Electrical Engineering - Venkatesh Ramaiyan

Duration: 2012 - 2014

See also: http://www-sop.inria.fr/members/Eitan.Altman/Ganesh/Home.html

This project aims at producing outstanding contributions to the foundations of the theory of networks, in game theory, team theory, optimization and analysis. Three areas in networking will be used to apply these: (i) economy of networks and network neutrality, (2) scheduling in wireless networks, and (3) distributed optimization issues in ad-hoc networks.

8.3.2. Inria International Partners

8.3.2.1. Informal International Partners

MAESTRO has continued collaborations with researchers from GERAD, Univ. Montreal (Canada), Flinders Univ. (Australia), National Univ. of Rosario (Argentina), Technion - Israel Institute of Technology (Israel), Univ. of Arizona (USA), Univ. of Illinois at Urbana-Champaign (USA), Univ. of Liverpool (UK), Univ. of Massachusetts at Amherst (USA), Univ. of Palermo (Italy), and Univ. of Twente (The Netherlands); Petrozavodsk State Univ. (Russia); Ghent Univ. (Belgium); see Sections 8.4.1.1 and 8.4.2 .

8.3.3. Participation In other International Programs

E. Altman, I. Brunetti, M. Haddad, G. Neglia, A. Reiffers and J. K. Sreedharan participated in the CEFIPRA workshop on "New Avenues for Network Models" (13-15 January 2014) and the IFCAM workshop on Social Networks (16 January 2014). CEFIPRA and IFCAM organized these workshops to celebrate 6 years of successful collaboration between Inria and Indian institutions. The travel and accommodation expenses were supported by CEFIPRA and IFCAM.

8.4. International Research Visitors

8.4.1. Visits of International Scientists

8.4.1.1. Professors / Researchers

Vivek Borkar

Date: 17 November 2014 - 6 December 2014

Institution: IIT Bombay (India)

Pavel Chebotarev

Date: 19-26 September 2014

Institution: RAS Institute of Control Problems (Russia)

Mohamed Shaheen ElGamel

Date: 7-10 October 2014

Institution: AAST Alexandria (Egypt)

Fabio Fagnani

Date: 28-31 January 2014

Institution: Politecnico di Torino (Italy)

Daniel Figueiredo
> Date: 20-29 November 2014
>
> Institution: Univ. Federal do Rio de Janeiro (Brasil)

Anurag Kumar
> Date: 27 May 2014 - 4 June 2014
>
> Institution: IISc Bangalore (India)

Joy Kuri
> Date: 18-24 May 2014
>
> Institution: IISc Bangalore (India)

Evsey Morozov
> Date: 20-24 October 2014
>
> Institution: Petrozavodsk State Univ. (Russia)

Alexey Piunovskiy
> Date: 19-24 May 2014
>
> Institution: Univ. of Liverpool (UK)

Shanmugasundaram Ravikumar
> Date: 25-30 April 2014
>
> Institution: Google (USA)

Bruno Ribeiro
> Date: 6-15 July 2014, 24-28 November 2014
>
> Institution: Carneggie Mellon Univ. (USA)

Rajesh Sundaresan
> Date: 17 November 2014 - 6 December 2014
>
> Institution: IISc Bangalore (India)

Don Towsley
> Date: 18-21 February 2014
>
> Institution: Univ. of Massachusetts, Amherst (USA)

Sulan Wong
> Date: 9 December 2013 - 15 January 2014
>
> Institution: Univ. of A Coruña (Spain)

Uri Yechiali
> Date: 21 April 2014 - 4 May 2014
>
> Institution: Tel Aviv Univ. (Israel)

Yi Zhang
> Date: 19-24 May 2014
>
> Institution: Univ. of Liverpool (UK)

8.4.1.2. Ph.D. students

Giuseppe Di Bella
> Date: 1 May 2014 - 30 September 2014
>
> Institution: Univ. of Palermo (Italy)

Arnob Ghosh
> Date: 1 June 2014 - 31 August 2014

Institution: Univ. of Pennsylvania (USA)

Cristina Rottondi

Date: 1 April 2014 - 30 May 2014

Institution: Politecnico di Milano (Italy)

8.4.1.3. Internships

Aditya Aradhye

Date: 9 June 2014 - 11 July 2014

Institution: Madras Univ. (India)

Dalel Khalladi

Date: 1 March 2014 - 31 August 2014

Institution: Univ. Avignon (France)

Najmeddine Majed

Date: 1 May 2014 - 31 october 2014

Institution: SupCom Tunis (Tunisia)

Nedko Nedkov

Date: 1 April 2014 - 31 July 2014

Institution: National and Kapodistrian Univ. of Athens (Greece)

Shanay Shah

Date: 15 May 2014 - 14 July 2014

Institution: IIT Bombay (India)

Anastasiia Varava

Date: 1 March 2014 - 31 August 2014

Institution: Univ. of Nice Sophia Antipolis (France)

8.4.2. Visits to International Teams

8.4.2.1. Research stays abroad

MAESTRO members have visited (the)

- Create-Net, Italy in the period 14-19 April 2014 (**A. Reiffers**);
- Eurandom, The Netherlands in the period 20-24 January 2014 (**K. Avrachenkov**);
- Federal Univ. Of Rio de Janeiro, Brazil in the periods 30 July - 5 August 2014 (**E. Altman**) and 21-31 August 2014 (**G. Neglia** and **A. Reiffers**);
- Ghent Univ., Belgium in the period 15-16 December 2014 (**K. Avrachenkov**);
- Indian Institute of Science and Indian Institute of Technology (Mumbai), India in the period 11-23 January 2014 (**E. Altman**);
- National Univ. of Rosario, Argentina in the period 29 November - 16 December 2014 (**A. Jean-Marie**);
- Technion - Israel Institute of Technology, Tel Aviv, Israel in the periods 2-16 February 2014, 19 April - 3 May 2014 and 15-24 October 2014 (**E. Altman**) and 20 October - 17 December 2014 (**A. Reiffers**);
- Univ. of Bamberg, Germany in the period 19-21 March 2014 (**K. Avrachenkov**);
- Univ. of Delft, The Netherlands in the period 12-14 October 2014 (**E. Altman**);
- Univ. of Florence, Italy in the periods 14-18 July 2014 and 10-13 November 2014 (**G. Neglia**);
- Univ. of Illinois at Urbana-Champaign, USA in the period 1 October 2013 - 31 January 2014 (**M. El Chamie**);
- Univ. of Liverpool, UK in the period 30 March - 3 April 2014 (**K. Avrachenkov**);
- Univ. of Massachusetts at Amherst, USA in the periods 15 April – 16 May 2014 (**P. Nain**);
- Univ. of Waterloo, Canada in the period 16-19 July 2014 (**E. Altman**).

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

8. Partnerships and Cooperations

8.1. European Initiatives

8.1.1. User-Centric Networking (UCN)

Type: FP7
Instrument: Specific Targeted Research Project
Duration: October 2013 - September 2016
Coordinator: Technicolor
Other partners: Eurecom, Fraunhofer FOKUS, Intamac, University of Cambridge, University of Nottingham, Martel, NICTA, Portugal Telecom
Inria contact: Renata Teixeira
Abstract: This project introduces the concept of User Centric Networking (UCN), which is a new paradigm leveraging user information at large to deliver novel content recommendation systems and content delivery frameworks. UCN recommendation and content delivery systems will leverage in-depth knowledge about users to help them find relevant content, identify nearby network resources and plan how to deliver the actual content to the appropriate device at the desired time. These systems will additionally account for influences from users' social networks on their content consumption. The goal of this project is to design a UCN system architecture for user-centric connected media services. We will build UCN upon three complementary research pillars:

1. understanding user context: This data can be broadly categorized into three groups. First, the physical and environmental context A second category of data is that which can be extracted from social network interactions. The third category of data is behavioural

2. profiling and predicting user interests: By gaining a deep understanding of the user, we may be able to cast a much wider net in the content ocean and locate a richer catalogue of interesting content for the user

3. personalizing content delivery: Rather than the user (or the service provider) having to worry about the mode of connectivity, device, service, location, etc., the network intelligently directs and adapts the transport stream, or perhaps pre-fetches and replicates content chunks, to the particular and immediate needs of the user.

See also: http://usercentricnetworking.eu/

8.2. International Initiatives

8.2.1. Informal International Partners

- Georgia Institute of Technology (Prof. Nick Feamster and his doctoral students Srikanth Sundaresan and Sarthak Grover): We have a long-term collaboration on measuring the performance of residential broadband Internet access networks and more recently on home network diagnosis.
- ICSI, UC Berkeley (Prof. Vern Paxson, Dr. Christian Kreibich, Dr. Robin Sommer): With V. Paxson and C. Kreibich, we have been developing Fathom, a browser-based network measurement platform. We are now adding home network diagnosis capabilities to Fathom. In addition, with Robin Sommer we are working on the potential of matching the profiles of a user across multiple online social networks.

8.3. International Research Visitors

8.3.1. Internships

- O. Belkadi, master intern, National School of Applied Sciences (ENSA), Tangier, from Apr 2014 until Aug 2014.
- S. Grover, doctoral intern from Georgia Tech, from May 2014 until Aug 2014.
- M. Santoro, master intern, Universidad Politecnica de Valencia, from May 2014 until Sep 2014.

RAP Project-Team

6. Partnerships and Cooperations

6.1. International Research Visitors

RAP team has received the following people:

- Louigi Addario-Berry (McGill)
- Shankar Bhamidi (University of North Carolina at Chapel Hill)
- Christina Goldschmidt (Oxford)
- Ross Hemsley (Inria Sophia)
- Stefan Langerman (UL Bruxelles)
- Gabor Lugosi (Pompeu Fabra)
- Ahmed Kharroubi (Casablanca, Marrocco)
- Juan Pablo Vigneaux (Santiago, Chile)
- Cecile Mailler (University of Bath)

6.2. National Research Visitors

RAP team has received the following people:

- Nicolas Gast (Inria Grenoble)
- Olivier Devillers (Inria Sophia)
- Marie Albenque (Ecole Polytechnique)

SOCRATE Project-Team

8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. Equipex FIT- Future Internet of Things (2011-..., 1.064 k€)

The FIT projet is a national equipex (*equipement d'excellence*), headed by the Lip6 laboratory. As a member of Inria, Socrate is in charge of the development of an Experimental Cognitive Radio platform that should be used as test-bed for SDR terminals and cognitive radio experiments. This should be operational in 2013 for a duration of 7 years. To give a quick view, the user will have a way to configure and program through Internet several SDR platforms (MIMO, SISO, and baseband processing nodes).

8.1.2. ANR - Cormoran - "Cooperative and Mobile Wireless Body Area Networks for Group Navigation" (2012-2015, 150 keuros)

Cormoran project targets to figure out innovative communication functionalities and radiolocation algorithms that could benefit from inter/intra-BAN cooperation. More precisely, the idea is to enable accurate nodes/body location, as well as Quality of Service management and communications reliability (from the protocol point of view), while coping with inter-BAN coexistence, low power constraints and complying with the IEEE 802.15.6 standard. The proposed solutions will be evaluated in realistic applicative scenarios, hence necessitating the development of adapted simulation tools and real-life experiments based on hardware platforms. For this sake, Cormoran will follow an original approach, mixing theoretical work (e.g. modelling activities, algorithms and cross-layer PHY/MAC/NWK design) with more practical aspects (e.g. channel and antennas measurement campaigns, algorithms interfacing with real platforms, demonstrations).

8.1.3. ANR - MetalibM - "Automatic generation of function and filters" (2014-2017, 200 keuros)

The goal of the Metalibm project is to provide a tool for the automatic implementation of mathematical (libm) functions. A function f is automatically transformed into machine-proven C code implementing an polynomial approximation in a given domain with given accuracy. This project is led by Inria, with researchers from Socrate and AriC; PEQUAN team of Laboratoire d'Informatique de Paris 6 (LIP6) at Université Pierre et Marie Curie, Paris; DALI team from Université de Perpignan Via Domitia and Laboratoire d'Informatique, Robotique et Microélectronique de Montpellier (LIRMM); and SFT group from Centre Européen de Recherche Nucléaire (CERN).

8.1.4. FUI ECONHOME - "Energy efficient home networking" (2010-2014, 309 keuros)

The project aims at reducing the energy consumption of the home (multimedia) data networks, while maintaining the quality requirements for heterogeneous services and flows, and preserving, or even enhancing the overall system performance. the equipments under concern are residential gateways, set-top-boxes , PLC modules, Wifi extenders, NAS. The user equipment, such as smartphones, tablets or PCs are not concerned. The approach relies on combining both individual equipments IC and system level protocols that have to be eco-designed.

8.1.5. FUI SMACS - "SMart And Connected Sensors" (2013-2016, 267 keuros)

The SMACS projet targets the deployement of an innovating wireless sensor network dedicated to many domains sport, health and digital cities. The projet involves Socrate (Insavalor), HIKOB and wireless broadcasting company Euro Media France. The main goal is to develop a robust technologie enabling real-time localization of mobile targets (like cyclist for instance), at a low energy (more generaly low cost). The technology will be demonstrated at real cycling races (Tour de France 2013 and 2014). One of the goal is to include localisation information with new radio technology. Another subject of study is distributed wireless consensus algorithms for maintaining a neighborhood knowledge with a low energy budget that scales (more than 200 cycles together)

8.2. European Initiatives

8.2.1. Greentouch GTT project- "Interference Alignment" (2013-2014, 63 keuros)

The Greentouch GTT (Green transmission technology) project aims at proposiing new energy efficient transmission techniques, and focus specifically on the Energy efficiency - spectral efficiency (EE-SE) trade-off. Interference management is a critical issue and socrate aims at designing a dynamic and distributed approach allowing to cancel strong interfers by combining control theory and interference alignment principles.

8.3. International Initiatives

8.3.1. Inria International Partners

Socrate has strong collaborations with several international partners.

- **Princeton University**, School of Applied Science, Department of Electrical Engineering, NJ. USA. This cooperation with Prof. H. Vincent Poor is on topics related to decentralized wireless networks. Samir Perlaza has been appointed as Visiting Research Collaborator at the EE Department. Jean-Marie Gorce spent his Sabatical year at the EE Department. Scientific-Leader at Inria: Jean-Marie Gorce.
- **University of Sheffield**, Department of Automatic Control and Systems Engineering, Sheffield, UK. This cooperation with Prof. Inaki Esnaola is on topics related to information-driven energy systems. Scientific-in-charge at Inria: Samir Perlaza.
- **Virginia Tech**, Discovery Analytics Center, Department of Computer Science, Blacksburg, VA, USA. This cooperation with Prof. Ravi Tandon is on topics related to channel-output feedback in wireless networks. Scientific-Leader at Inria: Samir Perlaza.
- **University of Cyprus**, Department of Electrical and Computer Engineering, University of Cyprus (ECE), Nicosia, Cyprus. This cooperation with Prof. Ioannis Krikidis is on topics related to energy-harvesting and wireless communications systems. Scientific-Leader at Inria: Guillaume Villemaud.

8.3.1.1. Informal International Partners

- **Universidade Federal do Ceará**, Department of Tele-informatics, GTEL lab. A formal cooperation is currently under preparation but, exchange of researchers for seminars and courses already took place between 2012 and 2014. Mutual topics of interests include interference management and massive MIMO.

8.4. International Research Visitors

8.4.1. Visits of International Scientists

8.4.1.1. Sabbatical programme

Gorce Jean-Marie

Princeton University (USA). September 2013 - July 2014. CMIRA regional council Scholarship Programme.

8.4.1.2. Research stays abroad

Samir Perlaza spent few months visiting the following academic partners:

University of Sheffield (UK), May 2014 and October 2014.

Princeton University (UK), June - July 2014.

<center>

URBANET Team

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8. Partnerships and Cooperations

8.1. Regional Initiatives

- BQR INSA CROME 12/2013-12/2016
  Participants: Fabrice Valois
  The partners in this project are the CITI DynaMid team and LIRIS. The project studies the coordination of a fleet of mobile robots for the multi-view analysis of complex scenes.

- Labex IMU Priva'Mov 10/2013-10/2016
  Participants: Djamel Benferhat, Patrice Raveneau, Hervé Rivano, Razvan Stanica
  The partners in this project are DRIM LIRIS, Inria Privatics, INSA EVS, and LET ENTPE. The aim of this project is to develop and deploy a crowdsensing platform to collect mobility traces from a sample of real users equipped with android devices, while carrying research on privacy preservation issues. Our contribution consists on developing the platform and using the collected data to analyze cellular network offloading strategies.

8.2. National Initiatives

8.2.1. ANR

- ANR ABCD 10/2013-04/2017.
  Participants: Diala Naboulsi, Marco Fiore, Razvan Stanica
  The partners in the ANR ABCD project are: Orange Labs, Ucopia, Inria UrbaNet, UPMC LIP6 PHARE, Telecom ParisTech. The objective of ABCD is to characterize large-scale user mobility and content consumption in urban areas via mobile data mining, so as to achieve efficient deployment and management of cloud resources via virtual machines. Our contribution in the project consists on the characterization of human mobility and service consumption at a city scale, and the design of appropriate resource allocation techniques at the cellular network level.

- ANR IDEFIX 10/2013-04/2017.
  Participants: Soukaina Cherkaoui, Hervé Rivano, Fabrice Valois
  The partners in the ANR IDEFIX project are: Orange Labs, Alcatel Lucent - Bell Labs, Telecom Paris Tech, Inria UrbaNet, Socrate and Dyogene.

8.2.2. Pôle ResCom

- Ongoing participation (since 2006)
  Communication networks, working groups of GDR ASR, CNRS (http://rescom.inrialpes.fr). Hervé Rivano is member of the scientific committee of ResCom.

8.2.3. Common Laboratory Inria/Alcatel-Lucent Bell Labs

- ADR Green
  UrbaNet is part of the ADR Green of the common laboratory Inria/Alcatel-Lucent Bell Labs. This ADR provides the PhD grant of Soukaina Cherkaoui on the adaptation of wireless sensor network control protocols for optimizing the energy consumption of heterogeneous cellular LTE networks.

8.2.4. EquipEx

- SenseCity
We have coordinated the participation of several Inria teams to the SenseCity EquipEx. Within the SenseCity project, several small reproduction of 1/3rd scale city surroundings will be built under a climatically controlled environment. Micro and nano sensors will be deployed to experiment on smart cities scenarios, with a particular focus on pollution detection and intelligent transport services. Urbanet will have the opportunity to tests some of its capillary networking solutions in a very realistic but controlled urban environment. The first deployment is scheduled early 2015.

8.2.5. Inria Project lab

- CityLab
Urbanet is involved in the CityLab Inria Project Lab lead by Valérie Issarny. Within this project, Hervé Rivano is the networking referent for the PhD thesis of Raphael Ventura, advised by Vivien Mallet, in the Clime Inria team.

8.3. European Initiatives

8.3.1. FP7 & H2020 Projects

- ReFleX 04/2014-03/2018.
Participants: Marco Fiore
ReFleX (http://www.wcsg.ieiit.cnr.it/Reflex/website/) is a European Union-funded project, within the People Programme (Marie Curie Actions) of the European Union's Seventh Framework Programme (FP7/2007-2013) under Research Executive Agency grant agreement n.630211. ReFleX aims at characterizing in a comprehensive manner the topological features of large-scale urban vehicular networks built on top of DSRC-based V2V and V2I communication technologies. To that end, the project adopts a multidisciplinary approach, bringing together tools from vehicular networking, wireless communications, transportation theory, and complex network science.

8.4. International Initiatives

8.4.1. Inria International Partners

8.4.1.1. Informal International Partners

- **Politecnico di Torino (Italy)**. Multiple publications co-authored with members of the Telecommunication Networks Group.

- **University of Waterloo (Ontario, Canada)**. Cooperation and joint publications on the optimization of wireless mesh networks.

8.5. International Research Visitors

8.5.1. Internships

- S. Ancona, MS thesis, Politecnico di Bari, Italy: Offloading Cellular Networks through Residential Wi-Fi Access Points (4 months).

- A. Hadji, MS thesis, SupCom, Tunis, Tunisia: Coordination Model for Fleets of Mobile Robots (5 months).

- O. Jimenez Hidalgo, intern, Simon Bolivar University, Caracas, Venezuela: Visualization of Mobile Data Statistics (3 months).

- I. Keskes, MS thesis, ENIT Tunis, Tunisia: Floating Car Data Resource Allocation in Mobile Vehicular Networks (5 months).

- D. Martella, intern, Politecnico di Torino, Italy: Performance Evaluation of Coordinated Mobility Algorithms with Connectivity Constraints (3 months).

- P. Mikulski, intern, University of Lodz, Poland: Combining DSRC and VLC in Safety Vehicular Networks (3 months).
- B. Mordzak, intern, University of Lodz, Poland: Offloading Capacity of Residential Wi-Fi Networks (3 months)
- C. Ortegon Barajas, intern, University Icesi, Cali, Colombia: Performance Evaluation of Coordinated Mobility Algorithms with Connectivity Constraints (3 months).
- A. Vaidya, intern, Nanyang Technological University, Singapore: Simulation of Vehicular Networks (5 months).

8.5.2. Visits to International Teams

8.5.2.1. Research stays abroad

- **Razvan Stanica** and **Fabrice Valois** were visiting researchers at University of Yaoundé 1 (Cameroon), in June 2014 (one week).
- **Diala Naboulsi** was a visiting scholar within the Telecommunication Networks Group at Politecnico di Torino (Italy), between Sep 2013 and Jan 2014, under the CMIRA Explora'Doc programme.