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**Université des sciences et
technologies de Lille (Lille 1)**

Activity Report 2013

Project-Team ADAM

Adaptive Distributed Applications and Middleware

IN COLLABORATION WITH: Laboratoire d'informatique fondamentale de Lille (LIFL)

RESEARCH CENTER
Lille - Nord Europe

THEME
Distributed Systems and Services

Table of contents

1. Members	1
2. Overall Objectives	2
2.1. Introduction	2
2.2. Highlights of the Year	2
3. Research Program	3
3.1. Introduction	3
3.1.1. Aspect-Oriented Software Development (AOSD)	3
3.1.2. Component-Based Software Engineering (CBSE)	3
3.1.3. Context-Aware Computing (CAC)	4
3.2. Two Research Directions	4
3.2.1. Adaptable Component Frameworks for Middleware	4
3.2.2. Distributed Application Design for Adaptive Platforms	5
4. Application Domains	5
4.1. Introduction	6
4.2. Electronic Commerce	6
4.3. Embedded Systems	6
4.4. Health Care Information Systems	6
4.5. Information Systems for Terrestrial Transport	7
5. Software and Platforms	7
5.1. APISENSE	7
5.2. FraSCAti	7
5.3. PowerAPI	8
6. New Results	8
6.1. Self-Adaptive Software Systems	8
6.2. Energy Management in Software Systems	8
6.3. Automated Software Repair	9
7. Bilateral Contracts and Grants with Industry	9
7.1. France Telecom	9
7.2. Kaliterre	9
7.3. ip-label	9
7.4. dooApp	10
8. Partnerships and Cooperations	10
8.1. Regional Initiatives	10
8.1.1. ADT eSurgeon	10
8.1.2. ADT Adapt	10
8.1.3. North European Lab SOCS	10
8.1.4. LEDA	11
8.2. National Initiatives	11
8.2.1. ANR SocEDA	11
8.2.2. ANR MOANO	11
8.2.3. ANR YourCast	11
8.2.4. FUI Macchiato	12
8.2.5. FUI EconHome	12
8.2.6. FUI Hermes	12
8.2.7. FSN PIA Datalyse	12
8.2.8. Inria ARC SERUS	12
8.2.9. Inria ADT AntDroid	13
8.3. European Initiatives	13
8.4. International Initiatives	14

8.4.1. Inria Associate Teams	14
8.4.2. Inria International Partners	15
8.4.2.1. Declared Inria International Partners	15
8.4.2.1.1. University of Los Andes, Bogota, Colombia	15
8.4.2.1.2. University of Oslo, Norway	15
8.4.2.2. Informal International Partners	15
8.4.3. Participation in Other International Programs	15
8.4.3.1. OW2	15
8.4.3.2. ERCIM Working Group on Software Evolution	15
8.5. International Research Visitors	16
9. Dissemination	16
9.1. Scientific Animation	16
9.2. Teaching - Supervision - Juries	18
9.2.1. Teaching	18
9.2.2. Supervision	19
9.2.3. Juries	20
9.3. Popularization	20
10. Bibliography	21

Project-Team ADAM

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Creation of the Project-Team: 2008 January 01, end of the Project-Team: 2013 December 31.

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2. Overall Objectives

2.1. Introduction

With the increasing need of self-managed systems and the emergence of multi-scale environments, software developers have to cope with variability. Software must be developed to be adapted and reconfigured automatically on heterogeneous platforms in accordance with the unavoidable evolution of information and communication technologies. Therefore, the adaptation is now considered as a first-class problem that must be taken into account throughout the entire software life-cycle.

An *adaptive system* is a software-intensive system that can adjust and respond to changes in its environment, evolving requirements, removal of obsolete technologies or introduction of new technologies, and new knowledge. The objective of the ADAM project-team is to provide a set of paradigms, approaches and frameworks based on advanced software engineering techniques, such as *Component-Based Software Engineering* (CBSE), *Aspect-Oriented Software Development* (AOSD), or *Context-Aware Computing* (CAC), to build distributed adaptive software systems evolving in multi-scale environments and to take into account the adaptation all along the software life-cycle. We propose to follow two research directions: the definition of adaptable component frameworks for middleware and the design of distributed applications for adaptive platforms.

2.2. Highlights of the Year

Romain Rouvoy received the Best Paper Award on distributed systems of the 28th Symposium On Applied Computing (SAC) for the paper *Improving Context Interpretation by Using Fuzzy Policies: The Case of Adaptive Video Streaming* written in collaboration with Lucas Provensi, Frank Eliassen, and Roman Vitenberg from the University of Oslo (Norway) within the context of the *Sensor-as-a-Service* (SEAS) associate team. Furthermore, Romain Rouvoy has been invited as a keynote speaker of the French conference on software architectures (CAL - *Conférence sur les Architectures Logicielles*) to report on the contributions of the SEAS associate team in the area of designing distributed software architectures for sensor-based systems.

The APISENSE[®] crowd-sensing platform developed by the project-team has been awarded a research grant by the **Microsoft Azure for Research program** to work on the elastic processing of crowd-based datasets. This grant intends to leverage APISENSE[®] to support the real-time processing of big datasets collected in the physical world by a large crowd of smartphones. Examples of case studies covered in this area include the automatic inference of roadmaps, the continuous cartography of network coverage quality, or even the detection and the dynamic analysis of earthquakes. In particular, the unpredictable volume of data to be collected in the wild requires the adoption of elastic computation models and infrastructures to continuously provision the processing capabilities to fit uploads of information reports.

Gabriel Tamura has won the 2013 PRES Université Lille Nord de France International PhD Award for his PhD dissertation [85] on the reliable preservation of quality of service (QoS) contracts in self-adaptive distributed systems. The contribution is twofold. The first one is a model for component-based software systems where reconfiguration rules are viewed as typed attributed graphs [64] and where QoS-contracts are viewed as state machines in which transitions correspond to software reconfigurations. The second contribution is the characterization of adaptation properties to evaluate self-adaptive software systems in a standardized and comparable way. This work led to the development of the QOS-CARE framework that was the topic of several major publications [42], [43], [86], [84] in addition to the thesis dissertation itself.

BEST PAPER AWARD :

[36] Improving Context Interpretation by Using Fuzzy Policies: The Case of Adaptive Video Streaming in 28th ACM Symposium on Applied Computing (SAC) - 8th Track on Dependable and Adaptive Distributed Systems (DADS). L. PROVENSİ, F. ELIASSEN, R. VITENBERG, R. ROUYOY.

3. Research Program

3.1. Introduction

In order to cope with our objective, we will consider software paradigms that will help us in our approach at the various levels of our life-cycle of adaptive systems, but also in the tools themselves for their composition. We will also study these paradigms in the middleware and application design in order to extend them and to have a better understanding. These extensions will be formalized as much as possible.

3.1.1. Aspect-Oriented Software Development (AOSD)

In modern software engineering, language constructs are classified according to how they recombine partial solutions for subproblems of a problem decomposition. Some constructs (*e.g.*, methods and classes) recombine partial solutions using classic hierarchical composition. Others recombine the partial solution using what is known as crosscutting (a.k.a. aspectual) composition. With crosscutting composition, two partial solutions (called aspects) are woven into each other in a way that is dictated by so-called pointcut languages. The necessity of crosscutting composition is the main motivation for the AOSD [60], [68] paradigm. The challenge will be first to study new expressive pointcut languages in order to have a better description of composition locations in adaptable software. The second objective will be to extend and to integrate new techniques of weaving at design time, but also at run time in order to compose software safely. The third objective will be to go beyond simple aspects as persistence and logging services. We plan to study complex aspects such as transactions or replication and to control their weaving in order to master the evolution of complex software.

3.1.2. Component-Based Software Engineering (CBSE)

In a post-object world [65], software components [69] are, with other artifacts such as aspects, one of the approaches that aims at overcoming the limitations of objects and providing more flexibility and dynamicity to complex applications. For that, software components present many interesting properties, such as modularity, encapsulation, and composability. Yet, many different component models and frameworks exist. A survey of the literature references more than 20 different models (including the most well-known, such as EJB [59] and CCM [58]), but the exact number is certainly closer to 30. Indeed, each new author proposes a model to address her/his own need related to a particular execution environment (from grid computing to embedded systems) or the technical services (from advanced transactions to real-time properties), which must be provided to the application components. These different component models seldom interoperate and their design and implementation are never founded on a common ground. The research challenge that we identify is to define and implement solutions for adaptive software components. These components will be adaptive in the sense that they will be able to accommodate execution environments of various granularities (from grid computing, to Internet-based applications, to mobile applications, to embedded systems) and incorporate on-demand different technical services. This challenge will be conducted by designing a micro-kernel for software components. This micro-kernel will contain a well-defined set of core concepts, which are at the root of all component models. Several concrete software component models will then be derived from this micro-kernel.

3.1.3. Context-Aware Computing (CAC)

In adaptive systems, the notion of “*context*” becomes increasingly important. For example, mobile devices sense the environment they are in and react accordingly. This is usually enabled by a set of rules that infer how to react given a certain situation. In the Ambient/Ubiquitous/Pervasive domain ¹, CAC is commonly referred to as the new paradigm that employs this idea of context in order to enmesh computing in our daily lives [72]. Many efforts that exist today focus on human-computer interaction based on context. On the one hand, computational models, middleware, and programming languages are being developed to take the inherent characteristics of multi-scale environments into account, such as connection volatility, ambient resources, etc. An important challenge is to bridge the gap between the domain level and the computational level. The former is concerned with the expected behavior of the system from a user’s viewpoint, such as how and when a system responds to changes in the context, when information can be made public, etc. On the other hand, the computational level deals with the inherent and very stringent hardware phenomena of multi-scale environments. Nevertheless, both levels have to coexist: the computational level needs to be steered by the concepts, behavior and rules which exist at the domain level, whereas the domain needs to adapt to the specificities of the ever changing environment that is monitored and managed by the computational level. In order to address this challenge, we first intend to investigate representations at the domain level of concepts such as user profile, local positioning information and execution context [83]. Furthermore, a mapping has to be devised between these concepts and generic concepts at the computational level, the latter being as independent as possible from concrete platforms or languages. This mapping has to be bidirectional: the computational level needs to be steered by the concepts, behavior and rules that exist at the domain level, whereas the domain needs to adapt to the particulars of the ever-changing environment that is monitored and managed at the computational level. Furthermore, the mapping has to be dynamic since the changes have to be propagated between the levels at run time. An explicit domain level is not only useful for bridging the aforementioned gap, but also for designing and developing open task-specific languages at the domain level, which allow users to dynamically adapt the behavior of the applications in multi-scale environments in well-defined ways.

We will base the design approach of the future implementation prototype on Model Driven Engineering (MDE). The goal of MDE [80] consists of developing, maintaining and evolving complex software systems by raising the level of abstraction from source code to models. The latter is in our case the domain level, which will be connected to the computational level by means of MDE techniques. One added benefit of MDE is that it provides means for managing model inconsistencies.

3.2. Two Research Directions

We propose to follow two research directions to foster software reuse and adaptation. The first direction, that could be coined as the spatial dimension of adaptation, will provide middleware platforms to let applications be adapted to changing execution contexts. The second direction, the so-called temporal dimension of adaptation, will provide concepts and artifacts to let designers specify evolvable applications.

3.2.1. Adaptable Component Frameworks for Middleware

As a cornerstone of next generation software, adaptation is a property which must be present throughout the entire life cycle, from design to execution. We develop then a vision where adaptation is not only a property that is desirable for end-user applications, but also for the middleware platform that executes these applications. Until now, middleware is a rather specialized activity where each new environment forces the development of a corresponding platform, which is specific to the given environment. This has led to a large number of platforms (from Web Services, to EJB, to CORBA, to ad hoc middleware for embedded systems). Although at a high level, solutions for communication interoperability often exist between these platforms, they stay loosely coupled and separated. Furthermore, the concepts which are at the core of these platforms and their architectures are too different to allow, for example, sharing technical services.

¹These terms are more or less equivalent.

The research challenge that we propose here is to define and develop middleware and associated services which could be adapted to a broad range of environments from grid computing, to Internet-based applications, to local networks, to mobile applications on PDA's and smart phones, to embedded systems. The benefits of that are twofold. First, it enables the easier deployment of mobile applications in different environments by taking advantage of the common ground provided by adaptable middleware. Second, middleware is a rapidly changing domain where new technologies appear frequently. Yet, up to now, each new technological shift has imposed a complete re-development of the middleware. Having a common ground on which middleware is built would help in such transitions by fostering reuse. In terms of industrial output, the impact of these results will also be helpful for software editors and companies to adapt their products more rapidly to new and emerging middleware technologies.

This research challenge has close links with MDE and product line families. We believe that the added value of our proposal is to cover a more integrated solution: we are not only interested in middleware design with MDE technologies, but we also wish to integrate them with software component technologies and advanced programming techniques, such as AOP. We will then cover a broad spectrum of middleware construction, from design (MDE) to implementation (CBSE) to application development (AOP).

3.2.2. Distributed Application Design for Adaptive Platforms

Considering adaptation in the first design steps of an application allows for its preparation and follow-up during the entire life-cycle. As mentioned previously, some software paradigms help already in the design and the development of adaptable applications. AOSD proposes separation of concerns and weaving of models in order to increase the mastering and the evolution of software. MDE consists of evolving complex software systems by raising the level of abstraction from source code to models. Several programming approaches, such as AOP or reflective approaches, have gained in popularity to implement flexibility. Other approaches, such as CBSE, propose compositional way for reuse and compose sub-systems in the application building. Finally, context-aware programming for mobile environment proposes solutions in order to consider context evolution. Overall, the objective of these approaches is to assist the development of applications that are generic and that can be adapted with respect to the properties of the domain or the context.

The research challenge that we propose to address here is similar to static points of variation in product line families. We plan to study dynamic points of variation in order to take into account adaptation in the first design steps and to match this variation. The first research challenge is the introduction of elements in the modeling phase that allow the specification of evolution related properties. These properties must make it possible to build safe and dynamic software architectures. We wish to express and validate properties in the entire software life cycle. These properties are functional, non-functional, static, behavioral, or even qualitative properties. We also want to be able to check that all the properties are present, that the obtained behavior is the expected one, and that the quality of service is not degraded after the addition or the withdrawal of functionalities. We will base our approach on the definition of contracts expressed in various formalisms (*e.g.*, first order logic, temporal logic, state automata) and we will propose a composition of these contracts.

The second challenge will be to implement design processes that maintain coherence between the various stages of modeling in a MDE approach of the applications, as well as maintaining coherence between the phases of modeling and implementation. To do so, we will design and implement tools that will enable traceability and coherence checking between models, as well as between models and the application at execution time.

Finally, we will introduce context information in the development process. At the modeling level, we will represent concepts, behavior and rules of adaptive systems to express adaptation abstraction. These models will be dynamic and connected to implementation levels at the computational level and they will consider context knowledge. The goal is to bridge the gap between the computational level and the domain level in adaptive systems by synchronization of models and implementations, but also by representation of such common knowledge.

4. Application Domains

4.1. Introduction

The ADAM project-team targets the software engineering of adaptive service-oriented applications and middleware. The application domain covered by ADAM is broad and spans from distribution applications to middleware. In all these cases, adaptability is the property which is sought: applications and middleware must be adaptable to new execution contexts, they must react to changes in the environment and they must be able to discover and integrate new services.

The ADAM project-team produces software and middleware building blocks. This explains why the application domain is broad, yet targeting applications where adaptability is the key requirement. This includes electronic commerce, embedded systems, health care information systems, and terrestrial transport information systems. These domains are in direct relation with our currently funded activities. They act as testbeds for the solutions that we propose in terms of middleware services, middleware platforms, runtime kernels, component libraries, languages design or domain modeling.

4.2. Electronic Commerce

Applications in the domain of electronic commerce are by essence distributed. They involve many different participants with heterogeneous information systems which cannot be changed. The challenge is then to provide an adaptation layer to be able to compose and let these systems interoperate. In the context of the ANR TLog SCOrWare, the ICT SOA4All and the FUI CAPPUCINO projects, our activities in this domain aim at supporting service-oriented architectures. We want to have adaptive architectures that can be composed and orchestrated seamlessly. In this domain, the business relationship with customers is vital and many different usage scenarios must be supported. Customers are roaming, and the services must be kept operational across different devices. This puts some constraints on the server tier where technical services must be adapted to manage, for instance, long lasting transactions. The application server infrastructure must then provide a support for adapting technical services.

4.3. Embedded Systems

Embedded systems form a domain where adaptation is a key requirement. The design and the implementation of modern embedded software uses advanced software engineering techniques such model-driven development or software component frameworks. In this domain, we have been involved in several projects, such as the ANR TLog Flex-eWare, and the FUI MIND projects. Several challenges must be addressed here. For example, when a model-driven developed application is adapted, designers have to ensure that the models and the operational level are kept synchronized. The co-evolution of these two levels is one of the challenges that we are addressing. A second challenge is related to software components that need to be customized in order to fit the requirements imposed by constrained environments. It is, for example, a matter of providing component frameworks that can accommodate various granularities of services.

4.4. Health Care Information Systems

Health care information systems form a third application domain in which the ADAM project-team is involved, for instance through demonstrators which have been implemented in the context of the ANR TLog FAROS project. The challenge here is to provide a distributed infrastructure where information will be available to medical staff wherever they are. This imposes to be able to provide this information on many different devices (from high resolution screens to embedded devices on the scene of an accident), while ensuring the privacy of the medical data of a patient (several level of data access must be granted depending on the categories of medical staff). Given the vital role of such an information system, we want to provide guarantees that the services will be highly available and trustworthy. We envision to provide a service-oriented architecture which will be extended to support software contracts and multi-scale environments.

4.5. Information Systems for Terrestrial Transport

Information systems for terrestrial transport are also a domain that we are relying on. Applications are here characterized by frequent disconnections, poor quality network links, and high mobility. We want to provide an infrastructure where the technical services, and among others the communication services, can be adapted to support new requirements. One of the paths that we propose to investigate is to include such a scenario in the general context of the adaptiveness of component frameworks.

5. Software and Platforms

5.1. APISENSE

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

APISENSE[®] is a distributed platform dedicated to crowdsensing activities [30], [31], [24], [77], [67], [66]. Crowdsensing intends to leverage mobile devices to seamlessly collect valuable dataset for different categories of stakeholders. APISENSE[®] intends to be used in a wide variety of scientific and industrial domains, including network quality monitoring, social behavior analysis, epidemic predictions, emergency crisis support, open maps initiatives, wild applications debugging. APISENSE[®] is composed of a HIVE and an HONEYCOMB delivered as a *Platform-as-a-Service* (PaaS) to the stakeholders who can pilot and customize their own crowdsensing environment [77], and *Bee.mob* supporting participants with a mobile application to control the sensors to be shared with the rest of the world [30], [31]. The platform is used by the **Metroscope** project, an Internet scientific observatory initiative supported by Inria.

Web site: <http://www.apisense.fr>. Registered with the APP (*Agence pour la Protection des Programmes*) under reference IDDN.FR.001.080006.000.S.P.2013.000.10000 is pending. License: Proprietary.

5.2. FraSCaTi

Participants: Gwenaël Cattez, Philippe Merle [correspondant], Fawaz Paraïso, Romain Rouvoy, Lionel Seinturier.

FRASCATI is a service-oriented component-based middleware platform implementing OASIS *Service Component Architecture* (SCA) specifications. The main originality of OW2 FRASCATI is to bring FRACTAL-based reflectivity to SCA, *i.e.*, any FRASCATI software component is equipped with both the SOA capabilities brought by SCA and the reflective capabilities (*i.e.*, introspection and reconfiguration) brought by FRACTAL. Various micro-benchmarks have shown that FRASCATI reflectivity is achieved without hindering its performance relative to the de facto reference SCA implementation, *i.e.*, Apache Tuscany. Non-functional concerns (logging, transaction, security, etc.), so called intents in SCA terms, are also programmed as FRASCATI components and are (un)woven on business components dynamically at runtime, this is based on aspect-oriented concepts defined in FAC [78]. OW2 FRASCATI supports various implementation technologies (SCA Composite, Java, WS-BPEL, Spring Framework, OSGi, Fractal ADL, native C library, Apache Velocity templates, and seven scripting languages as BeanShell, FScript, Groovy, JavaScript, JRuby, Jython, XQuery) for programming services or integrating legacy code, various binding protocols (SOAP, REST, JSON-RPC, UPnP, HTTP servlets, Java RMI, JMS, JGroups) and interface definition languages (WSDL, Java, WADL) for inter-operating with existing services. OW2 FRASCATI provides management tools like standalone, Web-based, and JMX-based graphical consoles and a dedicated scripting language for reconfiguring SCA applications. The whole OW2 FRASCATI platform is itself built as a set of reflective SCA components.

Inria Evaluation Committee Criteria for Software Self-Assessment: A-4-up, SO-4, SM-4-up, EM-3-up, SDL-4-up, DA-4, CD-4, MS-4, TPM-4. FRASCATI is a project of the OW2 consortium for open-source middleware. Web site: <http://frascati.ow2.org>. 292 Kloc (mainly Java). Registered with the APP (Agence pour la Protection des Programmes) under reference FR.001.050017.000.S.P.2010.000.10000. License: LGPL. Embedded into several industrial software systems: EasySOA, Petals Link EasyViper, EasyBPEL, EasyESB, OW2 PETALS, OW2 Scarbo. Various demonstrators built during funded projects: ANR SCOrWare, FP7 SOA4All, ANR ITeMIS, ANR SALTY, ANR SocEDA, FUI Macchiato, FUI EasySOA, ADT Galaxy and ADT Adapt. Main publications: [82], [81], [70], [71], [62], [61].

5.3. PowerAPI

Participants: Aurélien Bourdon, Maxime Colmant, Loïc Huertas, Adel Noureddine, Romain Rouvoy [correspondant].

PowerAPI is a Scala-based library for monitoring energy at the process-level. It is based on a modular and asynchronous event-driven architecture using the Akka library. PowerAPI differs from existing energy process-level monitoring tool in its pure software, fully customizable and modular aspect which let users precisely define what they want to monitor, without plugging any external device. PowerAPI offers an API which can be used to express requests about energy spent by a process, following its hardware resource utilization (in terms of CPU, memory, disk, network, etc.). Its applications cover energy-driven benchmarking [74], [50], [49], [23], energy hotspots and bugs detection [75], [76] and real-time distributed system monitoring.

Web site: <http://www.powerapi.org>. Registered with the APP (Agence pour la Protection des Programmes) under reference IDDN.FR.001.400015.000.S.P.2012.000.10000. License: AGPL.

6. New Results

6.1. Self-Adaptive Software Systems

Participants: Russel Nzekwa, Romain Rouvoy [correspondant], Lionel Seinturier.

The design of self-adaptive and autonomic software systems raises many challenges. In his PhD thesis, Russel Nzekwa [12] proposes a new result with the CORONA framework that enables to build flexible autonomic systems. CORONA relies on an architectural description language which reifies the structure of the control system architecture. CORONA enables the flexible integration of non-functional-properties during the design of autonomic systems. It also provides tools for checking conflicts in the architecture of autonomic systems. Finally, the traceability between the design and the runtime implementation is carried out through the code generation of skeletons from architectural descriptions of control systems. The work on CORONA goes toward the long term objective of setting up an integrated design and programming solution for self-adaptive systems, where feedback control loops play the central role as first class elements.

6.2. Energy Management in Software Systems

Participants: Rémi Druilhe, Laurence Duchien, Lionel Seinturier [correspondant].

Energy management and saving is a concern that spans the entire domain of information and communication technologies and sciences. Recently it has been recognized that to improve its efficiency, energy has to be managed, not only at the hardware level, but also at the level of software systems, especially in distributed environments. In his PhD thesis, Rémi Druilhe [11] proposes a new result with the HOMENAP system for networked digital home environments. This work is the result of a collaboration with Orange Labs. HOMENAP takes into account three main properties: heterogeneity, dynamicity and quality of service. HOMENAP proposes an autonomic decision-making system to deal with the placement of digital services on networked devices. Based on the observation of relevant events, the system takes the decision to modify the distribution of digital services on devices in order to preserve a defined tradeoff between energy efficiency and quality of service. HOMENAP participates to the long term objective of dealing with energy as a main steering factor for self-optimizing software systems.

6.3. Automated Software Repair

Participant: Martin Monperrus [correspondant].

Automated software repair aims at assisting developers in order to improve the quality of software systems, for example by recommending some repair actions to fix bugs. In [15], we present some major results in this direction by mining fix transactions of existing software repositories. From the empirical study of 14 software repositories containing 89,993 versioning transactions, we show that we can learn a probability distribution of repair actions. We show that certain distributions over repair actions can result in an infinite time (in average) to find a repair shape while other fine-tuned distributions enable to find a repair shape in hundreds of repair attempts. We now aim at going beyond this empirical study and theoretical analysis by exploring how to use this learned knowledge for new software systems.

7. Bilateral Contracts and Grants with Industry

7.1. France Telecom

Participants: Rémi Druilhe, Laurence Duchien [correspondant], Romain Rouvoy, Lionel Seinturier, Amal Tahri.

DigiHome is a contract with France Telecom to study the adaptation of software systems in distributed digital home environments. These environments and their extensions (vehicles, holiday homes, work at home) are now invaded by a multitude of communicating objects dedicated to content management, viewing multiple video streams, or information sharing within a community network. These objects offer services with capacities of configuration and remote administration, and advanced interactions with the end-user or between devices or services. Given the lack of universality of proposals from IT and device companies and the lack of interoperability of these devices and services, it becomes necessary to offer a virtual environment named Extended Digital Home to encompass and unify these proposals and make life easier for the inhabitants. First, we will propose a unified model for integrating devices and services inside and outside the home with a continuum between private and public lives. Second, we will study an energy model to save energy in this extended environment. Overall, the goal of this project will be to propose to design a model for a cloud inside home and to provide some means to reduce the energy using on media devices. First results have been published in [73] and [63]. This contract is complemented by two contracts, which are the CIFRE contract associated to Rémi Druilhe PhD thesis [11] and the CIFRE contract associated to Amal Tahri PhD thesis.

7.2. Kaliterre

Participants: Aurélien Bourdon, Romain Rouvoy [correspondant].

Web Energy Archive (WEA) is a project funded by the French Environment and Energy Management Agency (ADEME) to archive the energy consumption of Web sites that are accessible on the Internet. The objective of this project is to constitute an international referential on the evolution of the Web energy consumption. The adopted methodology focuses on the quality of experience and measures the energy consumed by users when they browse a specific website. The benefit of this approach is that it is representative of Internet usages and takes into account the variety of Web browsers and computer architectures. The software solution developed by this project will build on the [HTTP Archive project](#), initiated by Google, and will extend it with consumption measures that will be collected by our PowerAPI library. The objective of this collaboration is to port our solution to the Windows operating system.

7.3. ip-label

Participants: Nicolas Haderer, Christophe Ribeiro, Romain Rouvoy [correspondant].

This collaboration aims at transferring APISENSE[®] in the industry by investigating the deployment of this platform as a solution to monitor the quality of the GSM signal in the wild. The objective is to provide developers and stakeholders with a feedback on the quality of experience of 3G connection depending on their location.

7.4. dooApp

Participant: Martin Monperrus [correspondant].

The collaboration with dooApp aims at studying a bi-directional automated link between the specifications and standards they work with (from AFNOR, ISO) and their code base in order to facilitate and automate software evolutions.

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 Adapt

Participants: Gwenaël Cattez, Philippe Merle [correspondant].

ADT Adapt (2011–13) is a technology development initiative supported by the Inria Lille - Nord Europe Center that aims at building a demonstrator of our ADAM software technologies in the application domain of smart digital homes. Firstly, this demonstrator will show adaptive and reflective capabilities of FraSCAti (see Section 5.2), *i.e.*, supporting various implementation languages (*e.g.*, Java, WS-BPEL, scripting languages, template technologies) to develop business components, supporting various remote communication protocols (*e.g.*, SOAP, REST, JMS, JGroups) to access and expose services, supporting various non functional properties, deploying business components on demand, and reconfiguring business applications/components/services at runtime. Secondly, these capabilities will be illustrated on several ambient intelligence scenarios, *e.g.*, Fire Emergency and Home Automation. Thirdly, this demonstrator will integrate our recent and future scientific results in the domains of dynamic software product lines, autonomic computing, control loops, complex event processing, energy control, etc. Gwenaël Cattez (recent graduated engineer) has been recruited in the context of this ADT.

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 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 (Self-Optimization of Cyber-physical Systems) therefore intends to extend the technologies developed as part of the SEAS associate team and more recently the APISENSE platform (see Section 5.1) to leverage the development of agile CPS.

8.1.4. LEDA

Participants: Gwenaël Cattez, 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 ADAM project-team in the domains of distributed systems, adaptable middleware, software product lines, green computing, and ambient computing. These results are illustrated around the scenario of a mock digital home.

- **North European Lab SOCS** (2013–2015) 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 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 (Self-Optimization of Cyber-physical Systems) therefore intends to extend the technologies developed as part of the SEAS associate team and more recently the APISENSE[®] platform (see Section 5.3) to leverage the development of agile CPS.

Participants: Maria Gomez Lacruz, Nicolas Haderer, Christophe Ribeiro, Romain Rouvoy, Lionel Seinturier.

8.2. National Initiatives

8.2.1. ANR SocEDA

Participants: Nabil Djarallah, Fawaz Paraïso, Romain Rouvoy, Lionel Seinturier [correspondant].

SocEDA is a 36-month ANR ARPEGE project started in November 2010 and involving EBM WebSourcing, ActiveEon, EMAC, I3S, LIG, LIRIS, Inria ADAM, France Telecom and Thales Communications. The goal of SocEDA is to develop and validate an elastic and reliable federated SOA architecture for dynamic and complex event-driven interaction in large highly distributed and heterogeneous service systems. Such architecture will enable exchange of contextual information between heterogeneous services, providing the possibilities to optimize/personalize their execution, according to social network information. The main outcome will be a platform for event-driven interaction between services, that scales at the Internet level based on the proposed architecture and that addresses Quality of Service (QoS) requirements.

8.2.2. ANR MOANO

Participants: Nabil Djarallah, Laurence Duchien [correspondant], Nicolas Petitprez.

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 of Lille/LIFL/Inria. 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 not 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.

8.2.3. ANR YourCast

Participants: Laurence Duchien [correspondant], Clément Quinton, Daniel Romero.

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 Inria ADAM. 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.

8.2.4. *FUI Macchiato*

Participants: Nabil Djarallah, Laurence Duchien [correspondant], Nicolas Petitprez, Romain Rouvoy.

Macchiato is a 36-month project of the competitiveness cluster PICOM (**Pôle des Industries du COMmerce**), which has started in January 2011. The partners of this project are Auchan (leader), University of Bordeaux/LABRI, Inria, and the Web Pulser SME. The Macchiato project aims at rethinking the design of e-commerce sites to better integrate the Internet of Things and facilitate online sales. In addition to setting up an infrastructure and a common application base, this challenge needs to refocus the design of e-commerce sites on the concept of "single electronic cart". We believe that including the next generation of e-commerce sites will enable to offer a personalized offer to consumers by adapting the content and form of the web sites to their preferences and needs and will allow them to manage their purchases uniformly with a single electronic cart [79].

8.2.5. *FUI EconHome*

Participants: Aurélien Bourdon, Rémi Druilhe, Laurence Duchien, Adel Nouredine, Romain Rouvoy, Lionel Seinturier [correspondant].

EconHome is a 40-month project funded by FUI and labeled by the Minalogic and Systematic competitiveness clusters. The project started in July 2010. The partners of this project include Sagemcom, Orange, STMicroelectronics, ST-Ericsson, SPiDCOM, Utrema, COMSIS, DOCEA, CEA, ETIS. The project aims at reducing the energy consumption of home and middleware networks. The target is to reduce of at least 70% the energy consumption of devices such as residential gateways, set top boxes, CPL plugs. Two axes are investigated: the optimization of the energy consumption of individual devices with innovative low power and sleep modes, and the optimization of the overall network with innovative techniques, such as service migration and energy aware service feedbacks to the user.

8.2.6. *FUI Hermes*

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

Hermes is a 41-month project funded by FUI and labeled by the PICOM (**Pôle des Industries du COMmerce**) competitiveness 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.

8.2.7. *FSN PIA Datalyse*

Participants: Filip Křikava, Romain Rouvoy, Lionel Seinturier [correspondant], Bo Zhang.

Datalyse is a 36-month project of the FSN 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 correlated data at these two levels.

8.2.8. *Inria ARC SERUS*

Participants: Laurence Duchien [correspondant], Alexandre Feugas, Lionel Seinturier.

ARC SERUS (2011–13) (Software Engineering for Resilient Ubiquitous Systems) is funded by the Inria collaboration program. The partners are Inria ADAM, Inria PHOENIX and TSF-LAAS (CNRS). Resilience is defined as the ability of a system to stay dependable when facing changes. For example, a building management system (*e.g.*, anti-intrusion, fire detection) needs to evolve at runtime (*e.g.*, deployment of new functions) because its critical nature excludes interrupting its operation. Resilience concerns occur in various application domains such as civil systems (civil protection, control of water or energy, etc.) or private systems (home automation, digital assistance, etc.). The objectives of this project is to propose a design-driven development methodology for resilient systems that takes into account dependability concerns in the early stages and ensures the traceability of these requirements throughout the system life-cycle, even during runtime evolution. To provide a high level of support, this methodology will rely on a design paradigm dedicated to sense/compute/control applications. This design will be enriched with dependability requirements and used to provide support throughout the system life-cycle.

8.2.9. 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's PhD thesis into production. AntDroid therefore focuses on deploying and disseminating the APISENSE[®] software platform to the public and to support the users of the platform. APISENSE[®] is a distributed platform dedicated to crowd-sensing activities. APISENSE[®] exploits the sensors of mobile devices that are shared by participants to observe physical or behavioral phenomena. The challenges related to the development of such a platform encompasses user privacy and security, battery preservation, and user accessibility.

8.3. European Initiatives

8.3.1. FP7 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 für wissenschaftliche Datenverarbeitung mbH Göttingen (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 [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.

Participant: Martin Monperrus [correspondant], Matias Martinez.

8.4. International Initiatives

8.4.1. Inria Associate Teams

8.4.1.1. SEAS

Title: Middleware for Sensor as a Service

Inria principal investigator: Romain Rouvoy

International Partner:

University of Oslo (Norway) - Department of informatics

Duration: 2010–2012

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

Middleware for Sensor as a Service (SeaS) is a collaboration initiative that intends to contribute to the vision of the Future Internet as an open-source middleware platform, based on robust Web standards, breaking existing IT silos and leveraging the development of innovative hybrid service-oriented architectures spanning from Wireless Sensor Networks to Ubiquitous and Cloud Computing. Given that one of the objectives of Europe is to develop the convergence of IT networks (being it mobile or fixed) and the fact that many of the upcoming mobile devices are integrating services (from phones down to sensors and radio frequency identification), we believe that one of the challenges for the next generation society will consist in enabling a distributed middleware platform for the dynamic provision of hybrid services and the scalable dissemination of data. In particular, we believe that the sensor capabilities can be reflected as a service accessible from the Internet or any IT system using standard Web protocols. The resulting services will be hybrid in the sense that they will reflect the wide diversity of sensor devices available nowadays, but we aim at providing a uniform solution to leverage the development of applications on top of physical or virtual sensors. This platform includes not only the sensor level (description, discovery, communication, reconfiguration...), but also the platform level services (dissemination, storage, query, adaptation...) that are required for enabling such a vision. The resulting platform will bring additional opportunities for the development of innovative service-based systems by exploiting the emergence of Wireless Sensor Networks (WSN), Ubiquitous Computing, and Cloud Computing environments.

Participants: Nicolas Haderer, Russel Nzekwa, Daniel Romero, 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

The ADAM project-team has a long term collaboration since 2005 with this university. Over the years, four PhD thesis (Carlos Noguera, Carlos Parra, Daniel Romero, 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 [86][43] and in the PhD thesis document itself [85].

Participants: Laurence Duchien [correspondant], Clément Quinton, Daniel Romero, 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 SEAS associated team (see Section 8.4.1.1) contributes to this collaboration.

Participants: Nicolas Haderer, Russel Nzekwa, Daniel Romero, Romain Rouvoy [correspondant], Lionel Seinturier.

8.4.2.2. Informal International Partners

8.4.2.2.1. Université du Québec à Montréal

The ADAM project-team has established a new collaboration with UQÀM (*Université du Québec à Montréal*) to improve the software quality of distributed systems. This collaboration has been initiated with a joint PhD thesis (Geoffrey Hecht) that intends to empirically identify design patterns and anti-patterns in Cloud-based applications. The objective of this work is to leverage the development of *Software-as-a-Service* (SaaS) to build modular yet efficient solutions to be deployed in the Cloud.

Participants: Laurence Duchien, Geoffrey Hecht, Romain Rouvoy.

8.4.3. Participation in Other International Programs

8.4.3.1. OW2

Participants: Gwenaël Cattez, Philippe Merle [correspondant], Fawaz Paraïso, 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

8.5.1.1. Internships

Favio Demarco

Subject: Automated Software Repair
 Date: from Apr 2013 until Sep 2013
 Institution: University of Buenos Aires (Argentina)

Gabriel Moyano

Subject: Crowd-driven Automatic Inference of Traffic Maps
 Date: from Mar 2013 until Aug 2013
 Institution: University Los Andes (Colombia)

Herman Mekontso

Subject: An SOA Approach for the Design of Information Systems: The Case of the PPR FTH Platform in Central Africa
 Date: Oct 2013
 Institution: University of Yaoundé (Cameroon)

9. Dissemination

9.1. Scientific Animation

Laurence Duchien served in the following scientific animations actions:

- Chair of the 5ème Journées du GDR CNRS GPL, Nancy, April 2013,
- Member of the Editorial Board of Lavoisier TSI,
- Member of the Editorial Board of Special Issue "Advanced Architectures for the Future Generation of Software-Intensive Systems" in the Elsevier journal Future Generation Computer Systems,
- Member of the following PC committees:
 - 8th International Symposium on Software Engineering for Adaptive and Self-Managing Systems (SEAMS), San Francisco, USA, San Francisco, May 2013,
 - 7th European Conference on Software Architecture (ECSA), Montpellier, France, July 2013,
 - 17th European Conference on Software Maintenance and Reengineering (CSMR), Genova, Italy, March 2013,
 - 6th Day Lignes de Produits, Paris, November 2013,
 - Joint Workshop of MAPLE 2013 – 5th International Workshop on Model-driven Approaches in Software Product Line Engineering and SCALE 2013 – 4th Workshop on Scalable Modeling Techniques for Software Product Lines at the 17th Software Product Lines Conference, Tokyo, Japan, August 2013,
 - International Workshop on Software Engineering for Systems-of-Systems (SESoS) at the 7th European Conference on Software Architecture (ECSA), Montpellier, France, 2013,
 - 29th IEEE International Conference on Software Maintenance (ICSM), Eindhoven, the Netherlands, September 2013.

Philippe Merle served in the following scientific animation actions:

- Member of the steering committee of the Conférence en Ingénierie du Logiciel (CIEL),
- Member of the following PC committees:
 - 2nd Conférence en Ingénierie du Logiciel (CIEL), April 2013,
 - 12th International Workshop on Adaptive and Reflective Middleware (ARM), December 2013,
- Member of the Evaluation Committee for the special issue on Ingénierie du Logiciel of the TSI Journal,
- Reviewer for IEEE Computer Magazine, and both ECSA and DAIS conferences.

Romain Rouvoy served in the following scientific animations actions:

- Member of the steering committee of the IFIP International Conference on Distributed Applications and Interoperable Systems,
- Member of the following PC committees:
 - 28th International ACM Symposium on Applied Computing (SAC) - 7th Track on Dependable and Adaptive Distributed Systems (DADS), March 2013,
 - 28th International ACM Symposium on Applied Computing (SAC) - 1st Track on Software Engineering Aspects of Green Computing (SEGC), March 2013,
 - 1st International Workshop on Green in Software Engineering, Green by Software Engineering (GIBSE), March 2013
 - 10th International USENIX Conference on Autonomic Computing (ICAC) - 2nd Track on Self-Aware Internet of Things (Self-IOT), June 2013,
 - 10th International Conference on Services Computing (SCC) - Industry track, June 2013,
 - 15th International Symposium on Symbolic and Numeric Algorithms for Scientific Computing (SYNASC), September 2013,
 - 2nd Nordic Symposium on Cloud Computing & Internet Technologies (NordiCloud), September 2013,
 - 8th International Workshop on Middleware for Next Generation Internet Computing Workshop (MW4NG), December 2013,
 - 5th International IEEE Conference on Cloud Computing Technology and Science (Cloud-Com), December 2013,
 - 12th International Workshop on Adaptive and Reflective Middleware (ARM), December 2013,
 - 3rd International Workshop on Adaptive Services for the Future Internet (WAS4FI), September 2013,
- Reviewer for the following journals: Springer Journal of Internet Services and Applications, Journal of Ambient Intelligence and Smart Environments, IEEE Transactions on Computers.

Lionel Seinturier served in the following scientific animations actions:

- Guest co-guest editor of a special issue of the Springer Journal of Internet Services and Applications on Greening Distributed Systems,
- Member of the editorial board of the ISTE-Wiley series of books on Computer Science and Information Technology and editor for the Software Engineer domain of this series,
- co-PC Chair of the special session on Self-Adaptive Networked Embedded Systems (SANES) at the 3rd International Conference on Pervasive Embedded Computing and Communication Systems, Barcelona, February 2013,
- Member of the following PC committees:

- Workshop on Patterns Promotion & Anti-patterns Prevention (PPAP) at the 17th European Conference on Software Maintenance and Reengineering, Genova, March 2013,
 - 7ème Conférence francophone sur les architectures logicielles (CAL), Toulouse, May 2013,
 - 13th IFIP International Conference on Distributed Applications and Interoperable Systems (DAIS), Florence, June 2013,
 - International Workshop of Security and Dependability for Resource Constrained Embedded Systems (S& D4RCES) at the 13th International Conference on Software Reuse, Pisa, June 2013,
 - 16th ACM SIGSOFT International Symposium on Component-Based Software Engineering (CBSE), Vancouver, June 2013,
 - 39th Euromicro Conference on Software Engineering and Advanced Applications (SEAA), MOCS Track, Santander, Spain, September 2013,
 - 6th IEEE International Conference on Service-Oriented Computing and Applications (SOCA), Hawaii, December 2013.
- Reviewer for the following journals: Elsevier Science of Computer Programming, Elsevier Information and Software Technology, Elsevier Journal of System and Software, Lavoisier TSI.

9.2. Teaching - Supervision - Juries

9.2.1. Teaching

Permanent members teach the following courses.

Laurence Duchien heads the **research program** in Master of Computer Science at University Lille 1. She heads the Carrières et Emplois service and is referent for the professional insertion in the PhD program in Computer Science at PRES University Lille Nord de France. She is also Director of Doctoral Studies for Computer Science in Doctoral School Engineering Science (SPI) - PRES Lille Nord de France. She teaches the following courses:

Software Project Management, 50h, Level M2, Master MIAGE, University Lille 1,
 Design of distributed applications, 42h, Level M1, Master of Computer Science, University Lille 1,
 Software Product Lines, 8h, Level M2, Master of Computer Science, University Lille 1,
 Research and Innovation Initiation, 22h, Level M2, Master of Computer Science, University Lille 1,
 Tutoring Internship, 16h, Level M2, Master of Computer Science, University Lille 1.

Martin Monperrus teaches at the University Lille undergraduate and graduate courses. In particular:

Introduction to programming, 48h, Level L1, Licence of Computer Science, UFR IEEA, University Lille 1,
 Object-oriented design, 39h, Level L3, Licence of Computer Science, UFR IEEA,
 Automated software engineering, 40h, Level M2, Master of Computer Science speciality IAGL, UFR IEEA, University Lille 1.

Romain Rouvoy heads the **IAGL** specialty of the Master of Computer Science at the University Lille 1. He supervises the **Agil-IT** Junior Enterprise and gives the following courses at the University Lille 1:

Initiation à la Programmation, 48h, Level L1, Licence of Computer Science, UFR IEEA, University Lille 1,
 Conception d'Applications Réparties, 42h, Level M1, Master of Computer Science, UFR IEEA, University Lille 1,
 Qualité du Logiciel, 30h, Level M2, Master of Computer Science speciality MIAGE, UFR IEEA, University Lille 1,

Infrastructures et Frameworks Internet, 8h, Level M2, Master of Computer Science speciality IAGL, UFR IEEA, University Lille 1,

Innovation & Initiation à la Recherche, 14h, Level M2, Master of Computer Science speciality IAGL, UFR IEEA, University Lille 1,

Intergiciels Orienté Services, 50h, Level M2, Master of Computer Science speciality IPI-NT, UFR IEEA, University Lille 1,

Suivi de projets, 60h, Level M2, Master of Computer Science, UFR IEEA, University Lille 1,

Suivi d'alternants, 60h, Level M2, Master of Computer Science, UFR IEEA, University Lille 1.

Lionel Seinturier has headed the **E-Services** speciality of the Master of Computer Science at the University Lille 1 until August 2013. He gives the following graduate courses at the University Lille 1:

Conception d'Applications Réparties, 18h, M1, University Lille 1,

Infrastructures et Frameworks Internet, 6h, M2, University Lille 1.

9.2.2. Supervision

- PhD: Rémi Druilhe, Power Efficiency of Services in Dynamic and Heterogeneous Dynamic Systems, 5 December 2013, Laurence Duchien & Lionel Seinturier.
- PhD: Russel Nzekwa, Building Manageable Autonomic Control Loops for Large Scale Systems, 5 July 2013, Lionel Seinturier & Romain Rouvoy.
- PhD in progress: Maxime Colmant, Amélioration de l'efficacité énergétique des logiciels dans les systèmes multi-coeurs, October 2013, Lionel Seinturier & Romain Rouvoy.
- PhD in progress: Benoit Cornu, Automated Runtime Software Repair, October 2012, Lionel Seinturier & Martin Monperrus.
- PhD in progress: Alexandre Feugas, Maintien de la qualité de service au cours de l'évolution d'applications orientées services, October 2010, Laurence Duchien & Sébastien Mosser (Lab. I3S, University Nice-Sophia-Antipolis).
- PhD in progress: Maria Gomez Lacruz, Self-Optimization of Software Systems Driven by Wisdom of the Crowds, October 2013, Lionel Seinturier & Romain Rouvoy.
- PhD in progress: Nicolas Haderer, AntDroid: Opportunistic Mobile Sensing of User Activities, October 2010, Lionel Seinturier & Romain Rouvoy.
- PhD in progress: Geoffrey Hecht, Auto-optimisation des architectures orientées services : Application aux applications mobiles et Cloud, October 2013, Laurence Duchien & Romain Rouvoy.
- PhD in progress: Matias Martinez, Automated Program Repair at Development and Runtime, October 2011, Laurence Duchien & Martin Monperrus.
- PhD in progress: Vincenzo Musco, Etude de la topologie et de l'évolution des graphes logiciels, October 2013, Philippe Preux (Inria SequeL) & Martin Monperrus.
- PhD in progress: Adel Noureddine, Towards a Better Understanding of the Energy Consumption of Software Systems, October 2010, Defense planed on 19 March 2014, Lionel Seinturier & Romain Rouvoy.
- PhD in progress: Fawaz Paraiso, Interopérabilité des environnements middleware de cloud computing, October 2011, Lionel Seinturier & Philippe Merle.
- PhD in progress: Clément Quinton, Migration d'applications dans les environnements middleware de cloud computing, October 2011, Laurence Duchien.
- PhD in progress: Marc Sango, Composants logiciels, boucle de contrôle et adaptation pour applications safety critical dans le domaine ferroviaire, October 2012, Laurence Duchien & Christophe Gransart.
- PhD in progress: Amal Tahri, Evolution logicielle multi-vues : des réseaux domestiques au Cloud, March 2013, Laurence Duchien & Jacques Pulou (Orange).

- PhD in progress: Bo Zhang, Elasticité spontanée des services et infrastructures dans le Cloud, October 2013, Lionel Seinturier & Romain Rouvoy.

9.2.3. Juries

Laurence Duchien was in the following HDR examination committee:

- Vasile-Marian Scuturici, INSA Lyon, University Claude Bernard Lyon1, December 2013 (referee)

Laurence Duchien was in the following PhD examination committees:

- Pengfei Liu, University of Bordeaux, January 2013, (referee),
- Mehdi Chouiten, University of Evry-Val d'Essone, January 2013, (co-referee),
- Diana Guadalupe Moreno-Garcia, University of Grenoble, February 2013 (referee),
- Jimmy Lauret, University of Toulouse, April 2013, (referee),
- Thibaut Possompès, University of Montpellier, October 2013 (referee),
- Julie Hamon, University Lille 1, November 2013 (chair),
- Rémi Druilhe, University Lille 1, December 2013 (co-director),
- Sylvain Frey, Paris-Tech, December 2013 (referee),
- Aurélien Favarelon, University of Grenoble, December 2013 (referee).

Romain Rouvoy was in the following PhD examination committees:

- Mehdi Chouiten, University of Evry-Val d'Essone, January 2013, (co-referee),
- Russel Nzekwa, University Lille 1, July 2013 (co-director).

Lionel Seinturier was in the following HDR examination committee:

- Tomas Bures, Charles University, Prague, March 2013 (referee).

Lionel Seinturier was in the following PhD examination committees:

- François Fouquet, University Rennes 1, February 2013 (referee),
- Gérard Nicolas, Telecom Paris, June 2013 (referee),
- Russel Nzekwa, University Lille 1, July 2013 (co-director),
- Ali Ghaddar, University of Nantes, July 2013 (referee),
- Elmedhi Damou, University Grenoble 1, October 2013 (referee),
- Joao Americo, University Grenoble 1, November 2013 (referee),
- Olga Melekhova, University Paris 6, November 2013 (referee),
- Filip Křikava, University of Nice, November 2013 (referee),
- Yacine Kessaci, University Lille 1, November 2013 (president),
- Rémi Druilhe, University Lille 1, December 2013 (co-director),
- Miruna Stoicescu, University Toulouse, December 2013 (referee),
- Petr Spacek, University Montpellier 2, December 2013 (referee),
- Sana Fathallah, University of Nice, December 2013 (referee).

9.3. Popularization

Christophe Ribeiro gave several demonstrations of the APISSENSE platform (see Section 5.1), especially for the Recherche, Innovation, Creation (RIC) day that was held on 1 October 2013 in Lille and that targets graduate students from the M.Sc and Computer Engineering programs. He also participated to the Forum des PME innovantes organized the PICOM competitiveness cluster on 16 October 2013. The APISSENSE platform has been the subject of some popularization articles in ERCIM News [24] and L'Usine Nouvelle [51].

The PowerAPI library (see Section 5.3) has been the subject of some popularization articles in ERCIM News [23], GreenIT.fr [49] and 01 Business & Technologies [50].

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- [2] N. MOHA, Y.-G. GUÉHÉNEUC, L. DUCHIEN, A.-F. LE MEUR. *DECOR: A Method for the Specification and Detection of Code and Design Smells*, in "IEEE Transactions on Software Engineering", January 2010, vol. 36, n^o 1, pp. 20-36, Rank (CORE) : A+, <http://hal.inria.fr/inria-00538476>
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N. VILLEGAS, T. VOGEL, D. WEYNS, K. WONG, J. WUTTKE. *Software Engineering for Self-Adaptive Systems: A Second Research Roadmap*, in "Software Engineering for Self-Adaptive Systems", R. DE LEMOS, H. GIESE, H. MÜLLER, M. SHAW (editors), Dagstuhl Seminar Proceedings, Springer, 2013, vol. 7475, pp. 1-26, <http://hal.inria.fr/inria-00638157>

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