INRIA

INSTITUT NATIONAL DE RECHERCHE EN INFORMATIQUE ET EN AUTOMATIQUE

Project-Team ADAM

Adaptive Distributed Applications and Middleware

Lille - Nord Europe

Theme : Distributed Systems and Services

Table of contents

1. Team

Research Scientists

Christophe Gransart [Research Associate (CR1), INRETS, external collaborator]
Philippe Merle [Research Associate (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]
Romain Rouvoy [Associate Professor, Université Lille 1]
Lionel Seinturier [Professor, Université Lille 1, HdR]

Technical Staff

Pierre Carton [Expert Engineer, INRIA, CAPPUCINO Project until September 30th 2010]
Christophe Demarey [Research Engineer, INRIA, Galaxy ADT]
Nicolas Dolet [Expert Engineer, INRIA, UbInnov ADT]
Estéban Duguepéroux [Recent Graduate Engineer, INRIA, CALICO ADT, until September 21th 2010]
Julien Ellart [Expert Engineer, INRIA, ICOM Project, until June 30 th 2010]
Damien Fournier [Expert Engineer, INRIA, ICT FP7, IP SOA4All Project]
Rémi Mélisson [Expert Engineer, INRIA, Minalogic MIND Project, until October 1st 2010]
Clément Quinton [Recent Graduate Engineer, INRIA, UbInnov ADT]
Nicolas Petitprez [Expert Engineer, INRIA, ICT FP7, IP SOA4All project, since November 1st 2010]

PhD Students

Gabriel Hermosillo [INRIA CORDI-S grant]
Jonathan Labejof [CIFRE Thales]
Guillaume Libersat [MERT grant, until June 30th 2010]
Russel Nzekwa [INRIA CORDI-C grant]
Carlos Parra [INRIA / Région Nord/Pas-de-Calais grant]
Daniel Romero [EIFFEL grant]
Guillaume Waignier [ATER, until June 15th 2010]
Gabriel Tamura [Co-supervision with U. Los Andes, bogota, Colombia]
Rémi Druilhe [CIFRE Orange Labs, since October 11th 2010]
Alexandre Feugas [INRIA CORDI-S grant, since October 15th 2010]
Rémi Mélisson [CIFRE Orange Labs, since October 11th 2010]
Nicolas Haderer [Contrat doctoral Lille 1, since October 1st 2010]
Adel Nourredine [INRIA/Région Nord-Pas de Calais, since December 1st 2010]

Post-Doctoral Fellows

Frédéric Loiret [Expert Engineer, INRIA, ANR TLog Flex-eWare Minalogic MIND Project]
Nicolas Pessemier [Expert Engineer, INRIA, CAPPUCINO Project, until September 15th 2010]
Anthony Cleve [ERCIM grant, until November 30th 2010]
Sébastien Mosser [PostDoc, INRIA, since November 15th 2010]

Administrative Assistant

Malika Debuysschere [INRIA]

Others

Adel Noureddine [Master, February- September 2010]
Mohamed El Haddad [Master Intern - U. Lille 1 - February-June 2010]
Damien Leflon [Licence Intern - U. Lille 1 - April - June 2010]
Rubby Casallas [Visiting Scientist - U. Los Andes, Bogota, Colombia - June 2010]
Marc-Eduard Frincu [Visiting Scientist - West University of Timisoara, Romania - June 2010]
Norha Villegas [Visiting Scientist - U. of Victoria, Canada - June 2010]
Dario Correal [Visiting Scientist, Assistant Professor, U. Los Andes, Bogota, Colombia - March 2010]

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

- In the project FUI CAPPUCINO, we have defined and developed a software production line for context-aware mobile applications. This project has received the Research Prize awarded by the PRES Lille Nord de France for the cluster PICOM in December 2009. Our results in this project are in part covered by an industrial transfer to a spin-off named UbInnov and lead by Nicolas Dolet. The software named ApplIDE will be transferred in early 2011. In 2010, the spin-off UbInnov won the Emergence Oséo contest and the CréACC contest.
- The work on CALICO is the subject of Guillaume Waignier's Ph.D. thesis [11]. CALICO is 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. CALICO is an open source software (see Section 5.2) available at http://calico.gforge.inria.fr.

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 [52], [69] 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 [64], software components [72] 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 [51] and CCM [50]), 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 [75]. 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 [84]. 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.

[1] These terms are more or less equivalent.

We will base the design approach of the future implementation prototype on 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.

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 (cf. sections 8.2 and 8.3), 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 (cf. section 8.2). 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 (cf. section 8.2). 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 (cf. section 8.2). 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, Estéban Duguepéroux, Anne-Françoise Le Meur, Guillaume Waignier [correspondant].

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. Our contribution is concretized by a multi-platform implementation. 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 [11].

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 [55], [57], [73]. FRACTAL has been designed by both INRIA and France Telecom R&D.

FRACTAL is also an LGPL open source software project hosted by the OW2 international consortium and is available at http://fractal.ow2.org [61].

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 [82].
- **Fraclet** is an attribute-oriented programming model enabling the rapid development of FRACTAL components [79].
- **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 [59], [60]. 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], 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 will become a set of standardized OASIS's specifications.

FraSCAti includes Tinfi, which provides an 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 an SCA personality. As far as we know, this result, which has been presented in [81], 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 [76] 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 on some current and past funded projects (ICT FP7 SOA4All Integrated Project, ANR ARPEGE ITEmIS project, ANR TLog SCOrWare project).

FraSCAti is 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. Hulotte

Participants: Frédéric Loiret [correspondant], Lionel Seinturier.

Component-based technologies are widely used in various application domains (from grid computing to embedded systems) for which the functional needs are heterogeneous. To cope with such an heterogeneity, the execution infrastructures that provide the basic services required by the applications should be adapted to these targeted domains. Within ADAM, various works have been conducted to carry out this adaptation needed at infrastructure level, in particular :

- by using generative approaches allowing the generation of the sub-set of the infrastructure dedicated to the targeted domain,
- by exploiting the component paradigm not only at applicative level but also at infrastructure level. This allows us to capture the invariants of the infrastructure that could be reused independently of the targeted domain.

Hulotte is a generic framework focused on these two aspects. The originality of Hulotte is to be based on a flattened and unified representation of the whole system—*i.e.*, it allows reasoning on the applicative level as well as the infrastructure level. It is a mandatory requirement in order to ease the generation of domain-dependent components based on global properties of the system. The experiment described in [71] has been conducted using Hulotte. Hulotte is also based on several software developed within the ADAM team: Juliac, Koch, Spoon.

More information is available at http://adam.lille.inria.fr/soleil/hulotte/.

5.6. M2C

Participants: Pierre Carton, Laurence Duchien, Carlos Parra, Nicolas Pessemier [correspondant], Clément Quinton.

Model2Code (M2C) is directly connected to the work of Carlos Parra's PhD which covers the definition and implementation of a Context-Aware Dynamic Software Product Line (DSPL) named CAPucine. It provides a set of tools for metamodel transformation and code generation. The current implementation of M2C addresses transformation from CAPucine metamodel towards OSOA SCA metamodel, and Spoon EMF metamodel. The transformations were formerly written in pure Java, and are now in QVT language, which is a dedicated language for transformation, enhancing the readability. M2C meta models are based on the Eclipse Modeling Framework. Code generators are all written in Java.

Model2Code is registered with the APP (Agence pour la Protection des Programmes) under reference FR.001.270007.000.S.P.2010.000.10700.

5.7. 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 [63]. The current implementation of SPACES is based on the COSMOS context framework [56], [78] and the COMANCHE web server [55]. Both COSMOS and COMANCHE are based on the FRACTAL component model and use the JULIA implementation of the FRACTAL runtime environment [55].

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 [70] protocols. For the discovery, the implementation uses the Service Location Protocol (SLP) [66].
2. *Context Representation*: Following the REST principles, SPACES supports multiple representations of the context information: JSON [58], 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 [83]. SPACES benefits from the LDAP based queries of SLP to select the context providers.

We use XStream 1.3.13 [54] and JSON-lib 2.2.34 [53] to serialize context information as XML and JSON documents. For SLP and twitter we employ jSLP 1.0.0 [77] and twitter-4j 2.0.6 [85].

SPACES is in the process of being registered with the APP (Agence pour la Protection des Programmes).

5.8. TRASER

Participants: Laurence Duchien, Julien Ellart [correspondant], Gabriel Hermosillo, Lionel Seinturier.

Today's companies are suffering changes in the way they deal with their inventories and the management of their whole supply chain. New technologies are emerging to help them adapt to these changes and keep a competitive status, but the adoption of such technologies is not always easy. Even though a lot of research has been done for RFID, there are still some areas that are being left aside, like the traceability aspect, which is one of the most important in the retail supply chain. We propose a service named TRASER (TRAceability SErvice for the Retail supply chain) that will help companies to adopt new technologies into their existing environments, dealing with persistence and traceability, and allowing users to manage their operation according to their business rules, workflows and historical data [67]. This service is part of the whole ICOM platform, which aims at creating a shared technical infrastructure. This infrastructure is generic, parameterized and capable of managing the communication of heterogeneous systems (RFID, bar codes, NFC, etc.), within them and with existing IT services, in order to help companies to exploit and benefit from the

current technologies. TRASER uses OW2 Nova Bonita as a workflow engine. TRASER has been developed in the context of the ICOM project, funded by the «Pôle de compétitivité» PICOM and the Région Nord-Pas-de-Calais and is published as a LGPL project in the INRIA Gforge repository.

6. New Results

6.1. Adaptive Middleware

Participants: Damien Fournier, Rémi Mélisson, Philippe Merle, Russel Nzekwa, Lionel Seinturier, Daniel Romero, Romain Rouvoy.

Three results are worth mentioning around Adaptive Middleware. They deal with the FraSCAti platform, autonomic feedback control loops and complex event processing.

Concerning the FraSCAti middleware platform for adaptive SOA, in [25] we describe some new results which have been incorporated in the platform to support the autonomic discovery of services. We have built a demonstration scenario which highlights the adaptation capabilities of FraSCAti, and two new forms of remote bindings: resource-oriented and ubiquitous. This demonstration scenario is architectured around a case study in the domain of an ubiquitous home environment with devices such as set top boxes and smartphones.

In the context of the ANR SALTY project we worked on the specification of a DSL named CORONA and dedicated to the engineering of control loops in autonomic systems. The purpose of CORONA is twofold: First, it aims to reduce the cost of building autonomic administrative software. Secondly, it aims to enforce visibility of control loops in such software. Preliminary results of this work have been published in [27].

For Complex Event Processing (CEP), we have proposed in [21] and [22] a plug-in based framework, called CEVICHE, that allows the integration of different Complex Event Processing (CEP) engines, to create context-adaptive business processes, which are described with the Standard Business Process Language (SBPL) that we have proposed. SBPL is an extension of BPEL, which allows the user to include, in the business process definitions, the adaptation points, conditions and alternative processes to create adaptable business processes dynamically. We used two different approaches, AOP and SCA, to demonstrate the feasibility of business processes adaptability at runtime. This work is partially funded by the ICOM project.

6.2. Software Components for Embedded Systems

Participants: Laurence Duchien, Frédéric Loiret, Lionel Seinturier, Daniel Romero, Romain Rouvoy.

Two main results have been achieved in the domain of software components for embedded systems: at the design level [13] and at the platform level [23].

At the design level, [13] presents a framework that supports the compositional construction and development of applications that must meet various domain-specific requirements. The original result is to express these requirements as annotations on the software architectural description and to implement them both with open and extensible component-based containers and with a composition mechanism based on the Aspect-Oriented Programming paradigm.

At the platform level, [23] proposes a three-tier approach where application, runtime containers implementing concurrent execution patterns and the underlying operating system are designed using components. The originality of this result is to provide a homogeneous design and runtime space where optimization techniques can be applied from end-to-end, crossing boundaries which have been previously hermetic. This demonstrates that software components are a viable solution that do not hinder runtime performances, which is a stringent requirements, for implementing embedded systems.

6.3. Context-awareness and Ambient Intelligence Software

Participants: Pierre Carton, Anthony Cleve, Laurence Duchien, Carlos Parra, Nicolas Pessemier.

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 [28] we have proposed and approach to use both feature constraints and aspect model dependencies in order to create a complete derivation process that guarantees a conflict-free strategy for aspect weaving. To do it, we propose to analyze and compare the constraints defined at the feature level with the aspect dependencies that are implicitly defined en every aspect. This work corresponds to Carlos Parra's PhD thesis and is partially funded by the CAPPUCINO project.

6.4. Formal Model for Software Adaptation

6.4.1. SCeSAME: Formal Definition of Software Architecture Adaptation

Participants: Rubby Casallas, Anthony Cleve, Laurence Duchien, 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 [62], 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 first results have been published in [16], [35].

6.4.2. FracToy : Formal Methodology to Specify Self-Configurable Component-Based Systems

Participants: Philippe Merle, Lionel Seinturier.

One of the key research challenges in autonomic computing is to define rigorous mathematical models for specifying, analyzing, and verifying high-level self-* policies. [36] presents the FracToy formal methodology to specify self-configurable component-based systems, and particularly both their component-based architectural description and their self-configuration policies. This rigorous methodology is based on the first-order relational logic, and is implemented with the Alloy formal specification language. [36] presents the different steps of the FracToy methodology and illustrates them on a self-configurable component-based example.

6.5. Software Evolution

6.5.1. Design and Evolution of Component-Based Software

Participants: Laurence Duchien, Anne-Françoise Le Meur, Guillaume Waignier.

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. CALICO has been developed in the context of Guillaume Waignier's PhD thesis [11].

CALICO is available on http://calico.gforge.inria.fr.

6.5.2. Detection of Design Defects

Participants: Laurence Duchien, Anne-Françoise Le Meur.

Following Naouel Moha's Ph.D. thesis [74], we have published this work in the journal of Formal Aspects of Computing Science (ranked A) and the journal of IEEE Transactions on Software Engineering (ranked A+). The first journal paper focuses on the automatic detection of code and design smells in software systems using a domain-specific language [15]. The second journal paper presents the DECOR method, which embodies and defines all the steps necessary for the specification and detection of code and design smells [14].

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.

8. Other Grants and Activities

8.1. Local Initiatives

8.1.1. INRIA ADT CALICO

Participants: Laurence Duchien, Estéban Duguepéroux, Anne-Françoise Le Meur, Guillaume Waignier.

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. Estéban Duguepéroux (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.

Further information is available on the website of the project: http://salty.unice.fr.

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 TLog Flex-eWare

Participants: Frédéric Loiret, Philippe Merle, Lionel Seinturier.

Flex-eWare is a 3-year ANR TLog project (of type "*plate-forme exploratoire*"), which has started on January 1st 2007. The partners of this project are: Thales (leader), Orange Labs, Schneider, STMicroelectronics, Teamlog, Trialog, CEA, ENST, INRIA, Univ. Paris 6.

The project aims at defining an open and adaptable middleware platform for component-based applications in the domain of embedded systems. This project addresses issues that are related to components, software architectures, and adaptable middleware. One of the research challenges of this project is to define software components, which are context-aware and can take into account the specificities in terms of resource management of the targeted embedded systems. Besides, Flex-eWare aims at federating and unifying the component approaches (Lw-CCM and FRACTAL) of the industrial and academic partners of the project, consolidating these technologies for the domain of embedded systems, and opening and fostering the use of these technologies by contributing some reference open source implementations.

Further information is available on the website of the project: http://www.flex-eware.org.

8.2.4. ANR ARPEGE SocEDA

Participants: Gabriel Hermosillo, 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.

8.2.5. INRIA ADT Galaxy

Participants: Christophe Demarey, Philippe Merle, Lionel Seinturier.

The galaxy ADT (*Technology Development Action*) contributes to make INRIA a value-added player in the SOA arena, by designing and developing an Open Framework for Agile and Dynamic Software Architecture. This ADT will work for INRIA and INRIA's research project-teams direct benefit, and aims at pre-assembling technological bricks from various teams, projects and preparing them to be transferred through the open source software channel. Contributors to this ADT are mainly research project-teams, including ADAM, OASIS, OBASCO, SARDES, SCORE, and TRISKELL, and the galaxy ADT is led and managed by the TUVALU team.

The goal of the galaxy ADT is to provide an IT agile platform, built on dynamic software architecture principles, and fitting for flexibility, dynamical reconfiguration, adaptability, continuity and autonomic computing. FRACTAL, SCA-FraSCAti and GCM-ProActive are the major technologies which will be the technological drivers of this ADT. The different usage scenarios as well as the different tools which will be developed at infrastructure, application and business levels will demonstrate that this platform is able to support the design, modelling, deployment and execution of business processes. At the same time, the ADT will target the definition of a new common language to manipulate dynamically adaptive distributed SOA-based systems, encompassing application and middleware layers. This common language will take different forms, inherited from works done by several project-teams with their distinct skills, and illustrates a new kind of collaboration between teams, coupling research and development works.

Further information is available on the website of the project: http://galaxy.gforge.inria.fr.

8.2.6. INRIA ADT UbInnov

Participants: Laurence Duchien, Nicolas Dolet, Nicolas Pessemier, 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 Quiton (INRIA ADAM New Graduate Engineer) has been recruited to achieve this task. In June 2010, Oséo provides its support to UbInnov. The next step is now to define the position of UbInnov in the mobile market place with a commercial offer including several versions of AppliDE. AppliDE will be transferred to a spin-off named UbInnov and led by Nicolas Dolet (INRIA ADAM Engineer).

8.2.7. Trade cluster CAPPUCINO

Participants: Pierre Carton, Anthony Cleve, Laurence Duchien, Carlos Parra, Nicolas Pessemier, Daniel Romero, Romain Rouvoy, Lionel Seinturier.

CAPPUCINO (Construction et Adaptation d'aPPlications Ubiquitaires et de Composants d'INtergiciels en environnement Ouvert pour l'industrie du commerce) is a 36-month project of the competitiveness cluster of trade industry of Nord/Pas-de-Calais PICOM (Pôle des Industries du COMmerce – http://www.picom.fr), which has started in September 2007. The partners of this project are NorSys (leader) which is a SME service company, TELECOM SUD Paris (School of Telecom industry), INRIA, AUCHAN and SI3SI (2 trade companies).

The Project CAPPUCINO aims to propose reliable solutions with the design, the deployment and execution problems of applications for ambient environments in the trade industry. This project addresses issues which are related to modeling context-aware information for ambient environments and take into account this information into runtime platforms. We propose to study the adaptation of the components - application components and execution platform supports - and their context evolution throughout the complete lifecycle of the application. The first ADAM's results are described in section 6.3.

The PRES - University Lille - Nord de France has awarded the research prize "Collaborative project" 2009 of the competitiveness cluster of trade industry (PICOM) to the CAPPUCINO Project.

8.2.8. Trade cluster ICOM

Participants: Laurence Duchien, Julien Ellart, Gabriel Hermosillo, Lionel Seinturier.

The ICOM project is realized in the context of the competitiveness cluster of trade industry of Nord-Pas de Calais PICOM (Pôle des Industries du COMmerce – http://www.picom.fr), has started in March 2008 and is a 24-month project. The partners of this project are Atos Origin, Auchan, Décathlon, La Poste, La Redoute, INRIA-ASAP, INRIA-ADAM, INRIA-POPS, GS1, ORANGE France.

Trade industry is being in constant evolution. The massive presence of the Internet, the increasing exigency of quality of service, the ubiquitous and pervasive nature of systems shatter the traditional trade practices, their economical and organizational models.

ICOM (Infrastructure pour le COMmerce du futur) aims at helping companies to enable a fast and easy deployment of new applications using new technologies and infrastructures from the ubiquitous computing world. It will provide a smart infrastructure that will hide the heterogeneity of identifiers (RFID, NFC, bar code), manage data storage and request routing to provide scalability. Several papers have been published this year [21], [22].

8.2.9. Trade cluster MIND

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

MIND is a 2-year 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.

8.3. European Initiatives

8.3.1. EGIDE PHC Aurora: University of Oslo

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

For the last years, Internet has been catalyzing the development of large scale distributed systems. These distributed systems provide users with advanced interaction artifacts developed to achieve a common objective. These systems, while still being investigated predominantly in the defense sector, is also seeing application in such fields as national air and auto transportation, space exploration, and health care, to name a few. These systems, also known as *Systems-of-Systems* (SoS) are made of heterogeneous pieces of software, which need to be combined in order to build a coherent platform. Keating et al. [68] define SoS as meta-systems that *"are themselves comprised of multiple autonomous embedded complex systems that can be diverse in technology, context, operation, geography and conceptual frame"*. A remaining challenge of SoS is the dependability and adaptation dimensions. From a scientific perspective the objective of this collaboration is to jointly research and develop common research projects with the goal of providing innovative approaches for the dependability and the adaptation of Systems of Systems. In particular we aim at developing a common framework that will include a comprehensive support for the following aspects:

- **Hierarchical SoS adaptation** is concerned with the layered adaptation of SoS. This activity consists in developing adaptation mechanisms that support the consistent adaptation of the different layers of a SoS, from the high level application down to the low level hardware resources;
- **Decentralized SoS adaptation** is concerned with the large scale adaptation of SoS. This activity consists in developing adaptation mechanisms that are able to perform adaptations independently based on information communicated by other adaptation mechanisms deployed in the system;
- **Dependable SoS adaptation** is concerned with the development of advanced adaptation mechanisms that are capable to cope with failure of non-dependable components. Our second objective is to make the adaptation planning mechanism itself fault-tolerant;
- **Adaptive SoS dependability** is concerned with providing multiple levels of guarantees, by deploying a variety of mechanisms that achieve adaptation planning in a coordinated fashion. The mechanisms belong to two categories: *i)* consistent replication techniques based on reliable group communication, and *ii)* strong agreement protocols.

Read more at http://adam.lille.inria.fr/pmwiki.php/Aurora.

8.3.2. 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/.

8.3.3. ERCIM Working Group Software Evolution

Participants: Anthony Cleve, 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.

We have organized the BENEVOL Workshop on Software Evolution in December 2010 at Lille. Anthony Cleve had an ERCIM post-doc grant.

8.3.4. IAP MoVES

Participants: Anthony Cleve, Laurence Duchien, Carlos Parra, Daniel Romero, Guillaume Waignier.

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.

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

8.3.5. 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 [18].

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. Philipe Merle and Lionel Seinturier are members of the Technology Council of OW2.

8.4.2. University of Los Andes (Bogota)

Participants: Laurence Duchien, Anthony Cleve, 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 first results have been published in [35], [16]. 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.

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 2010,
- Marc-Eduard Frincu, Ph.D student, West University of Timisoara, Romania, June 2010,
- Norha Villegas, Ph.D Student, University of Victoria, Canada, June 2010,
- Dario Correal, Assistant Professor, University of Los Andes, Bogota, Colombia, March 2010.

8.6. Other Activities

8.6.1. Data-intensive systems

Participant: Anthony Cleve.

During his postdoctoral year, Anthony Cleve has published some results of the work on data-intensive systems he had done during his PhD at the University of Namur (Belgium). Data-intensive systems are subject to continuous evolution that translates ever-changing business and technical requirements. System evolution usually constitutes a highly complex, expensive and risky process. This holds, in particular, when the evolution involves database schema changes, which in turn impact on data instances and application programs.

In [12] we identify the main challenges involved in data-intensive system evolution, we elaborate on the need for data reverse engineering as an initial phase of the process, and we argue for stronger collaboration between the software engineering and the database engineering communities.

In [20], we discuss the use of automated program analysis and transformation techniques in support to the evolution of the database component of the system. The program analysis techniques aim to help the developers to understand the data structures that are to be changed, despite the lack of precise and up-to-date documentation. The objective of the program transformation techniques is to adapt the application programs to the evolving database.

In [19], we present a comprehensive approach that supports the rapid development and the graceful evolution of data-intensive applications. The approach combines the automated derivation of a relational database from a conceptual schema, and the automated generation of data manipulation API providing programs with a conceptual view of the relational database.

In [29], we discuss the use of reverse engineering techniques to derive database requirement from prototype user interfaces. We show that this approach, based on an intensive user involvement, addresses a significant subset of data requirements, especially when combined with other requirement elicitation techniques.

8.6.2. Collaboration INRIA - INRETS-LEOST

Participant: Christophe Gransart.

Since several years, we collaborate with the *Laboratoire Electronique, Ondes et Signaux pour les Transports* (LEOST laboratory) of the french *Institut National de REcherche sur les Transports et leur Sécurité* (INRETS institute), and especially with Christophe Gransart. In the SIRSEC project, he is working on the definition of a library of software patterns that include safety properties. The goal is to use them for railway applications through a MDA/MDE approach. The target platforms should be based on software components like CCM [65].

He participated to a book on public transports and the implication of middleware to simplify the interoperability among the transport applications [37] .

9. Dissemination

9.1. Animation of the scientific community

9.1.1. Examination Committees

- **Anthony Cleve** was in the examination committee of the following Ph.D. thesis:
  - Diego Ordoñez Camacho, August 2010, Université catholique de Louvain (referee).
- **Laurence Duchien** was in the examination committee of the following HDR thesis:
  - Ileana Ober, November 2010, University of Toulouse (referee),
  - Ernesto Exposito, December 2010, University of Toulouse (member),
- **Laurence Duchien** was in the examination committee of the following Ph.D. thesis:
  - Guillaume Waignier, January 2010, University of Lille (Co-advisor),
  - Pierre Chatel, March 2010, University of Paris 6 (referee),
  - Idrissa Dieng, Mai 2010, University of Grenoble (referee),
  - Abdelkrim Amirat, September 2010, University of Nantes (referee),
  - Mahmoud Barhamgi, September 2010, University of Lyon (chair),
  - Matthias Brun, October 2010, University of Nantes (referee and chair),
  - An Phung-Khac, November 2010, Télécom Bretagne, Brest (referee),
- **Anne-Françoise Le Meur** was in the examination committee of the following Ph.D. thesis:
  - Guillaume Waignier, January 2010, University of Lille (Co-advisor).

- **Lionel Seinturier** was in the examination committee of the following Ph.D. thesis:
  - Marc Poulhiès, March 2010, University of Grenoble (referee),
  - Andrew Camilleri, April 2010, Lancaster University, UK (referee),
  - Olivier Gilles, April 2010, Telecom ParisTech (referee),
  - Lionel Touseau, May 2010, University of Grenoble (referee),
  - Paul Naoumenko, July 2010, University of Nice (referee),
  - Tayeb Bouhadiba, September 2010, University of Grenoble (referee),
  - Sébastien Mosser, October 2010, University of Nice (member),
  - Bao Le Duc, December 2010, University Paris 6 (referee),
  - Fady Hamoui, December 2010, University Montpellier (referee).

9.1.2. Journals, Conferences, Workshop

- **Anthony Cleve** has been
  - member of the following committees:
    * co-Chair of the ERCIM Working Group on Software Evolution, since 2010,
    * Steering committee member of the International Workshop on Principles of Software Evolution (IWPSE), since 2010 ,
    * Demonstration co-Chair of the 25th IEEE/ACM International Conference on Automated Software Engineering (ASE 2010),
    * Publicity co-Chair of the 3rd International Conference on Software Language Engineering (SLE 2010) ,
    * co-Organizer and Program co-Chair of IWPSE-EVOL 2010, the joint International Workshop on Principles of Software Evolution (IWPSE) and ERCIM Workshop on Software Evolution (EVOL),
    * co-Organizer and Program co-Chair of the 3rd International Workshop on Academic Software Development Tools and Techniques (WASDeTT'2010),
    * Program committee member of the 7th International Working Conference on Reverse Engineering (WCRE'2010),
    * Program committee member of the 3rd International Conference on Software Language Engineering (SLE'2010).
  - reviewer for the following journals:
    * Elsevier's Science of Computer Programming (SCP), special issue on Software Evolution, Adaptability and Variability.

- **Laurence Duchien** has been
  - member of the following committees:
    * Program committee SC 2010,
    * Program committee LMO 2010,
    * Program committee CAL 2010,
    * Program co-chair SEEA, Track EDISON 2010,
    * Program committee ECSA 2010,
    * Program committee MDPLE, ECMFA 2010,
    * Program committee MICS'10,

        * Program committee VARI-ARCH, ECSA 2010,
        * Program committee AVITAT, OTM 2010,
        * Program co-chair BENEVOL 2010,
        * Program committee SafeModel 2010,
        * Program committee Lignes de Production de logiciels 2010.
    - reviewer for the following journals:
        * Editorial board of the TSI (Hermes) journal,
        * Guest editor of special issue IDM, TSI, Hermès, March 2010,
        * Editorial board of special issue Special Issue Software Components, Architectures and Reuse of the Journal of Universal Computer Science (J.UCS), 2010.

- **Anne-Françoise Le Meur** has been
    - member of the following committees:
        * Organizing committee and program committee of the 5th AOSD Workshop on Domain Specific Aspect Languages (DSAL'10),
        * Organizing committee of the 9th BElgian-NEtherlands software eVOLution seminar (BENEVOL 2010).
    - reviewer for the following journals:
        * TSI journal (HERMES),
        * Annals of Telecommunications (SPRINGER).

- **Philippe Merle** has been member of the following committees:
    - Program committee of Conférence Langages et Modèles à Objects (LMO 2010).
    - Program committee of the International Middleware Workshop on *Adaptive and Reflective Middleware* (ARM'10), http://www.ics.uci.edu/ arm2010/,
    - Editorial board of the RSTI-L'Objet journal, Hermès.
    - External reviewer of International Conference on Embedded Software (EMSOFT 2010),

- **Lionel Seinturier** has been
    - chair of the following conferences:
        * Publicity Chair of the 9th International Conference on Aspect-Oriented Software Development (AOSD'10),
        * Co-chair of the 9th BElgian-NEtherlands software eVOLution seminar (BENEVOL'10).
    - member of the following committees:
        * Program committee of the 9th International Conference on Aspect-Oriented Software Development (AOSD'10),
        * Program committee of the IEEE Internation Conference on Service-Oriented Computing and Applications (SOCA'10),
        * Program committee of the Composition and Variability Workshop (CV'10) at AOSD 2010 ,
        * Program committee of the Distributed Architecture Modeling for Novel Component Based Embedded Systems (DANCE'10) at NOTERE 2010 ,

    * Program committee of the International Workshop on Security and Dependability for Resource Constrained Embedded Systems (S&D4RCES'10) at SAFECOMP 2010,
    * Program committee of the 2nd Workshop on Context-aware Adaptation Mechanisms for Pervasive and Ubiquitous Services (CAMPUS'10),
    * Program committee of the Conference on Software Engineering and Advanced Applications (SEAA) MOCS Track,
    * Program committee of the 28th French Congress on Information Systems (INFORSID'10),
    * Program committee of the 3rd French Conference on Architectures Logicielles (CAL'10),
  – reviewer for the following journals:
    * Elsevier Science of Computer Programming
    * Journal of Universal Computer Science
    * Springer Transaction on Aspect-Oriented Software Development

- **Romain Rouvoy** has been
  – member of the following committees:
    * Organizing committee and Program chair of the 3rd International DisCoTec Workshop on Context-aware Adaptation Mechanisms for Pervasive and Ubiquitous Services (CAMPUS'10) [42],
    * Organizing committee of the 9th BElgian-NEtherlands software eVOLution seminar (BENEVOL 2010),
    * Program committee of the IFIP International Conference on *Distributed Applications and Interoperable Systems* (DAIS'10),
    * Program committee of the International Symposium on *Middleware and Network Applications* (MNA'10),
    * Program committee of the International Middleware Workshop on *Adaptive and Reflective Middleware* (ARM'10),
    * Program committee of the International Middleware Workshop on *Middleware for Pervasive Mobile and Embedded Computing* (M-MPAC'10),
    * Program committee of the International ICSE Workshop on *Software Engineering for Sensor Network Applications* (SESENA'10),
  – reviewer for the following journals:
    * Elsevier Journal of *Data & Knowledge Engineering* (DKE) journal,
    * Elsevier Journal of *Network and Computer Applications* (NCA) journal, a Special Issue on Middleware Networks.

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 also Co-chair (with Jean-Louis Giavitto) of the Languages and Verification group of the GDR CNRS GPL (Génie de la Programmation et du Logiciel) since 2008. She has also been member of the scientific committee in the ANR ARPEGE Program. She has served as member of the recruitment committee for the professor and associate professor position at INSA Rennes, University of Bordeaux and Ecole des Mines de Nantes.

- **Anne-Françoise Le Meur** is elected member of the board of the LIFL laboratory. She was in the Comité de sélection for recruiting associate professors at the Polytech Engineering School of the University of Lille 1 (June), University of Nantes (June and September) and University of Bordeaux 1 (June). She has been a member of the Postdoc and PhD CORDIS Committee for the CR INRIA-Lille-Nord Europe. She has been reviewer for the ARPEGE program of ANR. In July 2010, she served as member of the jury for recruiting an Engineer (IGE) for the Faculté des Sciences Économiques et Sociales of the University of Lille 1.
- **Philippe Merle** is president of *Technological Development Council* (CDT) of the INRIA Lille Nord Europe research center. He is member of the steering committee of the "Grilles, Système et Parallélisme" (GSP) working group of the CNRS ARS GdR. He has served as member of the recruitment committee for associate professor position at University Pierre et Marie Curie (UPMC) and University Lille 1.
- **Lionel Seinturier** is elected member of the Comité de Centre INRIA Lille Nord Europe, member of Comité Hygiène et Sécurité INRIA Lille Nord Europe and member of the C2D (délégation and détachement) committee INRIA Lille Nord Europe. In June 2010, he served as member of the jury for recruiting an Assistant Engineer in charge of financial activities for the SAF INRIA Lille Nord Europe. In the LIFL laboratory, he is member of the council and member of the directorial board in charge of financial activities. Lionel Seinturier was in the Comité de sélection for recruiting associate professors at the Polytech Engineering School of the University of Lille 1, CNAM Paris (May 2010) and University Paris 10. Lionel Seinturier is member of the board of the IEEA faculty (UFR) at the University of Lille 1. He has served as chair of the Comité de sélection for recruiting an associate professor at CNAM Paris (November 2010). He has been reviewer for the JEI program of DRRT Nord and DRRT Champagne-Ardenne, the ARPEGE and Jeunes chercheurs programs of ANR, the CIFRE program of ANRT, and the postdoc program of RTRA Digiteo.
- **Romain Rouvoy** was in the Comité de sélection for recruiting associate professors at the IEEA faculty of the University Lille 1. He has served as member of the recruitment committee for associate professors at the Institut de Formation Supérieure en Informatique et Communication - Rennes 1;

9.3. Teaching

Permanent members teach the following courses:

- **Laurence Duchien** teaches several courses on Software Product Lines in Master 2 of Computer Science (IAGL), software project management in Master 2 MIAGE, advanced object-oriented design in Master 1 and on networks in Licence 3 MIAGE at the Université de Lille 1, UFR IEEA . She heads the research program in Master of Computer Science at University of Lille. She is also the referent for the professional insertion of the PhD program in Computer Science.
- **Anne-Françoise Le Meur** teaches a course on Domain-Specific Languages (DSL) and on "Being a researcher" in Master 2 Research at the Université de Lille 1, UFR IEEA;
- **Philippe Merle** teaches a course on Middleware and Design Patterns in Master Research Sciences et Technologies Mention Informatique at the Université de Lille 1, UFR IEEA;
- **Lionel Seinturier** Lionel Seinturier heads the E-Service specialty of the Master of Computer Science at the University of 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 of Lille 1;
- **Romain Rouvoy** teaches several courses on advanced object-oriented design (Master 1), service-oriented design and middleware (Master 2), distributed application design (Master 2), and dependable & adaptive middleware (Master 2 Research) at University Lille 1, UFR IEEA;

9.4. Miscellaneous

- The team has organized the New Challenges in Software Engineering in the GDR GPL days, Pau, March 2010.
- The team has hosted an Aurora/SeaS research seminar, Lille, INRIA, March 2010.
- The team has organized an Aurora/SeaS research workshop, Amsterdam, Netherlands, June 2010.
- The team has organized its internal seminar, Ennevelin, France, September 8th-10th, 2010.
- The team has participated to RIC (Research, Innovation, Creation) Day, Lille, October 2010.
- The team has organized the BENEVOL Workshop, Lille, December 2010.
- The team has organized the IDM Day Workshop, Lille, December 2010.

10. Bibliography

Major publications by the team in recent years

[1] O. BARAIS, J. LAWALL, A.-F. LE MEUR, L. DUCHIEN. *Software Architecture Evolution*, in "Software Evolution", T. MENS, S. DEMEYER (editors), Springer-Verlag, February 2008, p. 233–262, http://hal.inria.fr/inria-00371226.

[2] C. DEMAREY, G. HARBONNIER, R. ROUVOY, P. MERLE. *Benchmarking the Round-Trip Latency of Various Java-Based Middleware Platforms*, in "Studia Informatica Universalis Regular Issue", May 2005, vol. 4, n^{o} 1, p. 7–24, ISBN: 2-912590-31-0, http://studia.complexica.net/Art/RI040102.pdf.

[3] J.-M. GEIB, P. MERLE. *CORBA : des concepts à la pratique*, in "Techniques de l'Ingénieur. Informatique", February 2000, vol. HB2, n^{o} H2758, p. 1–31.

[4] 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, p. 20-36, Rank (CORE) : A+, http://www.computer.org/portal/web/csdl/doi/10.1109/TSE.2009.50, http://hal.inria.fr/inria-00538476, http://.

[5] R. PAWLAK, L. DUCHIEN, L. SEINTURIER. *CompAr: Ensuring Safe Around Advice Composition*, in "Proceedings of the 7th IFIP International Conference on Formal Methods for Open Object-based Distributed Systems (FMOODS 2005)", Athens, Greece, June 2005, p. 163-178.

[6] R. PAWLAK, L. SEINTURIER, L. DUCHIEN, G. FLORIN. *JAC: A Flexible Solution for Aspect-Oriented Programming in Java*, in "REFLECTION '01: Proceedings of the Third International Conference on Metalevel Architectures and Separation of Crosscutting Concerns", London, UK, Springer-Verlag, 2001, p. 1–24.

[7] N. PESSEMIER, L. SEINTURIER, T. COUPAYE, L. DUCHIEN. *A Component-Based and Aspect-Oriented Model for Software Evolution*, in "International Journal of Computer Applications in Technology (IJCAT)", 2008, vol. 31, n^{o} 1-2, p. 94-105, http://hal.inria.fr/inria-00269895.

[8] A. PLŠEK, F. LOIRET, P. MERLE, L. SEINTURIER. *A Component Framework for Java-based Real-time Embedded Systems*, in "Proceedings of ACM/IFIP/USENIX 9th International Middleware Conference", Leuven, Belgium, V. ISSARNY, R. SCHANTZ (editors), Lecture Notes in Computer Science, Springer-Verlag, December 2008, vol. 5346, p. 124–143, Rank (CORE) : A, http://hal.inria.fr/inria-00301410.

[9] R. ROUVOY, P. SERRANO-ALVARADO, P. MERLE. *A Component-based Approach to Compose Transaction Standards*, in "Proceedings of the 5th International Symposium on Software Composition (SC'06)", Vienna, Austria, Lecture Notes in Computer Science, Springer-Verlag, March 2006, vol. 4089, p. 114–130.

[10] G. WAIGNIER, P. SRIPLAKICH, A.-F. LE MEUR, L. DUCHIEN. *A Model-Based Framework for Statically and Dynamically Checking Component Interactions*, in "Proceedings of the ACM/IEEE 11th International Conference on Model Driven Engineering Languages and Systems (MODELS'08)", Toulouse, France, Lecture Notes in Computer Science, Springer-Verlag, October 2008, vol. 5301, p. 371-385, Rank (CORE) : A [*DOI :* 10.1007/978-3-540-87875-9_27], http://hal.inria.fr/inria-00311584.

Publications of the year

Doctoral Dissertations and Habilitation Theses

[11] G. WAIGNIER. *Canevas de développement agile pour l'évolution fiable de systèmes logiciels à composants et orientés services*, Université des Sciences et Technologie de Lille - Lille I, Jan 2010, http://hal.inria.fr/tel-00457590, http://.

Articles in International Peer-Reviewed Journal

[12] A. CLEVE, T. MENS, J.-L. HAINAUT. *Data-Intensive System Evolution*, in "Computer", Aug 2010, vol. 43, n^{o} 8, p. 110-112, http://hal.inria.fr/inria-00512726, http://.

[13] F. LOIRET, R. ROUVOY, L. SEINTURIER, D. ROMERO, K. SÉNÉCHAL, A. PLSEK. *An Aspect-Oriented Framework for Weaving Domain-Specific Concerns into Component-Based Systems*, in "Journal of Universal Computer Science (J.UCS)", Oct 2010, http://hal.inria.fr/inria-00521432, http://.

[14] 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, p. 20-36, Rank (CORE) : A+, http://www.computer.org/portal/web/csdl/doi/10.1109/TSE.2009.50, http://hal.inria.fr/inria-00538476, http://.

[15] N. MOHA, Y.-G. GUÉHÉNEUC, A.-F. LE MEUR, L. DUCHIEN, A. TIBERGHIEN. *From a Domain Analysis to the Specification and Detection of Code and Design Smells*, in "Formal Aspects of Computing Science", May 2010, vol. 22, n^{o} 3-4, p. 345-361, Special issue dedicated to FASE'08, Rank (CORE) : A [*DOI :* 10.1007/s00165-009-0115-x], http://www.springerlink.com/content/152n855088w747p4, http://hal.inria.fr/inria-00512135, http://.

Articles in National Peer-Reviewed Journal

[16] G. TAMURA, A. CLEVE. *A Comparison of Taxonomies for Model Transformation Languages*, in "Paradigma", Mar 2010, vol. 4, n^{o} 1, http://hal.inria.fr/inria-00488765, http://.

International Peer-Reviewed Conference/Proceedings

[17] M. ALIA, M. BEAUVOIS, Y. DAVIN, R. ROUVOY, F. ELIASSEN. *Components and Aspects Composition Planning for Ubiquitous Adaptive Services*, in "36th EUROMICRO International Conference on Software Engineering and Advanced Applications (SEAA'10)", France Lille, ACM, 2010, p. 1-6, Ranking C, acceptation rate 48%, http://hal.inria.fr/inria-00510632, http://.

[18] F. BAUDE, I. FILALI, F. HUET, V. LEGRAND CONTES, E. N. MATHIAS, P. MERLE, C. RUZ, R. KRUMMENACHER, E. P. B. SIMPERL, C. HAMMERLING, J.-P. LORRÉ. *ESB federation for large-scale SOA*, in "Proceedings of the 2010 ACM Symposium on Applied Computing (SAC)", Sierre, Switzerland, S. Y. SHIN, S. OSSOWSKI, M. SCHUMACHER, M. J. PALAKAL, C.-C. HUNG (editors), ACM, Mar 2010, p. 2459-2466.

[19] A. CLEVE, A.-F. BROGNEAUX, J.-L. HAINAUT. *A Conceptual Approach to Database Applications Evolution*, in "27th International Conference on Conceptual Modeling (ER'2010)", Canada Vancouver, Springer-Verlag, Nov 2010, vol. 6412, p. 132-145, Acceptance rate: 20%, Rank (CORE): A, http://hal.inria.fr/inria-00512718, http://.

[20] A. CLEVE. *Program Analysis and Transformation for Data-Intensive System Evolution*, in "26th IEEE International Conference on Software Maintenance (ICSM'2010)", Roumanie Timisoara, IEEE Computer Society, Sep 2010, p. 20-25, Rank (CORE): A, http://hal.inria.fr/inria-00512724, http://.

[21] G. HERMOSILLO, L. SEINTURIER, L. DUCHIEN. *Creating Context-Adaptive Business Processes*, in "The 8th International Conference on Service Oriented Computing", États-Unis San Francisco, California, Dec 2010, Acceptance rate : 15%, Rank (CORE) : A, http://hal.inria.fr/inria-00508988, http://.

[22] G. HERMOSILLO, L. SEINTURIER, L. DUCHIEN. *Using Complex Event Processing for Dynamic Business Process Adaptation*, in "Proceedings of the 7th IEEE 2010 International Conference on Services Computing (SCC 2010)", États-Unis Miami, Florida, IEEE Computer Society, Jul 2010, p. 466 -473, Acceptance rate : 18%, Rank (CORE) : A, http://hal.inria.fr/inria-00482578, http://.

[23] F. LOIRET, L. SEINTURIER, L. DUCHIEN, D. SERVAT. *A Three-Tier Approach for Composition of Real-Time Embedded Software Stacks*, in "13th International Symposium on Component Based Software Engineering", Tchèque, République Prague, Springer, Jun 2010, vol. 6092, http://hal.inria.fr/inria-00470160, http://.

[24] R. MÉLISSON, P. MERLE, D. ROMERO, R. ROUVOY, L. SEINTURIER. *Reconfigurable Run-Time Support for Distributed Service Component Architectures*, in "Automated Software Engineering, Tool Demonstration", Belgique Antwerp, Sep 2010, p. 171 - 172, http://hal.inria.fr/inria-00499477, http://.

[25] R. MÉLISSON, D. ROMERO, R. ROUVOY, L. SEINTURIER. *Supporting Pervasive and Social Communications with FraSCAti*, in "3rd DisCoTec Workshop on Context-aware Adaptation Mechanisms for Pervasive and Ubiquitous Services", Pays-Bas Amsterdam, Jun 2010, http://hal.inria.fr/inria-00485602, http://.

[26] R. NZEKWA, R. ROUVOY, L. SEINTURIER. *A Flexible Context Stabilization Approach for Self-Adaptive Application*, in "COMOREA - (PERCOM)", Allemagne Mannheim, Mar 2010, 6, http://hal.inria.fr/inria-00449850, http://.

[27] R. NZEKWA, R. ROUVOY, L. SEINTURIER. *Modelling Feedback Control Loops for Self-Adaptive Systems*, in "Third International DisCoTec Workshop on Context-Aware Adaptation Mechanisms for Pervasive and Ubiquitous Services", Pays-Bas Amsterdam, Sonia Ben Mokhtar and Romain Rouvoy and Michael Wagner, Apr 2010, 7, http://hal.inria.fr/inria-00485019, http://.

[28] C. PARRA, A. CLEVE, X. BLANC, L. DUCHIEN. *Feature-based Composition of Software Architectures*, in "4th European Conference on Software Architecture", Danemark Copenhagen, Aug 2010, p. 230-245, Acceptance rate : 19/75 (25,33%), Rank (CORE) : B, http://hal.inria.fr/inria-00512716, http://.

[29] R. RAMDOYAL, A. CLEVE, J.-L. HAINAUT. *Reverse Engineering User Interfaces for Interactive Database Conceptual Analysis*, in "22nd International Conference on Advanced Information Systems Engineering (CAiSE'2010)", Tunisie Hammamet, Springer-Verlag, 2010, vol. 6051, p. 332-347, Acceptance rate: 15%, Rank (CORE): A, http://hal.inria.fr/inria-00456994, http://.

[30] D. ROMERO, G. HERMOSILLO, A. TAHERKORDI, R. NZEKWA, R. ROUVOY, F. ELIASSEN. *RESTful Integration of Heterogeneous Devices in Pervasive Environments*, in "10th IFIP International Conference on Distributed Applications and Interoperable Systems (DAIS'10)", France Amsterdam, Netherlands, Springer, Jun 2010, vol. 6115, p. 1-14, Ranking B, acceptation rate 32%, http://hal.inria.fr/hal-00471922, http://.

[31] D. ROMERO, R. ROUVOY, L. SEINTURIER, P. CARTON. *Service Discovery in Ubiquitous Feedback Control Loops*, in "10th IFIP International Conference on Distributed Applications and Interoperable Systems (DAIS'10)", France Amsterdam, Netherlands, Springer, Jun 2010, vol. 6115, p. 113-126, Ranking B, acceptation rate 32%, http://hal.inria.fr/hal-00471930, http://.

[32] D. ROMERO, R. ROUVOY, L. SEINTURIER, F. LOIRET. *Integration of Heterogeneous Context Resources in Ubiquitous Environments*, in "36th EUROMICRO International Conference on Software Engineering and Advanced Applications (SEAA'10)", France Lille, ACM, 2010, 4, Ranking C, acceptation rate 48%, http://hal.inria.fr/hal-00484838, http://.

[33] A. TAHERKORDI, F. LOIRET, A. ABDOLRAZAGHI, R. ROUVOY, Q. LE-TRUNG, F. ELIASSEN. *Programming Sensor Networks Using REMORA Component Model*, in "6th IEEE International Conference on Distributed Computing in Sensor Systems (DCOSS'10)", Santa Barbara, California, USA, Jun 2010, 15, http://hal.inria.fr/hal-00471516, http://.

[34] A. TAHERKORDI, R. ROUVOY, F. ELIASSEN. *A Component-based Approach for Service Distribution in Sensor Networks*, in "5th International Workshop on Middleware Tools, Services and Run-Time Support for Sensor Networks", Inde Bangalore, ACM, Nov 2010, http://hal.inria.fr/inria-00522709, http://.

[35] G. TAMURA, R. CASALLAS, A. CLEVE, L. DUCHIEN. *QoS Contract-Aware Reconguration of Component Architectures Using E-Graphs*, in "7th International Workshop on Formal Aspects of Component Software", Portugal Guimaraes, United Nations University, International Institute for Software Technology, Universidade do Minho, Oct 2010, http://hal.inria.fr/inria-00525438, http://.

[36] A. TIBERGHIEN, P. MERLE, L. SEINTURIER. *Specifying Self-configurable Component-based Systems with FracToy*, in "ASM, Alloy, B and Z, 2010", Canada Orford, Springer, Feb 2010, vol. 5977, p. 91-104, http://hal.inria.fr/inria-00512442, http://.

Scientific Books (or Scientific Book chapters)

[37] M. BERBINEAU, F. BOUKOUR, C. GRANSART, M. HEDDEBAUT, C. TATKEU, M. WAHL. *Les communications dans les transports guidés urbains*, in "Innovation dans Les Transports Guidés Urbains et Régionaux", C. SOULAS, M. WAHL (editors), Hermès Sciences Publication, 2010, chap. 3.

[38] D. ROMERO, R. ROUVOY, L. SEINTURIER, S. CHABRIDON, D. CONAN, N. PESSEMIER. *Enabling Context-Aware Web Services: A Middleware Approach for Ubiquitous Environments*, in "Enabling Context-Aware Web Services: Methods, Architectures, and Technologies", M. SHENG, J. YU, S. DUSTDAR (editors), Chapman and Hall/CRC, May 2010, p. 113-135, http://hal.inria.fr/inria-00414070, http://.

Books or Proceedings Editing

[39] M. BLAY-FORNARINO, L. DUCHIEN (editors). *Numéro spécial TSI - Ingénierie Dirigée par les Modèles*, Techniques et science informatique - Hermès Science - Lavoisier, Apr 2010, vol. 29:4-5, 2, http://hal.inria.fr/inria-00512758, http://.

[40] A. CAPILUPPI, A. CLEVE, N. MOHA (editors). *Proceedings of the International Workshop on Principles of Software Evolution and ERCIM Workshop on Software Evolution (IWPSE-EVOL'2010)*, ACM, Sep 2010, 98, http://hal.inria.fr/inria-00514773, http://.

[41] E. CARIOU, L. DUCHIEN, Y. LEDRU (editors). *Actes des deuxièmes journées nationales du Groupement de Recherche CNRS du Génie de la Programmation et du Logiciel*, Université de Pau et des Pays de l'Adour, March 2010, 230, http://hal.inria.fr/inria-00512764, http://.

[42] S. BEN MOKHTAR, R. ROUVOY, M. WAGNER (editors). *Proceedings of the 3rd International DisCoTec Workshop on Context-aware Adaptation Mechanisms for Pervasive and Ubiquitous Services (CAMPUS)*, European Association of Software Science and Technology, Amsterdam, Netherlands, June 2010, vol. 38, http://journal.ub.tu-berlin.de/index.php/eceasst/issue/view/38.

Research Reports

[43] P. CARTON, N. PESSEMIER. *Lot 1.2.1 : Documentation technique MODEL2CODE Outil de Génération de Composants V2.0*, Trade cluster CAPPUCINO project, Lille, France, December 2010.

[44] P. COLLET, M.-A. ABCHIR, T. BATHIAS, M. BLAY-FORNARINO, F. KRIKAVA, J. LENOIR, J. LESBEGUERIES, S. MADELÉNAT, J. MALENFANT, D. MANSET, O. MELEKHOVA, R. MOLLON, J. MONTAGNAT, R. NZEKWA, A. PAPPA, J. REVILLARD, R. ROUVOY, L. SEINTURIER, I. TRUCK. *WP1 - Requirements and Architecture*, ANR SALTY project, July 2010.

[45] D. CONAN, S. CHABRIDON, D. ROMERO, R. ROUVOY, L. SEINTURIER. *Lot 2.1 : Modèle de répartition cohérente et fiable des informations de contexte - V2.0*, Trade cluster CAPPUCINO project, Lille, France, September 2010.

[46] L. DUCHIEN, C. PARRA, N. PESSEMIER, A. CLEVE, X. BLANC, R. LEAÑO. *Lot 1.2.1 : Définition d'une chaîne de production sensible au contexte pour les plates-formes ubiquitaires - V2.0*, Trade cluster CAPPUCINO project, Lille, France, June 2010.

[47] J. ELLART, L. DUCHIEN, L. SEINTURIER. *Lot 4.3 : Spécification interfaces applicative / médiation intergicielle*, Trade cluster ICOM project, Lille, France, April 2010.

Scientific Popularization

[48] C. DEMAREY, D. FOURNIER. *FraSCAti, prenez le contrôle sur vos applications*, in "Programmez", Dec 2010, http://hal.inria.fr/inria-00531342, http://.

[49] C. DEMAREY, D. FOURNIER. *SOA facile avec SCA*, in "Programmez", Nov 2010, n^{o} 135, http://hal.inria.fr/inria-00531338, http://.

References in notes

[50] *CORBA Component Model*, OMG, February 1999, http://www.omg.org.

[51] *Enterprise Java Beans*, Sun Microsystems, 1997, http://java.sun.com/.

[52] R. E. FILMAN, T. ELRAD, S. CLARKE, M. AKSIT (editors). *Aspect-Oriented Software Development*, Addison-Wesley, 2005.

[53] *json-lib*, 2009, http://json-lib.sourceforge.net.

[54] *XTream*, 2009, http://xstream.codehaus.org.

[55] É. BRUNETON, T. COUPAYE, M. LECLERCQ, V. QUÉMA, J.-B. STEFANI. *The* FRACTAL *Component Model and its Support in Java*, in "Software: Practice and Experience – Special issue on Experiences with Auto-adaptive and Reconfigurable Systems", August 2006, vol. 36, n^{o} 11-12, p. 1257–1284, John Wiley & Sons [*DOI :* 10.1002/SPE.767], http://fractal.objectweb.org/doc/pub/SPE06.pdf.

[56] D. CONAN, R. ROUVOY, L. SEINTURIER. *COSMOS : composition de noeuds de contexte*, in "Techniques et Sciences Informatiques", 2008, vol. 27, n^{o} 9-10, p. 1189–1224, http://hal.inria.fr/inria-00330574.

[57] T. COUPAYE, V. QUÉMA, L. SEINTURIER, J.-B. STEFANI. *Intergiciel et Construction d'Applications Réparties*, in "Le système de composants Fractal", ICAR, January 2007.

[58] D. CROCKFORD. *RFC 4627 - The application/json Media Type for JavaScript Object Notation (JSON)*, IETF, 2006, IETF RFC, http://tools.ietf.org/html/rfc4627.

[59] Y. DAVIN. *A la découverte du modèle de composants Fractal*, October 2009, 'Programmez!' developer magazine number 123.

[60] Y. DAVIN. *F4E: A Fractal Development Environment for Eclipse*, April 2009, Fractal Poster Session at OW2 Annual Conference (OW2'09), http://www.ow2.org/view/Events2009AnnualConference/Session8.

[61] Y. DAVIN. *The Fractal OW2 Project*, April 2009, Fractal Poster Session at OW2 Annual Conference (OW2'09), http://www.ow2.org/view/Events2009AnnualConference/Session8.

[62] H. EHRIG, K. EHRIG, U. PRANGE, G. TAENTZER. *Fundamentals of Algebraic Graph Transformation (Monographs in Theoretical Computer Science. An EATCS Series)*, Springer-Verlag New York, Inc., Secaucus, NJ, USA, 2006.

[63] R. T. FIELDING. *Architectural Styles and the Design of Network-based Software Architectures*, University of California, Irvine, 2000, http://www.ics.uci.edu/~fielding/pubs/dissertation/fielding_dissertation.pdf.

[64] R. GABRIEL, M. DEVOS, B. FOOTE, G. STEELE, J. NOBLE. *Objects Have Failed*, November 2002, Object-Oriented Programming, Systems, Languages and Applications (OOPSLA'02). Seattle, USA..

[65] C. GRANSART, A. FLISSI. *Infrastructure ubiquitaire à base de composants logiciels pour des services de transports*, in "Revue Génie Logiciel", December 2009, vol. 91, p. 21-26.

[66] E. GUTTMAN, C. PERKINS, J. VEIZADES, M. DAY. *Service Location Protocol, Version 2. RFC 2608 (Proposed Standard)*, June 1999, http://tools.ietf.org/html/rfc2608.

[67] G. HERMOSILLO, J. ELLART, L. SEINTURIER, L. DUCHIEN. *A Traceability Service to Facilitate RFID Adoption in the Retail Supply Chain*, in "Proceedings of the 3rd International Workshop on RFID Technology - Concepts, Applications, Challenges (IWRT 2009)", Milan, Italy, M. SHENG, Z. MAAMAR, S. ZEADALLY, K. MITROKOTSA (editors), INSTICC Press, Portugal, May 2009, p. 49-58, http://hal.inria.fr/inria-00391089.

[68] C. KEATING, R. ROGERS, R. UNAL, D. DRYER, A. SOUSA-POZA, R. SAFFORD, W. PETERSON, G. RABADI. *Systems of Systems Engineering*, in "Engineering Management Journal", September 2003, vol. 15, n^{o} 3, p. 36–45.

[69] G. KICZALES, J. LAMPING, A. MENDHEKAR, C. MAEDA, C. LOPES, J.-M. LOINGTIER, J. IRWIN. *Aspect-Oriented Programming*, in "Proceedings of the 11th European Conference on Object-Oriented Programming (ECOOP'97)", Lecture Notes in Computer Science, Springer, June 1997, vol. 1241, p. 220–242.

[70] K. MAKICE. *Twitter API: Up and Running Learn How to Build Applications with the Twitter API*, O'Reilly Media, Inc., 2009.

[71] M. MALOHLAVA, A. PLSEK, F. LOIRET, P. MERLE, L. SEINTURIER. *Introducing Distribution into a RTSJ-based Component Framework*, in "Proceedings of the 2nd Researcher Workshop on Real-Time Computing (JRWRTC'08)", Rennes, France, October 2008, http://hal.inria.fr/inria-00327342.

[72] M. D. MCILROY. *Mass Produced Software Component*, Report on the NATO Software Engineering Conference, 1968.

[73] P. MERLE, J.-B. STEFANI. *A formal specification of the Fractal component model in Alloy*, INRIA, November 2008, n^{o} 6721, http://hal.inria.fr/inria-00338987.

[74] N. MOHA. *DECOR : Détection et correction des défauts dans les systèmes orientés objet*, Université des Sciences et Technologies de Lille (USTL), Laboratoire d'Informatique Fondamentale de Lille (LIFL) et Université de Montréal, Lille, France, August 2008, http://tel.archives-ouvertes.fr/tel-00321081.

[75] T. P. MORAN, P. DOURISH. *Introduction to This Special Issue on Context-Aware Computing*, in "Human-Computer Interaction", 2001, vol. 16, n^{o} 2–4, p. 87–95.

[76] N. PESSEMIER, L. SEINTURIER, T. COUPAYE, L. DUCHIEN. *A Component-Based and Aspect-Oriented Model for Software Evolution*, in "International Journal of Computer Applications in Technology (IJCAT)", 2008, vol. 31, n^{o} 1-2, p. 94-105, http://hal.inria.fr/inria-00269895.

[77] J. S. RELLERMEYER. *JSLP project, Java Service Location Protocol*, 2009, http://jslp.sourceforge.net.

[78] R. ROUVOY, D. CONAN, L. SEINTURIER. *Software Architecture Patterns for a Context Processing Middleware Framework*, in "IEEE Distributed Systems Online (DSO)", June 2008, vol. 9, n^{o} 6, 12, http://hal.inria.fr/inria-00286616.

[79] R. ROUVOY, P. MERLE. *Leveraging Component-Based Software Engineering with Fraclet*, in "Springer Annals of Telecommunications, Special Issue on Software Components - The Fractal Initiative (Springer)", January/February 2009, vol. 64, n° 1–2 [*DOI :* 10.1007/s12243-008-0072-z], http://hal.inria.fr/inria-00429714.

[80] D. C. SCHMIDT. *Model-Driven Engineering*, in "IEEE Computer", February 2006, vol. 39, n° 2.

[81] L. SEINTURIER, P. MERLE, D. FOURNIER, N. DOLET, V. SCHIAVONI, J.-B. STEFANI. *Reconfigurable SCA Applications with the FraSCAti Platform*, in "Proceedings of the 6th IEEE International Conference on Service Computing (SCC'09)", September 2009, p. 268–275, Acceptance rate: 35/189 (18%). CORE A., http://hal.inria.fr/inria-00397856.

[82] L. SEINTURIER, N. PESSEMIER, L. DUCHIEN, T. COUPAYE. *A Component Model Engineered with Components and Aspects*, in "Proceedings of the 9th International SIGSOFT Symposium on Component-Based Software Engineering (CBSE'06)", Västeras, Sweden, Lecture Notes in Computer Science, Springer, June 2006, vol. 4063, p. 139–153.

[83] M. SMITH, T. HOWES. *RFC 4515 - Lightweight Directory Access Protocol (LDAP): String Representation of Search Filters*, IETF, 1996, IETF RFC, http://tools.ietf.org/html/rfc4515.

[84] T. STRANG, C. LINNHOFF-POPIEN. *A Context Modeling Survey*, in "Workshop on Advanced Context Modelling, Reasoning and Management at the Sixth International Conference on Ubiquitous Computing (UbiComp)", 2004.

[85] Y. YAMAMOTO. *Twitter4J*, 2009, http://yusuke.homeip.net/twitter4j/en/.