



Activity Report 2011

## Team AMAZONES

Ambient Middleware Architectures:  
Service-Oriented, Networked, Efficient and  
Secured

RESEARCH CENTER  
Grenoble - Rhône-Alpes

THEME  
Distributed Systems and Services



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# Team AMAZONES

**Keywords:** Ambient Computing, Service Oriented Architecture, Operating System

## 1. Members

### Research Scientist

Stéphane Grumbach [Senior Researcher, Inria, HdR]

### Faculty Members

Stéphane Frénot [Team leader, Professor, INSA-Lyon, HdR]

Antoine Fraboulet [Associate Professor, INSA-Lyon]

Frédéric Le Mouël [Associate Professor, INSA-Lyon]

Lionel Morel [Associate Professor, INSA-Lyon]

Julien Ponge [Associate Professor, INSA-Lyon]

Guillaume Salagnac [Associate Professor, INSA-Lyon]

Nicolas Stouls [Associate Professor, INSA-Lyon]

Kevin Marquet [Associate Professor, INSA-Lyon]

### Technical Staff

Stéphane d'Alu [Research Engineer, INSA-Lyon, 50%]

Julien Carpentier [Research Engineer, ADT Ended 11/2011]

### PhD Students

Ahmad Ahmad-Kassem [ANR grant, since 10/2009, 3rd year]

Fuda Ma [CSC china grant, since 09/2010, 2nd year]

Manuel Selva [Bull SA grant, since, 09/2011, 1st year]

Roya Golcha [Iranian grant, since, 09/2011, 1st year]

François Goichon [MENRT grant, since 09/2010, 2nd year]

Zheng Hu [Orange labs grant, since 01/2010, 2nd year]

Yufang Dan [CSC china grant, since 09/2010, 2nd year]

### Administrative Assistant

Joëlle Charnay [INSA-Lyon]

## 2. Overall Objectives

### 2.1. Introduction

Amazones is a research team hosted at the CITI laboratory, at INSA Lyon. It is attached to the Grenoble Rhône-Alpes INRIA Center. The team is set-up from a split of the Ares project, and is dedicated to ambient middleware environments.

The proposed goal of Amazones, as presented in the initial document, is to bring dynamic SOA paradigms to ambient environments. Ambient environments deal with constrained devices such as wireless sensors or gateways in which fast decision making with limited resources are real issues.

Merging together dynamic service-orientation and constrained devices needs to rely on an intermediate mapping layer that offers two fundamental features.

On one side, an approach based on formal methods is needed to get guarantees that dynamic services are composable within the system and validate the good behavior, cost or energy awareness of the resulting application.

On the other side, we need system observation techniques that capture relevant data representing these good behaviors, costs or energy consumption. These observations are used to improve the system architecture since it offers concrete elements to dynamic behavior improvement.

## 3. Scientific Foundations

### 3.1. An Ambient Software Stack

Amazones focuses on three goals: designing new software architectures for ambient environments, designing new approaches to the problem of managing these architectures, in particular using formal methods techniques, and finally designing new toolboxes and techniques for observation and control of the system at runtime.

We use a reference operating system stack as a confluence for our research directions. It will allow us to identify and study transversal topics so as to improve operating systems that cope with the specific constraints of both hardware and software for ambient applications.

We design and build this stack ourselves, and it is divided into three layers:

1. a hardware management layer,
2. a portable code layer,
3. a dynamic services layer.

A substantial set of existing approaches, frameworks and tools can be combined to fulfill each level requirements. Without loss of generality, we chose to leverage L4 [43] and the Genode [37] infrastructure at the microkernel management layer, JamVM [42] at the portable code layer, and Apache Felix / ROCS [25] at the dynamic services layer.

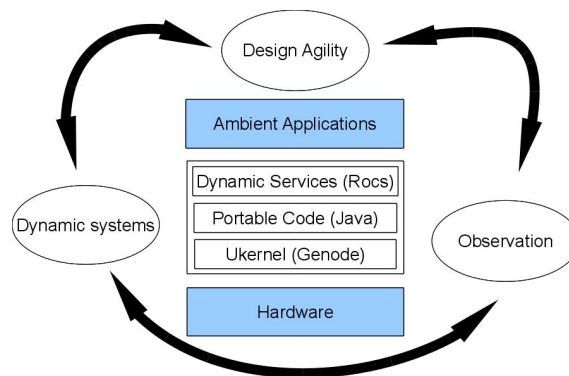


Figure 1. Amazones Interactions

The stack is initially used to demonstrate testbeds and transversal demonstrators, but will also serve as a reference model for works. We plan to optimize the stack to obtain at least an adequate operating system for Amazones studies. Nevertheless, our ambition goes beyond “just” assembling those pieces together. Our aim, is indeed to blur the limits between each of the three aforementioned layers, so as to see it as a coherent dynamic operating system rather than yet another proof-of-concept software stack tailored for our very own needs. Merging the middle-layers enables us to reuse standard services such as the registries and the resource allocators and minimizing their number. Merging layers will also need to rely on the same programming paradigms, such as component, service, binding and registries and will lead to a more homogeneous, easier to manipulate operating system. It will be comparable to an OSGi framework since we maintain the same high-level API, and we will be targeted to ARM-like based equipments.

## 3.2. Programming abstraction and verification

For the local level of abstraction, recursive rule languages (variants of Datalog) have been used to describe communication protocols [44] [45], thus reviving the recursive languages developed in the 80's for deductive databases [26] [27] [51], well-suited to define routes in networks. Query languages allow the expression of protocols, one or two orders of magnitude simpler than classical imperative programming languages. We continue this trend to demonstrate the potential of declarative rule languages for the local abstraction level, clarifying their semantics in asynchronous distributed computation, investigating further their expressive power and the complexity of their distributed evaluation. The definition of a rule language which admits efficient distributed execution while offering enough expressive power is still an active topic of research [40].

Having correct and robust protocols is fundamental for critical distributed systems. Ensuring the desirable properties of protocols is a very difficult problem. Neither simulations nor testbed implementations can ensure the quality required for network protocols. As an alternative to these methods, some researchers have successfully investigated the use of formal verification as a mean to guarantee the quality of protocols [30] [36] [46] [48].

Formal verification is a technique that assures whether a system enjoys a given property, based on a formal model of the system under evaluation. There are roughly two approaches to formal verification. The first approach is model checking [35], which consists of an exhaustive exploration of all states and transitions in the formal model of the system. A lot of model checking tools have been developed, such as SPIN [41], UPPAAL [24], PRISM [23], etc. The second approach is logical inference. It relies on a formal mathematical model for reasoning about the system, usually using theorem proving software such as the HOL [22], or the Coq [21]. This is usually only partially automated and is driven by the user's understanding of the system to validate.

We have pursued the second approach, by using the Coq proof assistant for protocols expressed in rule languages. This requires the modeling in Coq of the distributed systems, the machine evaluating the rule programs, as well as the theory of interest for the class of protocols considered.

# 4. Application Domains

## 4.1. Application Domains

This section illustrates the scientific challenges described above through a use-case scenario for dynamic middleware technologies in an ambient environment. An end-user has a mobile phone from which he/she can read emails, write new messages, and print documents. Printer devices and network access points are spread across the environment, thus availability varies based on user location. We illustrate that the dynamic service-oriented architecture that we envision fits at three levels of service provisioning granularities. Specifically, we consider dynamic SOA at the application level, at the operating system level and at the hardware radio communication level.

### 4.1.1. Application-level adaptation

The user launches an email application and wants to print a message. The dynamic service architecture is able to discover the "best" printing service available from the near environment. When the user moves to another room, the printing service can discover a new device and redirect the printing jobs to it. This usage emphasizes that, unless the user needs a printing service, the corresponding implementation is never loaded into the device memory. This "on-demand" service provisioning is the main point of dynamic service oriented architecture. When the user does not need printing anymore, the architecture can transparently remove the implementation to reclaim some memory at the benefit of other services. The challenge here is to formalize the process: how do we decide what the "best" service is, in a given context? what does "best" mean?

### 4.1.2. Operating system

Our user just composed an heavy email with some documents attached. At the time when the email client is sending message data through a WiFi connection, the user moves to another room with no WiFi connectivity. The operating system scans the available network interfaces and finds a 3G connection. In this case, it first dynamically downloads the available implementation, then changes the transport layer to 3G, and finally transmits the remaining bits of the email message without interrupting the user. The dynamic SOA enables reconfiguration of operating systems much like microkernels do, albeit the service granularity focuses on coarse-grained components to be mixed and matched. Finding the best service at launch time, or finding and switching to a better service at run-time is another key element of dynamic SOA for ambient environments. This implies comparison and evaluation of different but similar service implementations, which in turn requires some sort of “formal” behavioral description of these components. How do we get these descriptions ? What is the best language to reason about these models ?

### 4.1.3. Software-defined radio

One of the goals of software-defined radio technologies is to dynamically reconfigure hardware telecommunication layers depending on the incoming radio signal shapes. Current communication systems use specific hardware chips for each kind of signal processing. On the other hand, the software-defined radio approach tries to use a generic chip layer that can be reconfigured “on-demand”, leveraging the observation that the signal processing chain itself is similar across radio signal shapes. The various signal-specific functional units are brought together at run-time when some kind of received signal is to be processed. Dynamic service oriented architecture perfectly match this type of generic hardware approach. Although this is not possible at the moment, mainly due to response time delays, an efficient dynamic software architecture would be of great interest for the software radio environment. The question is, how to guarantee efficiency and correctness at this level of abstraction ?

Dynamic service-oriented architectures need not be confined to the world of heavyweight high-end systems. The goal of Amazones is to address the challenges which prevent dynamic SOA to be used in embedded environments : how to bring dynamicity to resource-constrained devices, how to express and validate properties on service components, and how to obtain these properties on an existing system.

Through these different use-cases we quickly showed that our approach can match various goals that spread across different application and system layers. Of course, the more constrained the hardware layer we consider, the more technical difficulties we meet, but the scientific concepts are still the same. These concepts are the objectives Amazones focuses on.

## 5. Software

### 5.1. Logos

**Participants:** Julien Ponge, Stéphane Frénot.

Logos is a development project linked to the LISE ANR grant. It’s goal is to generate execution logs from OSGi services interactions. The main idea is to intercept every service call and generate an entry in a log file. The log file system should be used in the LISE context which is related to legal issues. Generated Logos logs should be: Complete, encoded with a cryptographic algorithm, compact and immutable.

The software is currently used as a Amazones internal test suite. It is fully tested on standard OSGi architectures.

### 5.2. Logminer

**Participants:** Julien Ponge, Stéphane Frénot.



LogMiner is a toolbox, written in Scala in current development. The LogMiner framework takes Logos inputs and generates service usage automata. The goal of logminer is to represent application activity in a synthetic way in order to identify behavioral changes while updating the system. When one updates its applications on its environment, the logminer framework enables observation and identifies variations in service usages.

The software is currently under development it integrates a automata generator and a data visualisations modules.

### 5.3. Eimc

**Participants:** Zheng Hu, Stéphane Frénot, Bernard Tourancheau [Projet Swing].

Eimc is an architecture for managing sensor dedicated to legacy equipment management. The project aims at designing a dynamic framework that integrates sensors from the surrounding environment and detects new equipments from their physical behavior. For instance, a fridge vibrates when the compressor is working. The frequency of vibrations distinguishes a fridge from washing machine. The framework designs a Complex Based Event processing architecture where we need to focus on the number of manageable equipments, the number of deployed sensors and the number of physical measurements that can be handled.

The project is a joint project with Orange Labs, and a PhD student Zheng Hu. He is co-directed by Stéphane Frénot and Bernard Tourancheau from Amazones and Swing teams.

### 5.4. Aoraï

**Participant:** Nicolas Stouls.

Developed at CEA-LIST, Frama-C is an extensible and collaborative platform dedicated to source-code analysis of C software. The Aoraï [49] plug-in for Frama-C [31] provides a method to automatically annotate a C program according to a behavioral property P such that, if the annotations are verified, then we ensure that the program respects P.

The computation process is divided into two steps: the specification generation from the property and the constraints propagation for static simplification. According to the classical invariant verification granularity, observable states of a program correspond to each call or return statements of an operation. Each state of the program is associated to a set of transitions in an internal representation of the property, managed as a Büchi automata. Starting from a super-set of authorized behaviors, some static simplifications can be done in order to generate sufficient pre/post-conditions on each operation.

The classical method to validate generated annotations is to use the Jessie plug-in and the Why tool, using theorem provers.

A new research report [50] as been published and some new developments has been done in order to increase consequently the efficiency of the tool.

### 5.5. STOP

**Participants:** François Goichon, Stéphane Frénot, Pierre Parrend.

STOP is a security-oriented program analysis toolkit developed by François Goichon as part of his masters thesis. He was supervised by Stéphane Frénot and Pierre Parrend from FZI, Karlsruhe.

The tool implements a novel static analysis technique called *Service-oriented Tainted Object Propagation*, described in more detail in the Results section.

### 5.6. IzPack

**Participant:** Julien Ponge.

IzPack [47] is a software installer creation framework for the Java platform. Its main differentiator with respect to the other installation solutions is that it generates cross-platform installers that can adapt themselves to the underlying operating system so as to still provide tight integration. It was also designed to be highly customizable and extensible.

IzPack is nearing its 10 years landmark. It is hosted at the Coddehaus [32] Foundation and released under the terms of the Apache Software License version 2.0. Its users community non-exhaustively comprise Spring-Source, JBoss / RedHat, Oracle / Sun Microsystems, the Scala language, XWiki, Terracotta or Silverpeas.

The project was originally created by now INRIA Amazones team member Julien Ponge, who still leads the project. In 2010, it was presented at the Devvix conference.

## 5.7. WSNet

**Participants:** Guillaume Chelius [INRIA D-NET Team, project leader], Antoine Fraboulet, Loïc Lemaître [INRIA SensTools IJD].

WSNet is a modular wireless network simulator. It incorporates the following aspects: (i) accurate simulation of the radio channel: Supports MIMO, multi-interface, multi-channel, etc. (ii) simulation environment: simulation of the interaction between sensors and their environment: measurement and control, simulation of device power consumption. Furthermore, WSNet can be interfaced with the WSim sensor node emulator to form a distributed emulation of a sensor network.

WSNet source code is registered at the Agency For The Protection Of Programs (APP IDDN 06-370013-000). Licence: CeCILL (2). See also the web page <http://wsnet.gforge.inria.fr/>.

## 5.8. WSim

**Participants:** Guillaume Chelius [INRIA D-NET Team], Antoine Fraboulet [Project leader], Loïc Lemaître [INRIA SensTools IJD], Julien Carpentier [INRIA ORSI IJD].

WSIM is a platform emulator for embedded systems allowing performance evaluation and programming assistance during the application design stages of distributed wireless sensor networks. WSIM is a simulation tool enabling a rapid and relevant feedback on features and quality of embedded software in constrained systems. Its simulation model allows to interface with other tools like WSNet to build complex simulation environments.

WSim source code is registered at the Agency For The Protection Of Programs (APP IDDN 06-370012-000). Licence: CeCILL (2). See also the web page <http://wsim.gforge.inria.fr/>.

## 5.9. Esimu

**Participant:** Antoine Fraboulet.

eSimu is a complete system energy model based on non-intrusive measurements. This model aims at being integrated in fast cycle accurate simulation tools to give energy consumption feedback for embedded systems software programming. Estimations take into account the whole system consumption including peripherals. Experiments on a complex ARM9 platform show that our model estimates are in error by less than 10% from real system consumption, which is precise enough for source code application design, while simulation speed remains fast. eSimu can be used as a standalone tool or in conjunction with WSim.

Licence: CeCILL (2). See also the web page <http://esimu.gforge.inria.fr/>.

## 5.10. ABR

**Participants:** Frédéric Le Mouël, Stéphane Frénot.

The Ambient Bundle Repository (ABR) is an OSGi extension, compliant with the Bundle Repository API. Instead of proposing a centralized discovery as the default bundle repository implementation, ABR abstracts different discovery protocols (UPnP, ...) and publishes/subscribes a local repository containing bundles in a device geographically-close environment. ABR implements mobility models to track mobile devices, to warn the user deploying bundles of the remaining presence time of bundles and to anticipate a possible bundle deployment non-ending.

## 5.11. AxSeL

**Participants:** Amira Ben Hamida, Frédéric Le Mouël, Stéphane Frénot.

While installing and executing applications on mobile devices, the issue of the limit of resources is quickly encountered.

AxSeL (A conteXtual Service Loader) is an OSGi prototype extension that modifies the bundle loading at deployment time for a context-aware service loading at run time. The approach is based on a service graph colouring process. We represent an application as a bi-dimensional dynamic graph with services and bundles dependencies. The colouring decision provides an optimal deployment configuration of the application in a given context. Context listening mechanisms capture changes and propagate recolouring and redeployment processes.

Context elements currently implemented and monitored are the hardware memory and disk sizes. Application currently implemented and tested is a service-oriented PDF viewer that is adapting its display to available device resources [6].

This prototype is a part of the PhD thesis of Amira Ben Hamida [29].

## 5.12. QuestMonitor

**Participants:** Stéphane Grumbach, Ahmad Ahmad-Kassem, Fuda Ma.

QuestMonitor [28] is a visualization tool that allows to visualize dynamic networks, and monitor the execution of protocols written in the data centric language Netlog. The language allows to specify protocols which in sometimes their behavior, in dynamic networks, are tricky to understand. QuestMonitor allows to monitor all the communication between the nodes, the evolution of the data stores on each node, as well as the execution of the declarative code. It also allows to color the virtual data structures, such as routes, backbones, etc. Together with the code editing facility, it constitutes a good tool for rapid prototyping.

Amazones team aimed at bridging the gap between "high-level" developed architectures that we called the *northBound* and "low-level" run-time, the *southBound*. Northbound architecture rely on virtual machines and advanced development languages, whereas southbound architectures rely on micro-kernels and drivers development. Our results are mainly initial studies since we fixed our research team on November 2010, and the end notification arrived on June 2011. Although our time frame was short we managed to gain knowledge in three areas linked to Amazones goals.

# 6. New Results

## 6.1. SouthBound results

### 6.1.1. L4 micro kernels

As part of our investigations about what software architectures were the best candidates to base our Ambient Middleware Stack upon, we studied different micro-kernel operating systems such as CodeZero [33], OKL4, and L4/Fiasco. The objective here is to try and quantify the development effort that would be needed before being able to execute a Java application on top of a micro-kernel. These studies included, in addition to a lot of bibliographic research, several technical experiments such as booting each of these various micro-kernel systems in QEmu, as well as on real hardware. We use a BeagleBoard as a representative example of the kind of hardware platforms typically encountered in Ambient Intelligence scenarios.

### 6.1.2. *Virtual machines*

In parallel to our study of micro-kernel architectures, we worked on virtual machines as well, in the perspective of bridging the gap between the two. The basic question here is: what does it takes to cut down a Java virtual machine into pieces so as to run each of these pieces as a separate software component in the system. We ran two actions in order to investigate this question. First, we ported the JamVM virtual machine to run on top of the Genode operating system framework [37]. This provided us with better understanding of what are the real requirements of a Java virtual machine in terms of underlying operating systems support. Second, we focused on one particular service of the virtual machine, the garbage collector, and we precisely identified and studied the coupling between this component and all other parts of the virtual machine (bytecode interpreter, scheduler, etc). This work was done as part of a student summer internship (Yann Chevalier, INSA-Lyon 3IF). Removing a garbage collector at runtime, and “plugging in” another one dynamically proved to be vastly harder than expected. Still, this work provided us with great insights about the coupling relationships between different OS components.

### 6.1.3. *HiKoB*

Antoine Fraboulet (Amazone team), Guillaume Chelius (D-NET team) and Christophe Brailion (INRIA SED) started a new company called HiKob <http://openlab.hikob.com/> in July 2011. HiKoB is a development project following several successful research projects completed these last 6 years at INSA Lyon and INRIA. HiKoB hardware and software products help in building complex, large-scale and distributed applications in the domains of: motion capture, biomechanical study, biologging study, building instrumentation and many more applications targeting wireless sensor network solutions for distributed and embedded measurement. HiKoB business model is built on two major directions: complete solutions for industrial applications and software and hardware tools for research and innovation in the fields of sensor networking and embedded wireless measure. HiKoB is supported by IT-Translation and INSAValor.

### 6.1.4. *Service-Oriented Tainted Object Propagation*

Many Java technologies allow the execution of code provided by multiple parties. Service-oriented platforms based on components such as OSGi are good examples of such a scenario. Those extensible component-based platforms are service-oriented, as components may directly interact with each other via the services they provide. However, even robust languages such as Java were not designed to handle safely code interaction between trusted and untrusted parties.

In [38], we show how basic Java interactions can break encapsulation or execution safety and why the Java security layers’ threat coverage is incomplete. We also review flaws in the Java access control design that can allow untrusted code to bypass restrictions by exploiting vulnerabilities in trusted code.

As component-based platforms become more and more integrated to our daily life, we improved our Service-Oriented Tainted Object Propagation technique to find such vulnerabilities and used it on several open-source components to further demonstrate the real exposure that those vulnerabilities bring to the fore.

## 6.2. *NorthBound results*

Another key issue in the Amazonas architecture was to bring together formal methods and service oriented programming such as OSGi/Java approach. We developed the Logos framework that observes and records communications that occurs between an OSGi client and a corresponding server. This architecture is developed in the LISE ANR project, and we made various improvements to the architecture.

### 6.2.1. *Amazones Protocol*

It aims at building automata from running and observing applications. The logos framework observes a running application at builds at run-time an automata that represents the application behavior. Julien Ponge wrote the corresponding Scala code.

### 6.2.2. *Monitored oriented programming*

Another Logos extension integrates Monitored Oriented architectures such as JavaMOP and Larva. We are currently using and working with the larva people. Each time we intercept a call, it is transferred to the Larva automata manager.

### 6.2.3. *Real time SOA*

Admission control for service oriented application in real time infrastructure. This work led by Lionel Morel tries to bring together real time architecture configuration and component based architectures. The deal is to find a better way of managing the dynamicity of applications in real time context.

### 6.2.4. *B Model Slicing to Generate Tests*

In a model-based testing approach as well as for the verification of properties, B models provide an interesting modelling solution. However, for industrial applications, the size of their state space often makes them hard to handle. To reduce the amount of states, an abstraction function can be used. The abstraction is often a domain abstraction of the state variables that requires many proof obligations to be discharged, which can be very time consuming for real applications.

we propose a contribution to this problem that complements an approach based on domain abstraction for test generation, by adding a preliminary syntactic abstraction phase, based on variable elimination. We define a syntactic transformation that suppresses some variables from a B event model, in addition to three methods that choose relevant variables according to a test purpose. This way, we propose a method that computes an abstraction of a source model  $M$  according to a set of selected relevant variables. Depending on the method used, the abstraction can be computed as a simulation or as a bi-simulation of  $M$ . With this approach, the abstraction process produces a finite state system. We apply this abstraction computation to a Model Based Testing process. We evaluate experimentally the impact of the model simplification by variables elimination on the size of the models, on the number of proof obligations to discharge, on the precision of the abstraction and on the coverage achieved by the test generation.

This work is based on a B model approach. However, in the context of AMAZONES, one of our objectives is to extend it, in order to consider models automatically generated from the usage of the tested service on a particular context.

### 6.2.5. *Distributed Data Centric Programs Verification*

Netlog is a language designed to describe distributed programs. It has a precise semantics, provides a high-level of abstraction thanks to its datalog flavor and benefits from an efficient implementation. This makes it a very interesting target language for proofs of distributed programs. In [34], with the Coq proof assistant, we formalized the distributed computation model based on message passing with either synchronous or asynchronous behaviors; built the translation of Netlog programs; modeled the embedded machine evaluating Netlog programs, and thus established a framework to formally verify properties of distributed programs in Netlog. To test the framework, we proved the correctness of a concrete distributed program for constructing spanning trees over connected graphs.

### 6.2.6. *Managing dynamic service substitution at runtime*

The service oriented approach is a paradigm allowing the introduction of dynamicity in developments. If there are many advantages with this approach, there are also some new problems associated to service disappearance. The particular case of service substitution is often studied and many propositions exist. However, proposed solutions are mainly server-side in the context of web-services.

In this work, we propose a client side API-based approach to allow service substitution without any restart of the client and without any assumption on external services. Our proposition is based on a transactional approach, defined to authorized substitutions of services dynamically, by preserving the current run and collected data.

We designed a framework organized by Julien Ponge [14].

## 6.3. Application domain results

An emerging trend into Amazon team is to apply our northBound/southBound approach to the InternetOfThings wave. We try to apply our architectures to the IoT application domain.

### 6.3.1. Data Centric Applications Distribution

Peer to peer systems have been widely used to alleviate the burden of servers by transferring to peers in a network tasks that do not require a centralization of the information. A wide range of applications are now emerging over peer-to-peer, such as social networking, multiplayer games, mobile messaging, etc. Most of these applications are essentially data-centric, they rely on exchange of data between peers, and can be expressed by queries over the database.

We propose a tool that allows for such applications, programmed as a collection of queries over a database, to be ported seamlessly without changing the initial queries from a client/server system to peer-to-peer system. The distribution is done with overlays network defined by declarative data centric programs specified in the Netlog language, thus resulting in a fully data centric modeling of the peer-to-peer application. The communication between peers relies on implicit addresses which can be evaluated on the fly to ensure the persistence of data.

We demonstrate the technique on a multiplayer online game, written in SQL, with players who connect to a mobile ad hoc network through their portable devices. The overlay is defined by a combination of an ad hoc routing protocol, DSDV, together with a DHT. The application runs on the QuestMonitor system, which allows to monitor the communication between peers, the evolution of the local data stores, as well as the execution of the declarative code.

### 6.3.2. Service Deployment in Disrupted Networks

OLD / REMOVE ? Ambient environments classically use wireless connections that suffers from frequent disconnections. The hard research point is to ensure service continuity. This disconnection problem has been widely tackled for application data with proxy and prefetching approaches. For services, disconnections are more difficult to anticipate, since service calls are only solved at run-time.

We are currently working on service deployment and invocations in disrupted networks with a network coding approach. This research is a joint work with the Swing team and with Aline Viana (INRIA Saclay @ TU Berlin). The main idea is to study how social-oriented applications, that need inter-dependent services and updates to be distributed to all or part of the mobile users community, could benefit from a network coding approach. The project aims at assessing for the first time the performance, in terms of latency, energy efficiency and capacity, of standard network coding techniques in presence of realistic user mobility and service demands. Building on these results, we plan to propose original social-aware network coding techniques that take advantage of the heterogeneous nature of the opportunistic network to reduce delays and energy consumption, in presence of multiple concurrent service flows targeting either all users or specific groups of interests.

These performance issues tackle at the same time the overall network capacity optimizations, as well as the overall software stack optimizations of a device with local and autonomous network coding strategies.

An INRIA ARC project proposal, entitled SoCool, has been submitted jointly with INRIA AMAZONES, INRIA SWING, INRIA MAESTRO, INRIA Saclay, University of Nice, TU Berlin and Fordham University.

## 7. Contracts and Grants with Industry

### 7.1. Orange Labs CIFRE

We work with Orange Labs on Eimc project. The contracts is a CIFRE convention that pays Zheng Hu PhD work.

## 7.2. Bull SA CIFRE

We work in a joint work between Bull SA and Amazones for the design of a RealTime OSGi framework. Manuel Selva is the granted phd student on this Topic.

# 8. Partnerships and Cooperations

## 8.1. Local Initiatives

### 8.1.1. BQR - *Desing Methods for Energetic Optimisation in Wireless Sensor Networks*

**Participants:** Nicolas Stouls [Project leader], Antoine Fraboulet, Lionel Morel, Guillaume Salagnac.

Glossary

**BQR (Bonus Qualité Recherche)** project funded by an academic institution.

This project, funded by INSA Lyon, is a collaboration between three research laboratories: CITI (Center of Innovation in Telecommunications and Integration of services), LIRIS (Computer Science, Image and Information Systems Laboratory) and CETHIL (Lyon Thermal Center). The project aims at proposing a practical instrumentation technique for measuring energetic efficiency of buildings by means of using a wireless network of sensor nodes (WSN). In order to make it feasible to scale both space-wise (instrumenting a while building will require tens or hundreds of nodes) as well as duration-wise (the experiments we envision in this project will span over several months), we adopt a software architecture based on a dedicated streaming database technology [39]. Finally, this whole system is also a case-study for another goal of this project, that of proposing new metrics to characterize energy consumption on embedded devices (in particular we aim at somehow relating energy consumption to a high-level view of the software running on the nodes).

### 8.1.2. BQF - *Smart Chappe Building: A Context-aware Service Platform*

**Participants:** Frédéric Le Mouël [Project leader], Julien Ponge, Stéphane Frénot.

Glossary

**BQF (Bonus Qualité Formation)** project funded by an academic institution.

This project, funded by INSA Lyon, is leaded by the Telecommunication Department with the participation of two research laboratories: CITI (Center of Innovation in Telecommunications and Integration of services) and LIRIS (Computer Science, Image and Information Systems Laboratory).

Computers and Information Systems are now all around us (Ubiquitous Computing) with a great number of portable and mobile devices (Mobile Computing) that have to adapt to highly changing environments (Context-aware Computing) and that even disappear in our every life in small, active and smart objects (Ambient Intelligence). Smart Houses and Buildings is now an emerging research topic with power managing, security monitoring, .... We think that mobile phones will be the universal remote controller for a user-personalized access to services of such buildings.

Build in 2008, the Claude Chappe Building - hosting the Telecommunication Department and the CITI Lab - is the perfect experimentation place. The Smart Chappe Building proposes a Context-aware Service Platform integrating (i) devices: static ones (large display screens, interactive terminal), mobile phones (iPhone with iOS, Samsung with Androïd, HTC with Windows Mobile), sensors (temperature, hydrometry), RFID, (ii) wireless connectivity: Bluetooth, WIFI and (iii) context-aware and user-personalized services: building guidance, news broadcasting, lecture agenda. This plateform is bothly used for teaching and doing research, for instance, by allowing to develop and integrate new innovative services.

### 8.1.3. INRIA ADT ORSI

**Participants:** Antoine Fraboulet [Project leader], Julien Carpentier.

ORSI (*Outil de Raffinement de la Simulation à l'Implantation*) is an INRIA ADT project started in November 2010.

The ORSI ADT is in the context of programming tools for constrained embedded systems applications. This ADT is the continuation and extension of techniques and tools developed in the scope of wireless sensor networks. Projects like RECAP, SensLab, WASP and Mosar have demonstrated the value and contribution of WSIM and WNet software simulation tools which are now used outside of their original projects frames. Dissemination and software use in academic and industrial projects can consider their evolution in order to take into account new types of uses and new development paths. The ORSI ADT aims to extend the models used in these software to prepare them for next generation applications hardware and software targets.

## 8.2. Regional Initiatives

### 8.2.1. *SEmba - Embedded Systems*

**Participants:** Nicolas Stouls [Co-leader], Stéphane Frénot, Antoine Fraboulet, Lionel Morel, Guillaume Salagnac, Yufang Dan.

SEmba, standing for Embedded Systems ("Systèmes Embarqués" in French), is a project funded by the ISLE cluster of the Rhône-Alpe department. This project aims at animating and structuring regional research activities, in order to give more visibility of our results, and at promoting collaborations between academic and industrial teams of the regions. Current academic labs of the project are :

- TIMA, GIPSA-Lab, INRIA Grenoble, LIG, VERIMAG (Grenoble),
- CITI, INL, LIP (Lyon),
- LHC (Saint-Etienne),
- LAMA (Savoie),
- LCIS (Valence).

To produce enhanced embedded systems is a non-stopping effort, due to constant technologies evolutions in nano and micro-electronic. Locks lie in the low cost, low electrical consumption, fast conception and development processes and the quality of systems, as well for the hardware as for the software parts. Project is managed by Dominique Borrione (TIMA Lab) and Nicolas Stouls (CITI Lab), and is organized with three themes:

1. Architectures and conception (software/hardware, components, synthesis)
2. Evaluation of embedded systems quality (validation, test, reliability, performance, quality of service)
3. Communicating infrastructures (protocols, OS, middleware, sensors networks, security, networks on chip)

## 8.3. National Initiatives

### 8.3.1. *Ubiquist*

ANR Ubiquist, Ubiquitous Quest: declarative approach for integrated network and data management in wireless multi-hop networks, with Grenoble Institute of Technology (Christine Collet, Christophe Bobineau), 2009-2012

### 8.3.2. *ANR LISE*

**Participant:** Stéphane Frénot.

Software quality and patterns of security frauds are directly related to legal liability patterns but, so far, software providers have succeeded in limiting their legal liability for their products. The increasing dependence of society on software changes the situation however, and calls for stronger liability rules.



The precise definition of the expected functionalities of software products is quite a challenge, not to mention the use of such definition as a basis for a liability agreement. Taking up this challenge is precisely the objective of the LISE project. To achieve this goal, software liability is addressed both from the legal and the technical points of view with the aim to put forward methods (1) to define liability in a precise and legally sound way and (2) to establish liability in case of incident. <http://licit.inrialpes.fr/lise/>

### 8.3.3. ANR TLCOM Senslab

**Participant:** Antoine Fraboulet.

The purpose of the SensLAB project is to deploy a very large scale open wireless sensor network platform. SensLAB's main and most important goal is to offer an accurate and efficient scientific tool to help in the design, development, tuning, and experimentation of real large-scale sensor network applications.

Amazones contributes to the Senslab project through the participation of Antoine Fraboulet who was involved in the early project design phases and through the use of the software simulation suite WSNNet, WSim and eSimu in the Senslab project.

### 8.3.4. ADT SensTools

**Participant:** Antoine Fraboulet.

SensTools is a national INRIA ADT. The project ended in 2010, the final review was held in Lyon on December, 15th. SensTools provides a set of hardware and software tools for the WSN430 platform. Some basic drivers and several Oses are provided.

### 8.3.5. ADT SensAS

**Participants:** Antoine Fraboulet, Guillaume Salagnac.

SensAS is an INRIA national ADT project started in December 2010.

The SENSAS project's ambition is to support the development of innovative applications from INRIA EPIS involving several networks of sensors / actuators and / or fleets of robots. From the strong experience in sensor networks, the idea is to build and pool equipment and software in order to have a leverage at the application level. The target applications are selected monitoring / intrusion detection by a fleet robot, self organizing fleets of drones flying biologging applications in the field of health and supervision of large networks of sensors. The SENSAS ADT will amplify skills transfer and facilitate access to implementation of sensor networks technology. In deploying demonstrators at the forefront of technology, the SENSAS ADT showcases the technological expertise and scientific excellence of INRIA who established his reputation in this field.

Amazones is leader of the WP4: *SensBOX : software suite for sensor and actuator networks*.

## 8.4. European Initiatives

### 8.4.1. EU Project Wasp (FP6 IP project)

**Participant:** Antoine Fraboulet.

The WASP project (Wirelessly Accessible Sensor Populations, European Project IST-034963) ended in November 2010. The final review took place in London on October, 21th and 22th 2010. The general goal of the project was the provision of a complete system view for building large populations of collaborating objects. The system incorporates networking protocols for wireless sensor nodes to hide the individual nodes from the application.

Amazones was involved in the project through the participation of Antoine Fraboulet. Antoine Fraboulet was responsible for several deliverables for precompilation tools and software support. He was also member of the project's architecture team.

### 8.4.2. EU Project Mosar (LSH European Project)

**Participant:** Antoine Fraboulet.

The goal of the MOSAR project is to study of the dynamics of neighborhood people using networks of sensors in a hospital. Amazonas was involved in MOSAR through the participation of Antoine Fraboulet. Involvement: implementation of hardware and software support for the project, large scale deployment of a full wireless sensor network and study of dynamic graph patterns.

## 9. Dissemination

### 9.1. Animation of the Scientific Community

#### 9.1.1. Participation in Committees

**Frédéric Le Mouël** is elected expert for faculty hiring committee (computer science section, 27e section) in INSA Lyon. **Stéphane Grumbach** is a PC member of DASFAA'11, DEXA'11, WRIPE'11, OSSC'11, Sensorcom'11, SKG'11.

#### 9.1.2. Editorial Boards

##### 9.1.2.1. *Technique et Sciences Informatiques Journal*

**Participant:** Antoine Fraboulet.

Multidisciplinary journal designed to provide a synthesis tool for French researchers and industrial in computer science. <http://tsi.revuesonline.com/>

#### 9.1.3. Conferences and workshop organization

##### 9.1.3.1. *fOSSa 2011*

**Participant:** Julien Ponge [Steering committee, Program committee].

fOSSa 2011 was organized by INRIA, INSA de Lyon, the CITI laboratory, the IRILL laboratory and Engineering Group Italia. The conference gathers a unique blend of opensource actors, including academics, educators, associations and industrials. The 2011 edition comprised tracks on: education, community management, development, openness and new trends in opensource.

<http://fossa.inria.fr/>

##### 9.1.3.2. *EuroSys 2010 Conference*

**Participant:** Frédéric Le Mouël [Webmaster co-chair].

EuroSys 2010 is organised by EuroSys, the European Chapter of SIGOPS, sponsored by ACM SIGOPS.

The EuroSys conference series brings together professionals from academia and industry. It has a strong focus on systems research and development: operating systems, data base systems, real-time systems and middleware for networked, distributed, parallel, or embedded computing systems. As a highly recognized conference - rank 11 out of 581 in terms of 2007 CiteSeer impact factor - EuroSys has become a premier forum for discussing various issues of systems software research and development, including implications related to hardware and applications.

<http://eurosyst2010.sigops-france.fr/>.

##### 9.1.3.3. *SEmba Workshop (2009, 2010 and 2011)*

**Participant:** Nicolas Stouls [Program Chair].

In the context of the SEmba project (introduced Section 8.2.1), the SEmba workshop is an annual meeting where all participant of the project are invited to present there recent works. The two days are organized in four sessions corresponding to the three themes of the project and to an opening to work in the scope, but realized out of the region. This workshop meet 40 participants in 2009, 60 participants in 2010 and 70 participants in 2011, coming from all over the region.

Here is a link to the [Workshop Program](#).

### 9.1.4. Program committees

**Stéphane Frénot** has participated to the following conference program committees: NOMS'2012. He has chaired the mini-conf on Management Strategies at CNSM'2011.

**Frédéric Le Mouël** has participated to the following conference program committees: INFORSID'2011, PECCS'2011, UIC'2010, UBICOMM'2010; has been workshop chairman at: ERTSI'2010; has participated to the following workshop program committee: OTM Academy'2010.

**Julien Ponge** has participated to the ICSOC'2011 TPC. He has chaired the fOSSa 2011 DEV track.

## 9.2. Teaching

All Amazones team member are associate professor at INSA Lyon. We teach both at the Telecommunications and the Information Technology department, at the First Cycle department and at the RTS Master of INSA Lyon. We make external courses at ENSEIRB in Bordeaux and in the University of Lebanon. Our course material cover Operating Systems, Algorithmics and C programming, Hardware architectures, Java and OSGi programming, Middleware, Software Design.

## 9.3. Theses and Internships

### 9.3.1. Theses

#### 9.3.1.1. Theses in preparation

**Rolcha Goya** "*Operating system for handling IoT*", Iranian Grant, since 10/2011, 1st year.

**Manuel Selva** "*Real time SOA*", Bull SA Grant, since 10/2011, 1st year.

**François Goichon** "*Resource Control in Component-based Embedded Operating Systems*", MENRT grant, since 09/2010, 2nd year.

**Zheng Hu** "*Legacy equipment management in home environment*", Orange labs grant, since 01/2010, 2nd year.

**Yufang Dan** "*Ambient calculus for distributed, service oriented virtual machines*", CSC china grant, since 09/2010, 2nd year.

**Andreea Chis** "*English title of the thesis*", MENRT grant, since 10/2007, Defence scheduled on January, 10th, 2012, 5th year.

**Ahmad Ahmad-Kassem** "*High level abstraction for network programming*", ANR-09-BLAN-0131-01 grant, since 10/2009, 3rd year.

**Fuda Ma** "*High level modeling for applications distributed over networks*", CSC china grant, since 09/2010, 2nd year.

### 9.3.2. Participation in thesis committees

**Stéphane Frénot** has been member of the PhD Jury of Mr. Juan Navas, "Une infrastructure pour l'optimisation de systèmes embarqués volutifs à base de composants logiciels", University of Britany, 6 may, 2011.

### 9.3.3. Internships

**Alexis Giorkallos** "*Compressing/Cyphering logs*" (French Report).

**Damien Reimert** "*Ambiant Context Simulation*" (French Report).

**Moemen Cherni** "*Dynamic temporal specification building for service oriented application admission control*" (French Report).

**Yann Chevalier** "*Memory management in JamVM*" (French Report).

**Ferit Bayer Elhuseyni** "*A Cross-layer Approach to Achieve Efficient Service Delivery in Mobile Delay-Tolerant Networks with a Service-Oriented Network Coding*".

**Herman Mekontso Tchinda** "Specification and Service Substitution within OSGi framework" [14].

**Joffrey d'Hayer** "Implementing Hashing function on Lyrtec FGPA card" (French Document)

## 10. Bibliography

### Publications of the year

#### Articles in International Peer-Reviewed Journal

- [1] A. APAVATJRUT, W. ZNAIDI, A. FRABOULET, C. GOURSAUD, K. JAFFRÈS-RUNSER, C. LAURADOUX, M. MINIER. *Energy Efficient Authentication Strategies for Network Coding*, in "Concurrency and Computation: Practice and Experience", June 2011, <http://hal.inria.fr/hal-00644484/en>.
- [2] A. APAVATJRUT, W. ZNAIDI, A. FRABOULET, C. GOURSAUD, C. LAURADOUX, M. MINIER, K. JAFFRÈS-RUNSER. *Energy Efficient Authentication Strategies for Network Coding*, in "Concurrency and Computation: Practice and Experience", June 2011, <http://hal.inria.fr/inria-00611821/en>.
- [3] A. FRIGGERI, G. CHELIUS, E. FLEURY, A. FRABOULET, F. MENTRÉ, J.-C. LUCET. *Reconstructing Social Interactions Using an unreliable Wireless Sensor Network*, in "Computer Communications", April 2011, vol. 34, n<sup>o</sup> 5, p. 609–618 [DOI : 10.1016/J.COMCOM.2010.06.005], <http://hal.inria.fr/inria-00490195/en>.
- [4] S. FRÉNOT, F. LE MOUËL, J. PONGE, G. SALAGNAC. *Various Extensions for the Ambient OSGi Framework*, in "International Journal of Adaptive, Resilient and Autonomic Systems (IJARAS)", July 2011, vol. 2, n<sup>o</sup> 3, p. 1–12 [DOI : 10.4018/JARAS.2011070101], <http://hal.inria.fr/inria-00610543/en>.
- [5] N. IBRAHIM, F. LE MOUËL, S. FRÉNOT. *Semantic Service Substitution in Pervasive Environments*, in "International Journal of Services, Economics and Management (IJSEM)", 2011, "Service-Oriented Engineering" special issue, <http://hal.inria.fr/inria-00438223/en>.

#### Articles in National Peer-Reviewed Journal

- [6] A. BEN HAMIDA, F. LE MOUËL, S. FRÉNOT, M. BEN AHMED. *Déploiement adaptatif d'applications orientées services sur environnements contraints*, in "Technique et Science Informatiques", 2011, vol. 30, n<sup>o</sup> 1, p. 59-91, <http://hal.inria.fr/inria-00534596/en>.

#### International Conferences with Proceedings

- [7] C. BURIN DES ROSIERS, G. CHELIUS, T. DUCROCQ, E. FLEURY, A. FRABOULET, A. GALLAIS, N. MITTON, T. NOËL, J. VANDAËLE. *Using SensLAB as a First Class Scientific Tool for Large Scale Wireless Sensor Network Experiments*, in "Networking 2011", Valencia, Spain, April 2011, p. 241-253, <http://hal.inria.fr/inria-00599102/en>.
- [8] C. BURIN DES ROSIERS, G. CHELIUS, E. FLEURY, A. FRABOULET, A. GALLAIS, N. MITTON, T. NOËL. *SensLAB Very Large Scale Open Wireless Sensor Network Testbed*, in "Proc. 7th International ICST Conference on Testbeds and Research Infrastructures for the Development of Networks and Communities (TridentCOM)", Shanghai, China, April 2011, <http://hal.inria.fr/inria-00587862/en>.

- [9] B. FRANK, H. JOS, H. DE GROOT, M. BENNEBROEK, A. ABBO, O. SANTANA, J. VAN MEERBERGEN, A. FRABOULET. *A dual-core system solution for wearable health monitors*, in "GLSVLSI '11 Proceedings of the 21st edition of the great lakes symposium on Great lakes symposium on VLSI", Lausanne, Switzerland, 2011, p. 379–382 [DOI : 10.1145/1973009.1973087], <http://hal.inria.fr/hal-00597951/en>.

### National Conferences with Proceeding

- [10] R. GOLCHAY, F. LE MOUËL, S. FRÉNOT, J. PONGE. *Towards Bridging IoT and Cloud Services: Proposing Smartphones as Mobile and Autonomic Service Gateways*, in "Actes des 7ème Journées Francophones de la Mobilité et Ubiquité (UbiMob'2011)", Toulouse, France, June 2011, p. 45–48, Position Paper, <http://hal.inria.fr/inria-00610537/en>.

### Scientific Books (or Scientific Book chapters)

- [11] T. RISSET, R. BEN ABDALLAH, A. FRABOULET, J. MARTIN. *Programming Models and Implementation Platforms for Software Defined Radio Configuration*, in "Digital Front-End in Wireless Communication and Broadcasting", F.-L. LUO (editor), Cambridge university press, November 2011, <http://hal.inria.fr/hal-00644441/en>.

### Research Reports

- [12] W. L. CHOO, F. LE MOUËL, K. JAFFRÈS-RUNSER, M. FIORE. *Adding Network Coding Capabilities to the WSNet Simulator*, INRIA, March 2011, n° RT-0405, <http://hal.inria.fr/inria-00573998/en>.
- [13] C. LAURADOUX, J. PONGE, A. ROECK. *Online Entropy Estimation for Non-Binary Sources and Applications on iPhone*, INRIA, June 2011, n° RR-7663, <http://hal.inria.fr/inria-00604857/en>.
- [14] H. MEKONTSO TCHINDA, N. STOULS, J. PONGE. *Spécification et substitution de services OSGi*, INRIA, September 2011, n° RR-7733, <http://hal.inria.fr/inria-00619233/en>.
- [15] N. STOULS, J. GROSLAMBERT. *Vérification de propriétés LTL sur des programmes C par génération d'annotations*, February 2011, <http://hal.inria.fr/inria-00568947/en>.

### Other Publications

- [16] C. BURIN DES ROSIERS, G. CHELIUS, T. DUCROCQ, E. FLEURY, A. FRABOULET, A. GALLAIS, N. MITTON, T. NOËL, E. VALENTIN, J. VANDAËLE. *Two demos using SensLAB: Very Large Scale Open WSN Testbed*, June 2011, Demo in Proc. of The 7th IEEE International Conference on Distributed Computing in Sensor Systems (IEEE DCOSS '11), <http://hal.inria.fr/inria-00636847/en>.
- [17] Z. HU, S. FRÉNOT, B. TOURANCHEAU, G. PRIVAT. *Iterative Model-based Identification of Building Components and Appliances by Means of Sensor-Actuator Networks*, 2011, 2nd Workshop on eeBuildings Data Models, CIB W078, W102, Sophia Antipolis, France, <http://hal.inria.fr/inria-00636055/en>.
- [18] Z. HU, G. PRIVAT, S. FRÉNOT, B. TOURANCHEAU. *self-configuration of Home Abstraction Layer via sensors and actuators network*, November 2011, 2nd international joint conference on Ambient Intelligence, <http://hal.inria.fr/hal-00643940/en>.
- [19] J. PONGE. *Better Resource Management with Java SE 7: Beyond Syntactic Sugar.*, May 2011, Oracle Technology Network, Oracle Corporation., <http://hal.inria.fr/inria-00611453/en>.

- [20] J. PONGE. *Fork and Join: Java Can Excel at Painless Parallel Programming Too!*, July 2011, Oracle Technology Network, Oracle Corporation., <http://hal.inria.fr/inria-00611456/en>.

## References in notes

- [21] *The Coq Proof Assistant*, <http://coq.inria.fr>.
- [22] M. J. C. GORDON, T. F. MELHAM (editors). *Introduction to HOL: a theorem proving environment for higher order logic*, Cambridge University Press, New York, NY, USA, 1993.
- [23] *PRISM - Probabilistic Model Checker*, <http://www.prismmodelchecker.org>.
- [24] *UPPAAL*, [http://en.wikipedia.org/wiki/Uppaal\\_Model\\_Checker](http://en.wikipedia.org/wiki/Uppaal_Model_Checker).
- [25] APACHE. *Apache Foundation Felix*, apache.org, June 2009, <http://felix.apache.org>.
- [26] F. BANCILHON. *Naive evaluation of recursively defined relations*, 1986, p. 165–178.
- [27] F. BANCILHON, D. MAIER, Y. SAGIV, J. D. ULLMAN. *Magic sets and other strange ways to implement logic programs (extended abstract)*, in "PODS '86: Proceedings of the fifth ACM SIGACT-SIGMOD symposium on Principles of database systems", New York, NY, USA, ACM, 1986, p. 1–15.
- [28] E. BELLEMON, V. DUBOSCLARD, S. GRUMBACH, K. SUO. *QuestMonitor: A Visualization Platform for Declarative Network Protocols*, in "MSV 2011: The 8th International Conference on Modeling, Simulation and Visualization Methods, Las Vegas, USA", 2011.
- [29] A. BEN HAMIDA. *AxSeL : un intergiciel pour le déploiement contextuel et autonome de services dans les environnements pervasifs*, INSA de Lyon, Feb 2010, <http://hal.inria.fr/tel-00478169>.
- [30] K. BHARGAVAN, D. OBRADOVIC, C. A. GUNTER. *Formal verification of standards for distance vector routing protocols*, in "J. ACM", 2002, vol. 49, p. 538–576.
- [31] CEA. *Frama-C*, cea.fr, June 2009, <http://www.frama-c.cea.fr/>.
- [32] CODEHAUS. *CodeHaus Web Site*, CodeHaus, June 2009, <http://codehaus.org/>.
- [33] CODEZERO. *CodeZero: Embedded Hypervisor and OS*, January 2011, <http://l4dev.org/faq>.
- [34] Y. DENG, S. GRUMBACH, J.-F. MONIN. *Towards Verifying Declarative Netlog protocols with Coq*, 2010, <http://hal.inria.fr/inria-00506093>.
- [35] O. G. EDMUND M. CLARKE, D. A. PELED. *Model Checking*, The MIT Press, Cambridge, MA, USA, 1999.
- [36] A. P. FELTY, D. J. HOWE, F. A. STOMP. *Protocol Verification in Nuprl*, in "In Tenth International Conference on Computer Aided Verification", Springer-Verlag, 1998, p. 428–439.
- [37] GENODE. *Genode on L4/Fiasco*, January 2010.

- 
- [38] F. GOICHON, G. SALAGNAC, S. FRÉNOT. *Exploiting Java Code Interactions*, INRIA, 2011, n<sup>o</sup> To be published.
- [39] Y. GRIPAY, F. LAFOREST, J.-M. PETIT. *SoCQ: A Framework for Pervasive Environments*, in "ISPAN 2009, 10th International Symposium on Pervasive Systems, Algorithms and Networks", 2009, p. 154-159.
- [40] J. M. HELLERSTEIN. *The declarative imperative: experiences and conjectures in distributed logic*, in "SIGMOD Record", 2010, vol. 39, n<sup>o</sup> 1, p. 5-19.
- [41] G. J. HOLZMANN. *The Model Checker SPIN*, in "IEEE Trans. Software Eng.", 1997, vol. 23, p. 279-295.
- [42] JAMVM. *JamVM virtual machine*, sourceforge, June 2009, <http://jamvm.sourceforge.net/>.
- [43] L4. *The L4  $\mu$  - Kernel Family*, January 2011, <http://os.inf.tu-dresden.de/L4/>.
- [44] B. T. LOO, T. CONDIE, M. N. GAROFALAKIS, D. E. GAY, J. M. HELLERSTEIN, P. MANIATIS, R. RAMAKRISHNAN, T. ROSCOE, I. STOICA. *Declarative networking: language, execution and optimization.*, in "Proceedings of the ACM SIGMOD International Conference on Management of Data, Chicago, Illinois, USA, June 27-29", 2006.
- [45] B. T. LOO, J. M. HELLERSTEIN, I. STOICA, R. RAMAKRISHNAN. *Declarative routing: extensible routing with declarative queries*, in "SIGCOMM '05: Proceedings of the 2005 conference on Applications, technologies, architectures, and protocols for computer communications", New York, NY, USA, ACM, 2005, p. 289-300.
- [46] M. MUSUVATHI, D. R. ENGLER. *Model Checking Large Network Protocol Implementations*, in "In Proceedings of the First Symposium on Networked Systems Design and Implementation", 2004, p. 155-168.
- [47] J. PONGE. *izPack*, CodeHaus, June 2009, <http://izpack.org/>.
- [48] J. RUSHBY. *Specification, Proof Checking, and Model Checking for Protocols and Distributed Systems with PVS*, in "Tutorial, FORTE X/PSTV XVII'97", 1997.
- [49] N. STOULS. *Aorai plugin for Frama-C*, amazones / INRIA, June 2009, <http://amazones.gforge.inria.fr/aorai/index.html>.
- [50] N. STOULS, J. GROSLAMBERT. *Vérification de propriétés LTL sur des programmes C par génération d'annotations*, 02 2011, <http://hal.inria.fr/inria-00568947/en/>.
- [51] L. VIEILLE. *Recursive Axioms in Deductive Databases: The Query/Subquery Approach*, in "Expert Database Conf.", 1986, p. 253-267.