Activity Report 2011

Project-Team ADAM

Adaptive Distributed Applications and Middleware

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

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

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1. Members

Research Scientists

Christophe Gransart [Research Associate (CR1), INRETS, external collaborator]
Philippe Merle [Junior Researcher (CR1), INRIA, vice-head of project-team]

Faculty Members

Laurence Duchien [Professor, Université Lille 1, project-team leader, HdR]
Jean-Marc Geib [Professor, Université Lille 1, external collaborator, HdR]
Anne-Françoise Le Meur [Associate Professor, Université Lille 1, secondment INRIA, until April 30th 2011]
Martin Monperrus [Associate Professor, Université Lille 1, since September 1st, 2011]
Romain Rouvoy [Associate Professor, Université Lille 1]
Lionel Seinturier [Professor, Université Lille 1, IUF, HdR]

Technical Staff

Christophe Demarey [Research Engineer, INRIA, Adapt ADT]
Damien Fournier [Expert Engineer, INRIA, ICT FP7, IP SOA4ALL Project, until February 28th 2011]
Nicolas Petitprez [Expert Engineer, INRIA, Macchiato project]
Antonio de Almeida Souza Neto [Recent Graduate Engineer, INRIA, CALICO ADT, EasySOA project]
Michel Dirix [Expert Engineer, INRIA, EasySOA project, since March 1st 2011]
Christophe Munilla [Master, February- September 2011, then Expert Engineer, INRIA, EasySOA project, since October 15th 2011]
Aurélien Bourdon [Expert Engineer, INRIA, EconHome project, since April 1st 2011]
Gwenael Cattez [Research Engineer, INRIA, Adapt ADT, since October 15th 2011]

PhD Students

Gabriel Hermosillo [INRIA CORDI-S grant]
Jonathan Labejof [CIFRE Thales]
Russel Nzekwa [INRIA CORDI-C grant]
Carlos Andres Parra Acevedo [ATER, until August 31, 2011]
Daniel Romero [ATER]
Gabriel Tamura [Co-supervision with U. Los Andes, Bogota, Colombia]
Rémi Druilhe [CIFRE Orange Labs]
Alexandre Feugas [INRIA CORDI-S grant]
Rémi Mélisson [CIFRE Orange Labs]
Nicolas Haderer [Contrat doctoral Lille 1]
Adel Noureddine [INRIA/Région Nord-Pas de Calais]
Clément Quinton [Recent Graduate Engineer, INRIA, UbiNov ADT, until October 5th 2011, then INRIA CORDI-C grant]
Fawaiz Paraiso [Expert Engineer, INRIA, SocEDA project, since March 1st 2011, until September 30th 2011, then PhD student INRIA/Région Nord-Pas de Calais]
Matias Martinez [Erasmus Mundus, since October 1st 2011]

Post-Doctoral Fellows

Frédéric Loiret [Expert Engineer, INRIA, ANR TLog Flex-eWare Minalogic MIND Project, until February 28th 2011]
Sébastien Mosser [PostDoc, INRIA, until August 2011]

Administrative Assistants

Malika Debuysschere [INRIA, until November 18th 2011]
Sandrine Meilen [INRIA, since November 21th 2011]
Others
Rubby Casallas [Visiting Scientist - U. Los Andes, Bogota, Colombia - June 2011]
Norha Villegas [Visiting Scientist - U. of Victoria, Canada - April 2011]
Nadia Gamez [Visiting Scientist - U. Malaga, Spain - September - December 2011]
Patrick Heymans [Visiting Scientist - U. Namur, Belgium - September - December 2011]
Florian Lefevre [Master, May - October 2011]

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

- Daniel Romero's Ph.D thesis [12], [17] has shown that Feedback Control Loops (FCLs) can be ubiquitous and enable the integration of context information between heterogeneous entities, which is necessary in order to adapt applications according to the current environmental conditions. The decision making of the Ubiquitous FCLs is based on constraint programming techniques in order to select a new target configuration of the application regarding dimensions such as Quality of Service (QoS), reconfiguration cost and resource consumption.
- Carlos Parra's Ph.D. thesis [11] extends software product lines as Dynamic Software Product Lines (DSPL) by providing mechanisms to adapt products at runtime. We have characterized two processes of product derivation: design weaving and runtime weaving. Design weaving aims at building a single product from a selection of variants, it also features a set of algorithms that guarantee the correctness of the products being derived as detailed in [69]. Runtime weaving aims at adapting a product being executed by changing its configuration in terms of selected variants. Both processes use the same variability and aspect models which enables developers to have a unified representation of the software adaptation [16]. For the implementation, design weaving is based on model transformations and code generation, runtime weaving is based on the dynamic platform FraSCAti to execute reconfigurations during the execution of products.

3. Scientific Foundations

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 [49], [64] 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 [62], software components [66] 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 [48] and CCM [47]), 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 [68]. 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

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[1]These terms are more or less equivalent.

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 [78]. 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 MDE. The goal of MDE [74] 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.

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. Application Domains

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.

4.1.1. 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 CAPPUCINO projects, our activities in this domain will 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.

4.1.2. 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 are involved in several projects, such as the ANR TLog Flex-eWare, and the trade cluster MIND. 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.

4.1.3. 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 will be 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.

4.1.4. Information Systems for Terrestrial Transport

Information systems for terrestrial transport are also a domain that we are relying on, to apply our research activities in accordance with the ANR ARA REVE project and the INRETS collaboration). 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

5.1. Introduction

We intend to develop a number of software to evaluate and validate our solutions. We will complete our development by experimentation, benchmarks and deployment in multi-paradigm platforms. We list our actual software that we intend to continue and to extend in the ADAM project-team.

5.2. CALICO

Participants: Laurence Duchien, Antonio de Almeida Souza Neto, Anne-Françoise Le Meur.

Modern software is characterized by a need for constant and rapid evolution, such as in the mobile domain. To facilitate the development and the rapid evolution of complex systems, software engineering approaches have been proposed, such as software architecture and agile software development. However, current solutions offer poor support to enable the development of a reliable system.

In this context we propose CALICO, an agile development framework for the design and evolution of safe component-based and service-oriented software. The agile software development relies on an iterative and incremental development cycle that allows the architect to iterate between the design of the architecture and the debug of the software in its execution context. At each iteration, the architect can evolve its software and check the consistency of its evolution through the execution of static and dynamic analysis tools. Thus, during the design and the evolution of the system, the architect can use a set of metamodels to specify the structure of the architecture and its various quality of services requirement. During the deployment, CALICO instantiates the system on the target runtime platform from the models specified and keeps them synchronized with the software during its execution. Through this means, the architect has a conceptual view which allows him to reason on the critical software properties during its evolution. Moreover, in order to check these evolutions, CALICO provides a unifying framework which allows reuse of many static analysis tools of software architectures and dynamic debugging tools, that were scattered in different existing platforms. Thus, each change can be statically analyzed on the conceptual view before being propagated to the software system. Dynamic analysis are based on data values available during the execution only. The capture of these values is done through automatic instrumentation of the software system.

Globally, CALICO enables reliable evolution even if the underlying platforms does not natively provide this support. The current version handles four component-based and service-oriented platforms. Moreover, the benchmarks that we have performed show that CALICO is usable for the design and development of safe applications up to 10,000 components and services, which corresponds to the maximal load of most runtime platforms. CALICO has been developed in the context of Guillaume Waignier's PhD thesis [79].

CALICO is an open source software available at http://calico.gforge.inria.fr.

5.3. Fractal

Participants: Christophe Demarey, Philippe Merle [correspondant], Romain Rouvoy, Lionel Seinturier.

FRACTAL is a modular, extensible and programming language agnostic component model that can be used to design, implement, deploy and reconfigure systems and applications, from operating systems, middleware platforms to graphical user interfaces [53], [55], [67]. FRACTAL has been designed by both Inria and France Telecom R&D.

FRACTAL is also a LGPL open source software project hosted by the OW2 international consortium and is available at http://fractal.ow2.org [59].

Philippe Merle is the leader of the OW2 FRACTAL open source project. The ADAM project-team actively contributes to this project, and more specifically on the following modules:

- **AOKell** is an aspect-oriented implementation of the FRACTAL component model [76].

- **Fraclet** is an attribute-oriented programming model enabling the rapid development of FRACTAL components [73].

- **Fractal ADL** is the extensible architecture definition language for FRACTAL associated to an open FRACTAL component-based toolchain.

- **Fractal Distribution** is the module to produce packaged releases of the FRACTAL project.

- **Fractal Documentation** is the module to produce the whole documentation of the FRACTAL project.

- **Fractal Eclipse Plugin** is a plugin to create FRACTAL projects within the Eclipse IDE [57], [58]. This work was supported by an Inria ODL and is contributed to the FUI MIND project.

- **Fractal Explorer** is a framework to build graphical consoles to introspect and manage FRACTAL components dynamically at runtime.

- **FScript** is a scripting language for both introspection and reconfiguration of FRACTAL software systems.

- **Juliac** is an extensible framework for generating and compiling the code of FRACTAL component-based systems. Juliac is registered with the APP (Agence pour la Protection des Programmes) under reference FR.001.230007.000.S.P.2009.000.10600.

- **Koch** is an implementation of the FRACTAL component model where components have a component-based control membrane.

5.4. FraSCAti

Participants: Christophe Demarey, Damien Fournier, Rémi Mélisson, Philippe Merle [correspondant], Christophe Munilla, Romain Rouvoy, Lionel Seinturier.

FraSCAti is a runtime platform for the *Service Component Architecture* (SCA) component framework. SCA is an initiative for unifying *Service Oriented Architectures* (SOA) and *Component-Based Software Engineering* (CBSE). SCA is supported by the Open SOA consortium, which includes partners, such as IBM, Oracle, Sun and Iona, and is standardized by the OASIS consortium (see at http://www.oasis-opencsa.org/sca).

FraSCAti includes Tinfi, which provides a SCA personality for the FRACTAL component model. Thanks to the openness of this latter model, the necessary code elements (so called *controllers* and *membranes*) have been designed and developed to customize FRACTAL and to end up with components owning both a FRACTAL personality and a SCA personality. As far as we know, this result, which has been presented in [75], is original and is the first one to concretely demonstrates that FRACTAL is open and flexible enough to implement different component personalities. Moreover, Tinfi reuses the aspect-oriented concepts defined in FAC [70] for component-based programming and allows integrating smoothly non functional concerns (so called intents and policy sets in SCA terms). FraSCAti and Tinfi have been implemented by reusing modules developed in the context of the FRACTAL project, and among others, the Juliac FRACTAL compiler.

The development of the FraSCAti platform is conducted in the context of some current and past funded projects (ICT FP7 SOA4All Integrated Project, ANR ARPEGE ITEmIS project, FUI EasySOA project, Inria ADT Adapt).

FraSCAti is a LGPL open source software, hosted by the OW2 consortium since November 2008 at http://frascati.ow2.org. FraSCAti is registered with the APP (Agence pour la Protection des Programmes) under reference FR.001.050017.000.S.P.2010.000.10000.

5.5. SPACES

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

SPACES is a context mediation middleware that follows the *REpresentational State Transfer* (REST) principles [61]. The current implementation of SPACES is based on the COSMOS context framework [54], [72] and the COMANCHE web server [53]. Both COSMOS and COMANCHE are based on the FRACTAL component model and use the JULIA implementation of the FRACTAL runtime environment [53].

The main features of the current SPACES implementation are presented below:

1. *Ubiquitous connectors*: SPACES defines connectors that encapsulate the distribution concern. These connectors expose the COSMOS context nodes as REST resources with logical associated URLs, and enable interactions between consumers and producers via different communication protocols and the discovery of the available context sources. The current SPACES implementation supports interaction using the HTTP and twitter [65] protocols. For discovery, the implementation uses the Service Location Protocol (SLP) [63].

2. *Context Representation*: Following the REST principles, SPACES supports multiple representations of the context information: JSON [56], XML and Java serialization.

3. *Quality of context (QoC) information*: The QoC properties are incorporated as service attributes in the SLP advertisements of the context information.

4. *Context selection*: The restrictions in terms of QoC of the required context information are expressed as LDAP filters [77]. SPACES benefits from the LDAP based queries of SLP to select the context providers.

We use XStream 1.3.13 [51] and JSON-lib 2.2.34 [50] to serialize context information as XML and JSON documents. For SLP and twitter we employ jSLP 1.0.0 [71] and twitter-4j 2.0.6 [80].

SPACES is registered with the APP (Agence pour la Protection des Programmes) under reference IDDN 10-500002-000.

5.6. ApplIDE

Participants: Laurence Duchien, Christophe Demarey, Clément Quinton [correspondant].

AppliIDE is directly connected to the work of Carlos Parra's PhD and Ubinov ADT's work which covers the definition and implementation of a Context-Aware Dynamic Software Product Line (DSPL) named CAPucine. It provides a set of tools for selection of features, metamodel transformation and code generation for mobile applications [40]. The current implementation of ApplIDE addresses transformation from CAPucine metamodel towards SCA metamodel, and Spoon EMF metamodel. The transformations were formerly written with Acceleo tool, which is a dedicated language for transformation, enhancing the readability. ApplIDE meta models are based on the Eclipse Modeling Framework. Code generators are all written in Acceleo.

ApplIDE is registered with the APP (Agence pour la Protection des Programmes) under reference IDDN.FR.001.500004.000.S.A.2010.000.10600.

6. New Results

6.1. Adaptive Middleware

Participants: Aurélien Bourdon, Rémi Druilhe, Damien Fournier, Nicolas Haderer, Gabriel Hermosillo, Jonathan Labejof, Rémi Mélisson, Philippe Merle, Adel Noureddine, Russel Nzekwa, Lionel Seinturier, Daniel Romero, Romain Rouvoy.

In 2011, we pursued our goal to demonstrate that general and high level concepts and solutions can be proposed to design multi-scale middleware systems. The multi-scale aspect has particularly been put forward and we obtained several interesting results: we showed that the concepts of service, component, and software architecture can be successfully used, in the small for wireless sensor middleware platforms [19], [43] with applications to the Internet of Things (IoT) [27] and for embedded systems [14], in mid-size distributed environments such as digital home networks [17], and in the large in cloud computing platforms [30]. We focus below on two achievements which are illustrative in the sense that they address both ends of the targeted spectrum of sizes.

At the scale of small systems, we proposed the REMORA platform [19], [43], [27] which defines a lightweight event-based programming model for wireless sensor networks. A C-like language for component implementation and an extension of the state-of-the-art Service Component Architecture (SCA) standard for service-oriented systems are proposed. The platform has been successfully deployed on the Contiki operating system. We showed that despite the characteristics of such resource-constrained environments, we are still able to obtain reconfigurability and adaptability properties for the deployed systems.

At the scale of very large systems, we showed in [30] first results that illustrate the fact that the FraSCAti platform [18] can be used to achieve interoperability between applications deployed on heterogeneous cloud platforms. The experiment is currently deployed on 13 public IaaS and PaaS cloud infrastructures. The very same concepts of service and software architecture that are used at smaller scales are put into practice here. Furthermore, we benefit from the same adaptability properties to address the heterogeneity of concepts needed to fit these very large scale infrastructures.

6.2. Context-awareness and Ambient Intelligence Software

Participants: Laurence Duchien, Sébastien Mosser, Clément Quinton.

Context-aware applications are applications that can react to changes on their environment. To achieve such reacting behavior, several challenges have to be faced in terms of: context management, support for dynamic reconfiguration, automation of development, and a consistent development process. One possible way to face those challenges is to use the principles of Software Product Line (SPL) and specifically dynamic SPL (DSPL). DSPLs focus on variability management and aim at deriving different products from a same product family. Additionally, DSPLs allow for products to be derived both at design and at runtime. This enables applications to be adapted during execution and dynamically fit new requirements or resource changes. In [16] we have proposed an approach to unify adaptation at design and at runtime based on Aspect Oriented Modeling. Our approach proposes a unified aspect metamodel and a platform that realizes two different weaving processes to achieve design and runtime adaptations. This approach is used in a Dynamic Software Product Line which derives products that can be configured at design time and adapted at runtime in order to dynamically fit new requirements or resource changes. Such products are implemented using the Service Component Architecture and Java. Finally, we have illustrated the use of our approach based on an adaptive e-shopping scenario. This work corresponds to Carlos Parra's PhD thesis [11] and is partially funded by the CAPPUCINO project. Finally, in [40], we have proposed to develop an application for mobile devices using Software Product Lines (SPL). Considering variation factors, SPL allows the conception and the development of a software products family minimizing realization cost and time. The result is the APPLIDE framework, which provides SPL for smartphones, and we show how it works with a short demonstration.

6.3. SCeSAME: Formal Definition of Software Architecture Adaptation

Participants: Rubby Casallas, Laurence Duchien, Nohra Villegas, Gabriel Tamura.

In order to define properties on adaptation process, we need to formally model the architecture reconfiguration of a component-based (CB) system as an action performed by itself. These actions are performed in response to the disruption of Quality of Service (QoS) contracts, in the spirit of the Effeil's rescue clause in object-oriented programming. By doing this, we aim to develop on the vision of the CBSE as a sound base to produce software systems enabled to automatically and safely reconfigure themselves by reconfiguring their abstract (reflection) architectures at runtime. For such structural reconfigurations, a system architect may reuse design patterns from other disciplines with the purpose of restoring QoS contracts, thus preserving them.

Our approach, named SCeSAME for *"A Safe Contract-based Self-Adaptive Framework to Preserve QoS Properties on Mobile Devices"* is built on the theory of extended graph (e-graph) rewriting proposed in e-graph [60], as a formalism to represent QoS contracts on component. We have given a formal definition of component-based structure systems, QoS contracts, and architecture reconfiguration rules. Based on these definitions, we built a framework that enables a component-based system to preserve its QoS contracts through architecture self-reconfiguration as a responding action to QoS contract violations. Our approach

extends a theory of graph rewriting and defines a process calculus as formalisms to model the structure and reconfiguration process of architecture reconfiguration. The reconfiguration process, once parameterized with reconfiguration rules, can be verified as safe, i.e., component structural-compliant, terminating and confluent. This result is a part of Gabriel Tamura's PhD and the results have been published in [36], [44].

7. Contracts and Grants with Industry

7.1. Thales

Participants: Jonathan Labejof, Philippe Merle, Lionel Seinturier.

This contract is associated to the CIFRE Ph.D thesis of Jonathan Labejof between ADAM and the Thales company. The goal of the project is to study the evolution of heterogeneous service-oriented architectures. We address two problems. First, we study some various forms of support for heterogeneity in service architectures in terms of communication protocols and software component personalities. Second, we propose solutions for systems which are agile and respond smoothly to changes in their execution contexts. Overall, the goal of this project is to propose to design a model for adaptability, a runtime infrastructure and to provide some means by which these two levels can be causally connected and kept consistent.

7.2. Orange Labs

Participants: Rémi Druilhe, Laurence Duchien, Rémi Mélisson, Romain Rouvoy, Lionel Seinturier.

This contract is associated to Rémi Druilhe and Rémi Mélisson's PhD theses co-advised by ADAM and the Orange Labs company. The houses and their extensions (vehicles, holiday homes, work at home) are now invaded by a multitude of communicating objects to content management, viewing multiple video streams or the sharing of information within a community network. These objects offer such services with capacities of configuration remote administration, and advanced interactions with the end-user or between devices or services. Given the lack of universality of proposals from IT and devices 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 house 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. The first results have been published in [15] and [45].

8. Partnerships and Cooperations

8.1. Local Initiatives

8.1.1. INRIA ADT CALICO

Participants: Laurence Duchien, Antonio de Almeida Souza Neto, Anne-Françoise Le Meur.

The CALICO ADT (Action de Développement Technologique) is an ADT local to the INRIA Lille Nord Europe Center that aims to maintain and develop the CALICO framework (cf. section 5.2). The architecture of CALICO is based on a co-evolution approach where the model level enables software architects to describe and reason on application properties, and the runtime level holds the running application executed on a given platform. CALICO is generic and extensible in terms of target platforms, analyses at the model level, etc. This particularity makes CALICO a framework that could federate several of the ADAM research works and integrate external contributions. Antonio de Almeida Souza Neto (newly graduated engineer) has been recruited in the context of this INRIA ADT.

8.1.2. INRIA ADT UbInnov

Participants: Laurence Duchien, Christophe Demarey, Clément Quinton.

The UbInnov ADT (Action de Développement Technologique) aims at building a Software Product Line (SPL) for mobile applications named AppliDE reusing the technologies developed in the ADAM project-team. UbInnov aims to industrialize AppliDE, a software product line for mobile applications (iPhone, Android). With AppliDE, the development time of a mobile application is significantly reduced thanks to an automatic generation of code. The generated code supports required features from the device, such as geolocation, camera or connection to external services. Clément Quinton (INRIA ADAM New Graduate Engineer) has been recruited to achieve this task. The results have been published in [40].

8.1.3. INRIA ADT Adapt

Participants: Gwenael Cattez, Christophe Demarey, Philippe Merle.

The Adapt ADT (Action de Développement Technologique) is a local ADT of the Inria Lille - Nord Europe Center and 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 5.4, *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. Gwenael Cattez (newly graduated engineer) has been recruited in the context of this Inria ADT.

8.2. National Initiatives

8.2.1. ANR ARPEGE SALTY

Participants: Laurence Duchien, Philippe Merle, Russel Nzekwa, Romain Rouvoy, Lionel Seinturier.

SALTY is a 3-year ANR ARPEGE project started in November 2009 and involving University of Nice, Deveryware, EBM WebSourcing, INRIA ADAM, MAAT-G France, Thales, University Paris 8 and University Paris 6.

The main objective of the SALTY project is an autonomic computing framework for large-scale service-oriented architectures and infrastructures. The SALTY project will result in a coherent integration of models, tools and runtime systems to provide a first end-to-end support to the development of autonomic applications in the context of large-scale SOA in a model-driven way, including never-covered aspects such as the monitoring requirements, the analysis (or decision-making) model, and an adaptation model tackling large-scale underlying managed components. The project will be validated by two large use-cases: a neurodegenerative disease study for exploring the capacity of grid infrastructures and a path tracking application for exploiting the different positioning methods and appliances on a fleet of trucks.

8.2.2. ANR ARPEGE ITEmIS

Participants: Jonathan Labejof, Philippe Merle, Lionel Seinturier.

ITEmIS is a 30-month ANR ARPEGE project started in March 2009 and involving Thales, EBM WebSourcing, Inria (ADAM and ARLES), LAAS, ScalAgent,and IRIT.

The ITEmIS project aims at easing the evolution from today's world of separate lightweight embedded applications and IT services to the future world of seamlessly integrated services, thus qualifying and defining a new generation SOA enabling IT and Embedded Integrated Systems (ITEmIS systems). This endeavour is undertaken along three main lines: (1) At business level, where IT/embedded services are integrated into advanced workflows supporting the multi-faceted interoperability and scalability required for ITEmIS systems; (2) At service infrastructure level, by introducing a specialized ESB-based and component-based solution addressing the requirements of the embedded world including deployment; and (3) Transversally for both above levels addressing end-to-end assurance of Quality of Service (QoS) and correctness verification of deployments and workflows at the level of their execution models. The PhD thesis of Jonathan Labejof is conducted in the context of this project.

Further information is available on the website of the project: http://itemis-anr.org/.

8.2.3. ANR ARPEGE SocEDA

Participants: Gabriel Hermosillo, Fawaiz Paraiso, Romain Rouvoy, Lionel Seinturier.

SocEDA is a 3-year 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.

Further information is available on the website of the project: http://www.soceda.org.

8.2.4. ANR CONTINT MOANO

Participants: Laurence Duchien, Anne-Françoise Le Meur, Nicolas Petitprez.

MOANO (Models & Tools for Pervasive Applications focusing on Territory Discovery) is a 36-month project of the ANR CONTINT program which has started in January 2011. 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 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.

See http://moano.liuppa.univ-pau.fr/en.

8.2.5. Trade cluster MIND

Participants: Damien Fournier, Frédéric Loiret, Rémi Mélisson, Philippe Merle, Lionel Seinturier.

MIND is a 32-month project funded by the Minalogic cluster on micro- and nano-technologies. The project started in 2008. The partners of this project include: STMicroelectronics (Leader), CEA, France Telecom R&D, Grenoble 1, INERIS, INRIA, ICT, ISTIA, Itris Automation Square, LOGICA, Schneider Electric, Sogeti High Tech, VERIMAG.

It aims at consolidating the component-based technologies and the tools, which exist around the FRACTAL component model for building middleware and systems. The goal is to transfer these results into an industrial strength software tool suite in order to foster the adoption of the component-based technologies for designing and developing embedded applications and systems.

8.2.6. *Trade Cluster EconHome*

Participants: Aurélien Bourdon, Rémi Druilhe, Laurence Duchien, Adel Noureddine, Romain Rouvoy, Lionel Seinturier.

EconHome is a 30-month project funded by FUI and labelized by the Minalogic and Systematic clusters. The project started in 2011. 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.

8.2.7. *Trade Cluster MACCHIATO*

Participants: Laurence Duchien, Anne-Françoise Le Meur, Nicolas Petitprez, Romain Rouvoy.

Macchiato is a 36-month project of the competitiveness cluster of trade industry of Nord/Pas-de-Calais PICOM (Pôle des Industries du COMmerce, see http://www.picom.fr), which has started in January 2011. The partners of this project are Auchan (leader), University of Bordeaux/LABRI, INRIA, Web Pulser (an SME).

The Macchiato project is to rethink 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 basket". We believe that including the next generation of e-commerce sites will be able to offer a personalized offer to consumers by adapting the content and form of site to their preferences and needs and allowing them to manage its purchases uniformly by through a single basket [46].

See http://macchiato.lille.inria.fr/

8.2.8. *Trade Cluster EasySOA*

Participants: Michel Dirix, Philippe Merle, Christophe Munilla.

EasySOA is a 24-month project funded by FUI and labelized by the Systematic competitive cluster for Open Source (see at http://www.systematic-paris-region.org/). The project started in 2011. The partners of this project include: Open Wide (Leader), Bull, Easyfab, Inria, Nuxeo, Talend.

The EasySOA goal is to add an open, light, agile layer on top of « traditional » SOA, thanks to an online, social and collaborative approach, involving all actors of the SOA process. Beyond cartography and documentation, it helps gathering and fast-prototyping the business needs, and eases the transition to final implementations in the existing SOA solution.

Further information is available on the website of the project: http://www.easysoa.org.

8.2.9. *GDR GPL Action: UbiLab*

Participants: Nicolas Haderer, Romain Rouvoy, Lionel Seinturier.

The objective of UBILAB is to build an open software platform for federating scientific activities related to ubiquitous computing. In particular, UBILAB focuses on the definition of a remote sensing platform for collecting activity traces from mobile users using Android smartphones. This action is realized in collaboration with researchers from the CNRS LAAS research laboratory, who are currently working on geo-privacy concerns. In this context, the UBILAB action aims at defining common standards and procedures for collecting and exploiting such activity traces. At short-term, the results of UBILAB will leverage the research in the domains of geo-privacy and ubiquitous computing. At mid-term, we expect that the results of this action will allow other scientific communities to build specific experiments related to the study of mobile crowds behaviors.

8.2.10. INRIA ARC SERUS

Participants: Laurence Duchien, Alexandre Feugas, Anne-Françoise Le Meur, Lionel Seinturier.

SERUS (Software Engineering for Resilient Ubiquitous Systems) is founded by the INRIA collaboration program. The partners are INRIA ADAM Team, INRIA PHOENIX Team 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.

See http://serus.bordeaux.inria.fr/

8.3. European Initiatives

8.3.1. INRIA Associate Team SeaS: University of Oslo

Participants: Frédéric Loiret, Gabriel Hermosillo, Russel Nzekwa, Daniel Romero, Romain Rouvoy, Lionel Seinturier.

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 (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. Along the three years of activity, the SeaS collaboration will target to incrementally achieve the following objectives:

- TASK 1 on *Integration*: Enabling Hybrid Service-Oriented Architectures,

- TASK 2 on *Adaptation*: Supporting Dynamic Evolution of Hybrid Sensor Services,
- TASK 3 on *Scalability*: Building a Scalable Data Dissemination Infrastructure.

Read more at http://seas.ifi.uio.no/.

8.3.2. ERCIM Working Group Software Evolution

Participant: Laurence Duchien.

The Working Group (WG) on Software Evolution is one of the many 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. Read more at http://www.planet-evolution.org.

8.3.3. IAP MoVES

Participants: Laurence Duchien, Patrick Heymans, Daniel Romero.

The Belgium IAP (Interuniversity Attraction Poles) MoVES (Fundamental Issues in Software Engineering: Modeling, Verification and Evolution of Software) is a project whose partners are the Belgium universities (VUB, KUL, UA, UCB, ULB, FUNDP, ULg, UMH) and three European institutes (INRIA, IC and TUD) respectively from France, Great Britain and Netherlands. The project has started in January 2007 and is scheduled for a 60-month period.

This consortium combines the leading Belgian research teams and their neighbors in software engineering, with recognized scientific excellence in MDE, software evolution, formal modeling and verification, and AOSD. The long term objective of our network is to strengthen existing collaborations and forge new links between those teams, and to leverage and disseminate our research expertise in this domain at an European level. The project focuses on the development, integration and extension of state-of-the-art languages, formalisms and techniques for modeling and verifying dependable software systems and supporting the evolution of Software-intensive systems.

This year, we welcome Patrick Heymans from FUNDP as invited scientist.

Read more at http://moves.vub.ac.be.

8.3.4. ICT FP7 SOA4All Integrated Project

Participants: Damien Fournier, Philippe Merle.

Service-Oriented Architectures for All (SOA4All) is a large-scale Integrating Project funded by the European Seventh Framework Program, under the Service and Software Architectures, Infrastructures and Engineering research area. This is a 36-month project started in March 2008. Partners are: Atos Origin (Spain), British Telecommunications (UK), CEFRIEL (Italy), EBM WebSourcing (France), Hanival Internet Services GmbH (Austria), INRIA (France), Intelligent Software Components (Spain), Ontotext Lab (Bulgaria), Open University (UK), SAP AG (Germany), Seekda OG (Austria), TIE (Netherlands), The University of Manchester (UK), TXT e-Solutions Spa (Italy), Universitaet Karlsruhe (Germany), University Innsbruck (Austria).

SOA4All will help to realize a world where billions of parties are exposing and consuming services via advanced Web technology: the main objective of the project is to provide a comprehensive framework and infrastructure that integrates complementary and evolutionary technical advances—*i.e.*, SOA, context management, Web principles, Web 2.0 and Semantic Web—into a coherent and domain-independent service delivery platform [52].

Further information is available on the website of the project: http://www.soa4all.eu.

8.4. International Initiatives

8.4.1. OW2

Participants: Christophe Demarey, Damien Fournier, Philippe Merle, Romain Rouvoy, Lionel Seinturier.

OW2, previously ObjectWeb, is an international consortium to promote high quality open source middleware (see at http://www.ow2.org). The vision of OW2 is that of a set of components which can be assembled to offer high-quality middleware.

We are members of this consortium since a long time ago. 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.

8.4.2. *University of Los Andes (Bogota)*

Participants: Laurence Duchien, Gabriel Tamura.

The Ph.D. Student Gabriel Tamura is co-supervised by Rubby Casallas, University of Los Andes, and Laurence Duchien from University of Lille 1. The objective is to study a component-based architecture reconfiguration model and to address QoS (quality-of-service) contract preservation. The proposal is based on a formal theory to perform, in a safe way, the process of self-adaptation in response to quality-of-service (QoS) contracts violation. The results have been published in [36], [44]. The student has been in the ADAM project-team during six months this year. Laurence Duchien has visited the University of Los Andes in October 2009 and Rubby Casallas has visited the ADAM team in June 2010 and 2011.

8.5. Exterior research visitors

We have received four exterior research visitors in the year:

- Rubby Casallas, Associate Professor, University of Los Andes, Colombia, June 2011
- Norha Villegas, Ph.D Student, University of Victoria, Canada, April 2011
- Nadia Gamez, Ph.D. Student, University of Malaga, Spain, Sept-Dec 2011
- Patrick Heymans, Professor, University of Namur, Belgium, Sept-Dec 2011

9. Dissemination

9.1. Animation of the scientific community

9.1.1. *Examination Committees*

Laurence Duchien was in the examination committee of the following HDR thesis:

- François Taïani, November 2011, University of Rennes (referee),
- Laurent Réveillère, November 2011, University of Bordeaux (referee),
- Philippe Collet, December 2011, University of Nice-Sophia-Antipolis, (member).

She also was in the examination committee of the following Ph.D. thesis:

- Janick Laval, June 2011, University of Lille 1 (chair),
- Carlos Parra, March 2011, University of Lille 1 (co-advisor),
- Daniel Romero, July 2011, University of Lille 1 (co-advisor),
- Zeina Azmeh, September 2011, University of Montpellier, (member),
- Marie-Eléonore Marnion, December 2011, University of Lille 1 (chair),
- Damien Cassou, March 2011, University of Bordeaux (referee),
- Olfa Djebbi, May 2011, Université Paris I-Panthéon (referee),
- Cristobàl Costa Soria, May 2011, Universitat Politecnica de Valencia, Spain (referee),
- Abdelhakim Hannousse, November 2011, University of Nantes (referee).

Romain Rouvoy was in the examination committee of the following Ph.D. thesis:

- Christian Ruz, June 2011, University of Nice (co-referee),
- Daniel Romero, July 2011, University of Lille 1 (co-advisor),
- Grégory Nain, December 2011, University Rennes 1 (member).

Lionel Seinturier was in the examination committee of the following Ph.D. thesis:

- Daniel Romero, July 2012, University of Lille 1 (director)
- Judicael Ribault, January 2011, University of Nice (referee)
- Eric Simon, March 2011, University of Grenoble (referee)
- Yves Vanrompay, May 2011, Katholieke Universiteit Leuven, Belgium (member)
- Mohamed Zouari, June 2011, University Rennes 1 (referee)
- L.oris Bouzonnet, September 2011, University of Grenoble (referee)
- Kiev Dos Santos Gama, October 2011, University of Grenoble (referee)
- Anthony Hock-Koon, October 2011, University of Nantes (referee),
- Ali Assaf, October 2011, Ecole des Mines de Nantes (member)
- Kahina Hamadach, November 2011, University of Lille 1 (president)
- Vincent Aranega, November 2011, University of Lille 1 (president)

Philippe Merle was in the examination committee of the following Ph.D. thesis:

- Virginie Legrand Contes, December 2011, University of Nice-Sophia-Antipolis, (co-advisor).

9.1.2. *Journals, Conferences, Workshop*

Laurence Duchien has been

- member of the following committees:
    - Program committee CBSE 2011, http://cbse-conferences.org/2011/,
    - Program committee VaMoS 2011, http://info.fundp.ac.be/~gsa/vamos2011/,
    - Program committee ECSA 2011, http://www.ecsa2011.org/,
    - Program committee ESEC/FSE 2011, news ideas track, http://2011.esec-fse.org/cfp-new-ideas-papers,
    - Program committee MAPLE/SCALE 2011, http://sites.lero.ie/maplescale2011,
    - Program committee Lignes de Production de logiciels 2011, http://www.jldp.org/.

- reviewer for the following journals:
    - Editorial board of the TSI (Hermes) journal,
    - Reviewer for the following journals: Elsevier Journal of System and Software, Springer Software and System Modeling, Elsevier Science of Computer Programming.
    - Reviewer for the book Software Engineering for Self-Adaptive Software Systems Volume 2.

Philippe Merle has been member of the following committees:

- Program committee of the International Middleware Workshop on *Adaptive and Reflective Middleware* (ARM'11), http://arm11.lifl.fr/.

Lionel Seinturier has been

- guest co-editor of a special issue of the Elsevier Science of Computing journal on Software Evolution, Adaptability and Maintenance,
- member of the steering committee of the DisCoTec Workshop on Context-aware Adaptation Mechanisms for Pervasive and Ubiquitous Services,
- member of the following committees:
  - 10th ACM International Conference on Generative Programming and Component Engineering (GPCE'11),
  - IEEE International Conference on Computer, Networks, System, and Industrial Engineering (CNSI'11),
  - 3rd IEEE International Conference on Service-Oriented Computing and Applications (SOCA'11),
  - 37th Euromicro Conference on Software Engineering and Advanced Applications (SEAA'11), MOCS Track and DANCE workshop,
  - ACM International Workshop on Security and Dependability for Resource Constrained Embedded Systems (S&D4RCES'11),
  - 4th DisCoTec Workshop on Context-aware Adaptation Mechanisms for Pervasive and Ubiquitous Services (CAMPUS'11),
  - Atelier Adaptation Dynamique des Logiciels (ADAPT'11) at RenPar'20,
- reviewer for the following journals: Wiley Software Practice and Experience, Elsevier Journal of System and Software, Springer Software and System Modeling, Elsevier Science of Computer Programming.

Romain Rouvoy has been

- member of the following committees:
  - member of the steering committee of the DisCoTec Workshop on Context-aware Adaptation Mechanisms for Pervasive and Ubiquitous Services,
  - member of the steering committee of the IFIP International Conference on Distributed Applications and Interoperable Systems,
- program co-chair of the following scientific events:
  - 10th International Workshop on Adaptive and Reflective Middleware (ARM'11),
  - 11th IFIP International Conference on Distributed Applications and Interoperable Systems (DAIS'11),
- member of the following program committees:
  - 4th DisCoTec Workshop on Context-aware Adaptation Mechanisms for Pervasive and Ubiquitous Services (CAMPUS'11),
  - 3rd International Workshop on Middleware for Pervasive Mobile and Embedded Computing (M-MPAC'11),
  - 6th International Workshop on Middleware for Service-Oriented Computing (MW4SOC'11),
  - 2nd International Workshop on Green Computing Middleware (GCM'11),
  - 6th International Workshop on Middleware Tools, Services and Run-time Support for Networked Embedded Systems (MidSens'11),
  - 1st International Workshop on Social Service Computing (SSC'11),

– 1st International Workshop on Adaptive Services for the Future Internet (WAS4FI'11)

– 1st International Workshop on Distributed Systems: Security, Privacy and Trust Challenges (DS:SPT'11),

– 1st International Workshop on Middleware and Architectures for Autonomic and Sustainable (MAASC'11),

– 1st International Workshop on Variability-intensive Systems Testing, Validation & Verification (VAST'11),

- reviewer for the following journals: Inderscience International Journal of Ad Hoc and Ubiquitous Computing (IJAHUC), Elsevier Journal of Information and Software Technology (IST), Elsevier Journal of Systems and Software (JSS).

Martin Monperrus has been

- referee for the following journals: ACM TOSEM, Springer SoSym, Elsevier Science of Computer Programming

- external referee for the following conferences: AOSD, FSE

9.2. Scientific and Administrative Responsibilities

Team members have several scientific and administrative responsibilities in the university, the INRIA institute and at the national level:

- **Laurence Duchien** is in the steering committee of the ERCIM Software Evolution Group since 2006. She is Co-chair (with Jean-Louis Giavitto) of the Languages and Verification group of the GDR CNRS GPL (Génie de la Programmation et du Logiciel – http://gdr-gpl.imag.fr) since 2008. She will be Director of GDR GPL since January 2012. Since 2010, she is referent for the professional insertion of the PhD program in Computer Science at PRES University Lille Nord de France. In 2011, she served as a member of the Comité de sélection for recruiting professors at INSA Lyon and as chair of the Comité de sélection for recruiting professors at University Lille 1. In 2011, she served as a member of Inria Lille-Nord Europe committee for junior scientists. In 2011, she served as an expert and reviewed projects for various ICT programs: ANR ARPEGE and EGIDE PHC Barrande.

- **Lionel Seinturier** is junior member of Institut Universitaire de France since October 2011. He has been elected member of Conseil National des Universités (CNU 27, collège A) in October 2011 for a 4-year term. In 2011 he served as a member of the Prime d'Excellence Scientifique jury for the Higher Education Ministry. He is financial director of Laboratoire d'Informatique Fondamentale de Lille since October 2007. He is an elected member of the LIFL council (since 2007) and of the Lille 1 UFR IEEA council (since 2007). In 2011, he served as a member of the Comités de sélection for recruiting associate professors at University Lille 1, Institut National Polytechnique Grenoble and INSA Toulouse. In 2011, he served as a member of Inria C2D Lille committee for granting "Inria délégations". In 2011, he served as an expert and reviewed projects for various ICT programs: ANR ARPEGE, ANR MN, EGIDE COFECUB France-Brazil, DRRT Nord label Jeune Entreprise Innovante and DRRT Nord Crédit Impôt Recherche.

9.3. Supervision

The PhD Students advised by team members are listed in Table 1.

Table 1. Supervision activities of ADAM

Name	Title	Start Date	Advisor
Rémi Druilhe	Réduction de l'emprunte énergétique dans la maison numérique	10/2010	Lionel Seinturier (Dir) et Laurence Duchien
Alexandre Feugas	Maintien de la qualité de service au cours de l'évolution d'applications orientées services	10/2010	Laurence Duchien (Dir), Sébastien Mosser
Nicolas Haderer	AntDroid: Opportunistic Mobile Sensing of User Activities	09/2010	Lionel Seinturier (Dir) et Romain Rouvoy
Gabriel Hermosillo	Towards Creating Context-Aware Dynamically-Adaptable Business Processes Using Complex Event Processing	10/2008	Laurence Duchien (Dir) et Lionel Seinturier
Jonathan Labéjof	Évolution des architectures orientées service hétérogènes	11/2009	Lionel Seinturier (Dir), Philippe Merle
Matias Martinez	Automated Program Repair at Development and Runtime	10/2011	Laurence Duchien (Dir), Martin Monperrus
Rémi Mélisson	Set Tob Box virtualization in a Software Defined Network context	10/2010	Laurence Duchien (Dir), Romain Rouvoy
Adel Noureddine	Software Engineering for Green Autonomic Systems	11/2010	Lionel Seinturier (Dir) et Romain Rouvoy
Russel Nzekwa	Building Feedback Control Loops for Self-Adaptive Very-Large-Scale Environments	10/2009	Lionel Seinturier (Dir) et Romain Rouvoy
Fawaz Fernand Paraïso	Interopérabilité des environnements middleware de cloud computing	10/2011	Lionel Seinturier (Dir), Philippe Merle
Clément Quinton	Migration d'applications dans les environnements middleware de cloud computing	10/2011	Laurence Duchien (Dir), Lionel Seinturier
Gabriel Tamura	QoS-CARE: A Reliable System for Preserving QoS Contracts through Dynamic Reconfiguration	10/2009	Laurence Duchien (Dir), Rubby Casallas

9.4. Teaching

Permanent members teach the following courses:

- **Laurence Duchien** teaches several courses on :
    - Software Product Lines, 6 H ETP, Level M2, Master of Computer Science speciality IAGL, University Lille 1, France,
    - Software Project Management, 50 HETP, Level M2, Master MIAGE, University Lille 1, France,
    - Network Computer, 37,5 H ETP, Level L3, Licence MIAGE, University Lille 1, France,
    - Object-Oriented Design, 42 H ETP, Level M2, Master of Computer Science, University Lille 1, France,
    - Research and Innovation Initiation, 17 H ETP, Level M2, Master of Computer Science, University Lille 1, France,
    - Tutoring Internship, 22 H ETP, Level M2, Master of Computer Science, University Lille 1, France.

    She heads the research program in Master of Computer Science at University Lille 1 (http://www.fil.univ-lille1.fr/portail/index.php?dipl=MInfo&sem=RIC&ue=ACCUEIL). She is referent for the professional insertion in the PhD program in Computer Science at PRES University Lille Nord de France.
- **Lionel Seinturier** heads the E-Service specialty of the Master of Computer Science at the University Lille 1. He teaches several courses on middleware, component-based software engineering, aspect-oriented programming, and object-oriented design in Master of Computer Science at the University Lille 1:
    - Conception d'applications réparties, 18h, M1, University Lille 1, France
    - Infrastructures et frameworks Internet, 6h, M2, University Lille 1, France

- **Romain Rouvoy** supervises the Agil-IT Junior Enterprise (http://agil-it.fr) and teaches at University Lille 1:
    - Mise à niveau Web, 25h ETP, Level L3, Master of Computer Science speciality MIAGE, UFR IEEA, University Lille 1, France,
    - Technologies Web, 20h ETP, Level L3, Master of Computer Science speciality MIAGE, UFR IEEA, University Lille 1, France,
    - Conception d'Applications Réparties, 18h ETP, Level M1, Master of Computer Science, UFR IEEA, University Lille 1, France,
    - Qualité du Logiciel, 30h ETP, Level M2, Master of Computer Science speciality MIAGE, UFR IEEA, University Lille 1, France,
    - Infrastructures et Frameworks Internet, 23h ETP, Level M2, Master of Computer Science speciality IAGL, UFR IEEA, University Lille 1, France,
    - Innovation & Initiation à la Recherche, 14h ETP, Level M2, Master of Computer Science speciality IAGL, UFR IEEA, University Lille 1, France,
    - Intergiels Orienté Services, 50h ETP, Level M2, Master of Computer Science speciality IPI-NT, UFR IEEA, University Lille 1, France,
    - Suivi de projets, 60h ETP, Level M2, Master of Computer Science, UFR IEEA, University Lille 1, France,
    - Suivi d'alternants, 60h ETP, Level M2, Master of Computer Science, UFR IEEA, University Lille 1, France.

- **Martin Monperrus** teaches at the University Lille undergraduate and graduate courses. In particular:
    - Introduction to programming, 48h, L1, University Lille 1, France
    - Object-oriented design, 39h, L3, University Lille 1, France
    - Automated software engineering, 28h, L3, University Lille 1, France

9.5. Miscellaneous

- The team has organized the 3rd "Journées du GDR CNRS GPL"[2]. The event gathered 226 participants from June 7 to June 20, 2011.
- The team has organized its internal seminar in Mombreux from August 31 to September 2, 2011.
- The team has participated to RIC (Research, Innovation, Creation) Day , Lille, October 2011[3].

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