INRIA

INSTITUT NATIONAL DE RECHERCHE EN INFORMATIQUE ET EN AUTOMATIQUE

Project-Team pops

System and Networking for Portable Objects Proved to be Safe

Lille - Nord Europe

Theme : Distributed Systems and Services

Table of contents

1. Team

Research Scientists

Nathalie Mitton [Junior Researcher]
Tahiry Razafindralambo [Junior Researcher]

Faculty Members

Jean Carle [Associate Professor, Univ. Lille 1]
Gilles Grimaud [Professor, Univ. Lille 1, HdR]
Michaël Hauspie [Associate Professor, Univ. Lille 1]
Samuel Hym [Associate Professor, Univ. Lille 1]
David Simplot-Ryl [Team Leader, Professor, Univ. Lille 1, HdR]
Isabelle Simplot-Ryl [Professor, Univ. Lille 1, HdR]
Marie-Emilie Voge [Associate Professor, Univ. Lille 1]
Julien Champ [ATER, IUT A, since Sept. 2010]

Technical Staff

Roudy Dagher [IE INRIA, since Nov. 2009]
Nicolas Debray [IE INRIA, Jan. 2010-Oct. 2010]
Grégory Guche [IE INRIA, Feb. 2008-Aug. 2010]
Lucie Jacquelin [IE INRIA, since Oct. 2010]
Xin Jin [IJD INRIA, Dec. 2009-June 2010]
Roberto Quilez [IE INRIA, since Jan. 2010]
Julien Vandaële [IR INRIA, since June 2008]
Lei Zhang [IE INRIA, since Jan. 2010]

PhD Students

Nicolas Boulenguez [Government Grant, Univ. Lille 1, since Feb. 2010]
Geoffroy Cogniaux [CIFRE Gemalto, since Jan. 2010]
Tony Ducrocq [IE INRIA, Dec. 2009-Nov. 2010, PhD since Dec. 2010]
Simon Duquennoy [Government Grant, Oct. 2007-Aug. 2010]
Donia El Kateb [European Contract, May 2009-July 2010]
Milan Erdelj [CORDIS, since Oct. 2010]
Alia Ghaddar [Cotutorial with Libanese Univ., since Dec. 2008]
Nicolas Gouvy [Government Grant, Univ. Lille 1, since Oct. 2010]
Fadila Khadar [European Contract, Sept. 2006-Feb. 2010]
Jovan Radak [CORDIS, since Sept. 2008]
Loïc Schmidt [European Contract, Jan. 2008-Dec. 2010]
Thomas Soete [Government Grant, Univ. Lille 1, Oct. 2006-Dec. 2010]

Post-Doctoral Fellows

Arnaud Fontaine [Post-doc fellow, INRIA, since Apr. 2009]
Xu Li [Post-doc fellow, INRIA, Feb. 2010-Jul. 2010]
Enrico Natalizio [Post-doc fellow, INRIA, since Nov. 2010]
Sylwia Romaszko [Post-doc fellow, Univ. Lille 1, July 2009-July 2010]

Administrative Assistant

Anne Rejl

2. Overall Objectives

2.1. Introduction

The POPS research group studies solutions to improve programmability, adaptability and reachability of "POPS" (Portable Objects Proved to be Safe). The POPS family contains small and limited devices like smart cards, RFID tags (see Fig. 1) [40], wireless sensors (see Fig. 3) [39] or personal digital assistants. Such small devices are characterized by limited resources, high mobility, frequent disconnections, low-bandwidth communications, passive (no battery) or limited battery life and reduced storage capacity. Moreover, in spite of these constraints and because of the use in an untrusted environment, users and applications require high security level for POPS. The development of applications integrating POPS suffers from lack of "*reachability*" of such platforms. For instance, software development is penalized by exotic and limited operating systems. Indeed, POPS, such as smart cards, are difficult to program and high level of expertise is needed to produce software. Some efforts were taken recently with the advent of Java Cards [36], PalmOS or Windows CE. But Java Card offers a very small part of Java API and a typical application written in Java cannot be directly translated to Java Card. POPS mobility induces sudden and frequent disconnections, long round trip times, high bit error rates and small bandwidth. Hence, POPS systems have to adapt themselves to application requirements or modification of the environment.

Figure 1. Example of RFID tags.

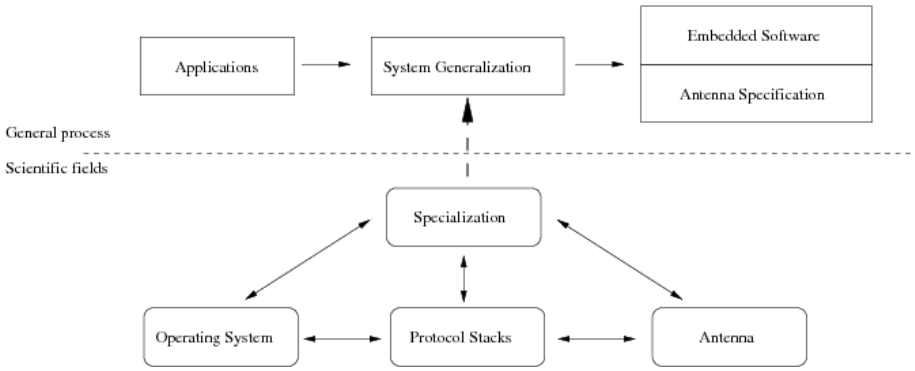

Figure 2. POPS' thematics and objectives.

Indeed, the application should guide the system. Therefore, the POPS research group aims to propose a generic approach allowing any application to specialize the system according to its own needs and characteristics (See Fig. 2). Since POPS are limited in capacity, specializing the system for the application will allow to embed much less code and functionalities.

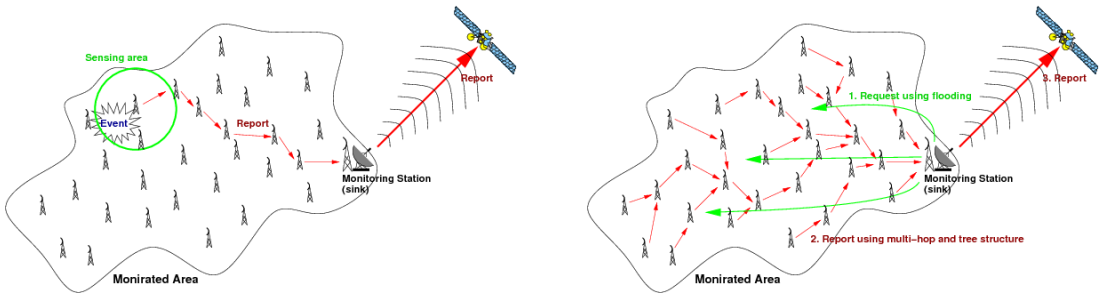

Figure 3. Example of a sensor network with event-driven (left) and on-demand (right) models.

POPS research action takes advantage of its strong partnership with Gemplus/Gemalto since more than 19 years. This collaboration brings both partners (the POPS research group of INRIA and Gemplus/Gemalto) to high level of expertise in embedded operating system design and mobile networking which are our two main research activities.

2.1.1. Embedded Operating Systems

We focus our activities on “adaptability” and on “connectivity” of embedded platforms dedicated to POPS. From then on, our researches have evolved around the smart card. In fact, in the nineties (birth date of POPS research group) smart card was the only valuable and industrially deployed POPS. Smart card integration in database management systems, smart card integration in Corba (using the Card Object Adapter), open platform for smart card (the first smart card virtual machine), have been milestones of the POPS research. More recently, we have focused our attention (according to our industrial inputs) on embedded operating system techniques, enabling “on-card” type checking and bytecode compression. Today, smart card manufacturers and other emerging POPS manufacturers have to deal with new technological ’lock-in’ inside and outside the mobile object. Dedicated operating systems are now powerful enough to run dynamically downloaded applications in a safe way. Typically, Java Card loads and runs a Java-like bytecode. Nevertheless, “Java-like” means “non-Java”. Embedded virtual machines do not support standard abstractions. And so, Java applications cannot be deployed in a limited embedded system. On the other hand, embedded applications do not limit their needs to the Java APIs. To overcome these limitations, we will focus on two complementary studies:

1. Firstly we study a new architectural way to embed a Java virtual machine. Conventional virtual machines are not operating systems but they overlap the abstractions proposed by the system. We plan to define a Java virtual machine designed to be the operating system (the virtual machine will manage the hardware itself).
2. Java is one of the possible hardware abstractions. However different applications require different abstractions: file-system, database systems, and so on. Camille OS is a smart card Exo-kernel enabling the download of different hardware abstractions in a safe way. In this way Camille ensures POPS “adaptability” to the applications requirements. Nevertheless some critical system extensions (enhanced IO protocols for example) need additional guaranties: real-time properties and hardware resources control.

2.1.2. Mobile Networking

POPS also have a non-conventional communication interface. Due to their mobility, they have transient and unpredictable communications with other entities. This fact motivates our focusing on the ad hoc network communication model which is the most flexible model.

Indeed wireless ad hoc networks [41], [37], [38], [35] encompass a wide range of self-organized network types, including sensor, mobile ad hoc, personal area, and rooftop/mesh networks. The design of data communication techniques in multi-hop ad hoc networks comprises challenges at all layers of communication: physical, medium access control (MAC), network, transport and application layers. This research project concentrates on the network layer. The network layer problems can be divided into three groups: data communication, service access, and topology control problems. Data communication problems include routing, quality-of-service routing, geocasting, multicasting, and broadcasting. The protocols need to minimize the communication overhead (since bandwidth in wireless communication is typically limited) and the power consumption of battery operated POPS. In service access problems, such as multi-hop wireless Internet (hybrid network, see Fig. 4), the goal is to provide or receive services from a fixed infrastructure with other hosts serving as relays if necessary. Topology control problems include neighbor discovery problems (detecting neighboring nodes located within transmission radius) and network organization problems (deciding what communication links to establish with neighboring nodes, operating sleeping period and adjusting transmission radii). Secure routing faces the following challenges: node selfishness, threats using modification of routing information, misrepresenting identity, fabrication of routing messages by one node, or between two malicious nodes (wormhole attack), and self-organized public-key management and authentication services. The main paradigm shift is to apply localized (or greedy) schemes as opposed to existing protocols requiring global information. Localized algorithms are distributed algorithms where simple local node behavior achieves a desired global objective. Localized protocols provide scalable solutions, that is, solutions for wireless networks with an arbitrary number of nodes, which is one of the main goals of this research project.

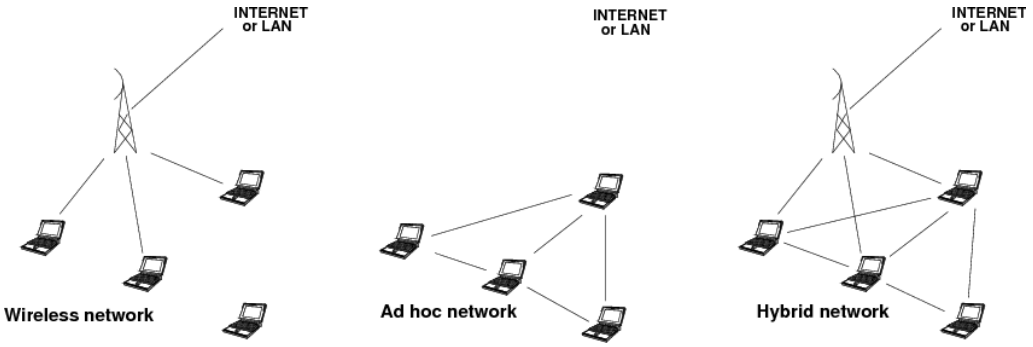

Figure 4. From wireless network to hybrid networks.

2.2. Highlights

- The Senslab platform is currently deployed in the framework of the ANR Senslab (See Section 7.6). The Lille platform has been deployed in November 2009 at Euratechnologies. It is composed of 246 nodes, 32 of them being mobile. A demo of the platform has been presented during IEEE MASS conference [10].

3. Scientific Foundations

3.1. Scientific Foundations

The POPS research group investigates solutions to enhance programmability, adaptability and reachability of small objects designated as "POPS" (Portable Objects Proved to be Safe). The POPS set includes small devices like smart cards, RFID tags or personal digital assistant which are characterized by limited resources, high mobility and high security level in spite of untrusted environment. The development of applications integrating POPS suffers from lack of "*reachability*" of these platforms. Indeed, most POPS are not easy to program and high level of expertise is needed to produce software for such limited operating systems and devices. Moreover, POPS mobility induces sudden and frequent disconnections, long round trip times, high bit error rates and small bandwidth.

We believe that the "system and networking" approach makes sense in the context of portable objects proved to be safe. We have demonstrated that the application-driven approach can be very efficient for customization of embedded software. We propose to focus on the following objectives where sensors are privileged platforms:

3.1.1. Customization of evolving and communicating systems

We propose to address the two following problems based on our work on customization of Java-systems:

1.1 Dynamical customization: It corresponds to what we proposed in the previous proposal: "The ability to adapt a POPS system while it is running (after it has been issued) can be an important differentiation factor to ensure the durability of the system, the update of the applications it can run, and its capacity to adapt to new usages and environments. The more POPS are complex (and expensive) and general purpose, the more these requirements are important. Dynamic configuration is clearly in the objectives of the Camille action since the system is designed to support dynamic extensions of the operating system kernel via techniques such as dynamic linking, on-the-fly compilation, and verifiable typed intermediate language." In means that we have to study how we can design a specialized system – where functionalities could be removed – which is able to evolve in order to get new functionalities while preserving safety of already installed applications.

Our goal is also to promote the JITS platform for POPS.

1.2 Optimization of the communication stack: The goal is to study the architecture of the communication stack in sophisticated cases (*i.e.* not limited to serial link) and in particular for objects with wireless capabilities. This is illustrated by the Figures 2 and 5. In the latter, we illustrate the case of a sensor network application. The "selection engine" takes a "model of the application" (including model of the network) and the "specification of the hardware". A set of protocols of each layer are evaluated according to "cost function" and the "selection engine" generates the combination of protocols which is optimal for the application and the hardware.

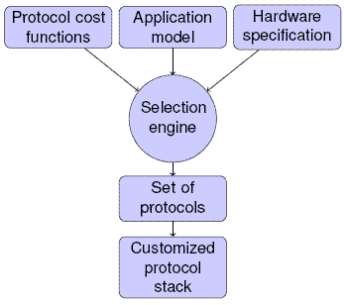

Figure 5. Complete scheme of the generation of the communication stack.

From our interaction with industrial partners, we see that it is also important to consider application layers and in particular http.

3.1.2. Realistic wireless networking

We show that the unit-disk graph model is not realistic and that an excellent and sophisticated algorithm can be jeopardized in the real world. Our approach is to consider realistic physical layer (*e.g.* Log-normal shadowing model). Moreover, it is necessary to validate results analytically, with simulators, but also with real experimentations.

We propose to investigate the two following objectives:

2.1 Position-based algorithms: The main advantage of this family of protocol is that they are both localized and memoryless. It means that these protocols are robust since they do not need a huge quantity of information (1-hop or 2-hop knowledge in most of cases) and that it can support an arbitrary number of simultaneous flows since intermediate nodes do not need to store information. We will investigate (i) protocols based on geographical coordinates (*e.g.* GPS coordinates) and (ii) protocols based on virtual coordinates when geographical coordinates. Our goal is to propose energy-efficient protocols with guaranteed delivery for the different kind of protocols: unicast, multicast, data collection (for sensors), topology control, etc.

In particular, we are interested in data collection with data fusion and we think that such techniques can be applied in RFID applications where RFID readers can be assimilated to sensors. Depending on the application, the network can apply different filters in order to limit the amount of data which is sent to the sink.

2.2 Hardware-software optimizations: We will focus on low consumption radio interface for wireless sensors. More precisely, we believe that energy constrained objects can take advantage of smart antenna technologies. This area seems very promising on paper but it raises a lot of implementation problems. In the context of a partnership with IEMN (Institut d'Electronique, de Microélectronique et de Nanotechnologie), we want to experiment the implementation of a full communication stack dedicated to smart antennas (physical layer, MAC layer, etc.).

4. Application Domains

4.1. Application Domains

We believe that it is necessary to validate proposition with analysis, simulations and real experimentations. In order to achieve this, we will focus on three specific targets which are:

- **Smartcards** which are the core of our 19-years partnership with Gemalto.
- **Sensors motes**. In the SensLab project, we will have a real experimental platform.
- **COM platform** which is developed in the hard-soft project with IEMN and which allows the experimentation of smart antenna implementation.

The relationship between objectives and platforms are underlined in Figure 6. It is clear that JITS platform is the ideal platform to support our experimentations.

We will also explore these problems in two new application domains which are (i) sensor and actuator networks – also called SANET – and (ii) wireless mesh networks.

	Smartcards	Sensor motes	COM platform
1.1 Dynamical customization	X	X	-
1.2 Communication stack optimization	X	X	X
2.1 Position-based algorithms	-	X	X
2.2 Hardware-software optimizations	-	-	X

Figure 6. Objectives vs Platforms.

In SANET, we consider active nodes in a sensor network denoted as actuators and the whole network will support the breakthrough functionality, which is necessary for massively deployed heterogeneous sensor networks pervading our everyday life. We envision actuators as independent participants in the network, *e.g.*, autonomous robots or other devices capable of acting upon their environment. They are resource rich nodes that can autonomously move and affect the sensor network operations, either by being a mobile data sink or actively inserting, removing, and relocating sensor nodes. Moreover, actuator nodes can perform actions on the environment, based on the sensed environment and some intelligent decision logic. For example, they can turn on water sprinklers to stop assumed fire when high temperature reports are received from nearby sensors.

The second application domain is wireless mesh networks which are similar to wireless LAN (typically WIFI) where access points are connected with wireless link. Some access point in the network are connected to internet – these nodes are called gateway. The network works like an ad hoc network or a hybrid wireless network where nodes are fixed and where traffic is massively directed to the gateways (like in wireless sensor networks).

5. Software

5.1. Java In The Small

Participants: Geoffroy Cogniaux, Gilles Grimaud [Contact].

Initial goal of Java was to allow high level software development on small devices. Eventually it found success and promotion with software deployment on the Web, and more recently as a solution for huge enterprise servers and massive parallel computing. Today small targets are still supported, but with dedicated (Java-like) APIs and VMs. These specific technologies dramatically restrain the context in which Java applications can be deployed.

JITS focuses on these technologies and on enhancements to allow the use of a real Java Runtime Environment and a Java Virtual Machine everywhere by targeting tiny devices such as SmartCards. These devices usually don't use a Virtual Machine layer over an OS, but expect the Virtual Machine to be the OS. This is possible thanks to the JVM features which can be presented as a specific hardware abstraction for most of them.

JITS platform can be found at the URI http://jits.gforge.inria.fr/.

5.2. STatic Alias aNalyser

Participants: Arnaud Fontaine, Samuel Hym, Gilles Grimaud, Isabelle Simplot-Ryl [Contact].

STAN is a Java abstract analyser that allows static alias analysis and checking of information flow. Moreover, STAN targets small systems, like embedded systems. The STAN tool statically checks already compiled source code and annotates the .class files with verifiable signatures at loading time. STAN is dedicated to embedded systems and adapted to their constraints, supports mobile code, easy to use.

STAN can be found at the URI http://stan-project.gforge.inria.fr.

5.3. Smart and Mobile Embedded Web Server

Participants: Simon Duquennoy, Gilles Grimaud [contact].

Smews is a Smart and Mobile Embedded Web Server designed for hardware-constrained devices like smart cards, sensor boards and other small targets. Smews provides high performances thanks to several points:

- Single process event-driven architecture,
- TCP-IP stack dedicated to HTTP, allowing cross-layer optimizations,
- On-line pre-calculations done on Web contents (protocol headers, checksums, parsing automatons).

Smews is able to serve rich Web applications:

- Able to send static and dynamic contents,
- Comet support (server pushed data),
- Advanced typing of dynamic Web contents (persistent, idempotent and volatile contents).

Smews is currently available for MicaZ sensor and Funcard 7 smart card (AVR 8 bits), WSN430 sensor (MSP430 16 bits), Game Boy Advance (ARM 32 bit) and as a single UNIX/win32 process (x86 32bits).

6. New Results

6.1. Routing in wireless ad-hoc and sensor networks

Efficient quality of service in mobile ad-hoc networks using OLSR. OLSR is a well-known proactive protocol for wireless networks. Although very efficient by many points, it suffers from the drawbacks of not taking into account QoS metrics such as delay or bandwidth. To overcome this pitfall, some QOLSR (QoS OLSR) solutions have been designed. Nevertheless, they still provide weak performance regarding QoS metrics. Hence, we introduce a novel and simple neighbor selection to allow routing with OLSR along quasi-optimal QoS paths [18].

Routing in vehicular ad-hoc networks. One of the notoriously difficult problems in vehicular ad-hoc networks (VANET) is to ensure that established routing paths do not break before the end of data transmission. This is a difficult problem because the network topology is constantly changing and the wireless communication links are inherently unstable, due to high node mobility. In [24], we give a classification of existing VANET routing protocols into five categories: connectivity-based, mobility-based, infrastructure-based, geographic-location-based, and probability-model-based, according to their employed routing metrics. For each category, we present the general design ideas and state of the art. Our objective is to attract more attention to the VANET routing problem and encourage more research efforts on developing reliable solutions.

Ad Hoc Routing Protocol Analysis in Civil Safety Context. We have conducted an investigation of the three reactive routing approaches in the context of civil safety, where non-multimedia and multimedia traffic requires different constraints, such as bit error rate, goodput or latency [22]. This performance analysis shows us which kind of protocol should be adequate in civil safety environment. In order to be able to analyze the cluster based scheme we have designed such routing protocol and investigated its characteristics within this research. We examine different sending intervals in order to form an image of which protocol could handle audio, video or data.

6.2. Efficient data management and high level layers

Energy-Efficient data aggregation in Wireless Sensor Networks. A primary purpose of sensing in a sensor network is to collect and aggregate information about a phenomenon of interest. The batteries on today's wireless sensor barely last a few days, and nodes typically expend a lot of energy in computation and wireless communication. Hence, the energy efficiency of the system is a major issue. Different representative mechanisms has been proposed to achieve a long- lived sensors such as "clustering mechanisms" as well as aggregation techniques to reduce the amount of data communication generated by sensors.

Depending on the data type, ARMA series and forecasting are possible ways to reduce data transmission. First, we adopt single-hop clustering mechanism where all sensor nodes in a cluster communicate with their cluster-head (or sink) via single hop (such as in/on-body sensors for personal health monitoring,...). We propose different data aggregation algorithms based on the auto-regressive model, to predict local readings and reduce the communication traffic [14]. We evaluate the performance of our work in terms of communication cost and energy consumption. We also extend our work to enhance the prediction accuracy by estimating dynamic prediction threshold. Our simulation shows that depending on data type, communication overhead and rate can be reduced and a considerable accuracy prediction can be obtained.

We also propose an algorithm to measure similarity between the data collected toward the base station(relative to a specific event monitoring), so that an aggregator sensor sends a minimum amount of information to the base station in a way that the latter can deduce the source information of sensing neighbors nodes [15]. Further, our experimental results demonstrate that the communication traffic and the number of bits transmitted can be minimized while preserving accuracy on the base station estimations.

Knowledge discovery and data analysis in resource constrained wireless sensor networks faces different challenges. One of the main challenges is to identify misbehaviors or anomalies with high accuracy while minimizing energy consumption in the network. In [16], we extend a previous work of us and we present an algorithm for temporal anomalies detection in wireless sensor networks. Our experiments results show that our algorithm can efficiently and accurately detect anomalies in sensor measurements. It also produces low false alarm rate for slow variation time series measurements without harvesting the source of energy.

Adaptive infrastructure deployment for data gathering in intermittently connected networks. We propose a process calculus featuring high level constructs for component-oriented programming in a distributed setting [20]. We propose an extension of the higher-order pi-calculus intended to capture several important mechanisms related to component-based programming, such as dynamic update, reconfiguration and code migration. In this paper, we are primarily concerned with the possibility to build a distributed implementation of our calculus. Accordingly, we define a low-level calculus, that describes how the high-level constructs are implemented, as well as details of the data structures manipulated at runtime. We also discuss current and future directions of research in relation to our analysis of component-based programming.

6.3. Topology control and self-deployment in sensor and actuator networks

Clustering and self-stabilization in multi-hop wireless networks. In large scale multihop wireless networks, flat architectures are typically not scalable. Clustering was introduced to support self-organization and enable hierarchical routing. When dealing with multihop wireless networks, robustness is a crucial issue due to the dynamics of such networks. Several algorithms have been designed for clustering but to date, in none of them the self-stabilization features of the resulting structure have been investigated. In [6], we show that a clustering algorithm, known for its good robustness properties, is actually self-stabilizing. We propose several enhancements to the scheme to reduce the stabilization time and thus improve stability in a dynamic environment. The key technique to these enhancements is a localized self-stabilizing algorithm for Directed Acyclic Graph (DAG) construction. We provide extensive studies (both theoretical and experimental) that show that our approach enables efficient yet adaptive clustering in wireless multihop networks.

Connectivity guarantee during wireless sensor networks deployment. We consider the self-deployment of wireless sensor networks. In [21], we present a mechanism which allows to preserve network connectivity during the deployment of mobile wireless sensors. Our algorithm is distributed and is based on a subset of neighbors for motion decision. Our algorithm maintains a connected topology regardless of the direction chosen by each sensor. To preserve connectivity, the distance covered by the mobile nodes is constrained by the connectivity of the node to its neighbors in a connected subgraph like the relative neighborhood graph (RNG). We show the connectivity preservation property of our algorithm through analysis and present some simulation results for the full coverage problem.

Partition detection in wireless ad hoc networks. Ad hoc networks are expected to have some critical connectivity properties before partitioning. The timely partition prediction signals action for improving fault tolerance and performing some data or service replication, so that the network can continue functioning after partition does occur. We propose a survey of existing prediction concepts and discusses their scalability, simplicity, correctness, speed, communication overhead and applications [7]. Existing centralized algorithms declare an edge or a node as critical if its removal will separate the network into several components. Several localized definitions of critical (or cut) nodes and links, and removable nodes, are demonstrated to be simple, useful, and scalable. A node is critical if the subgraph of p-hop neighbors of node (without the node itself) is disconnected. A link is critical if its endpoints have no common p-hop neighbors (assuming that the link between them does not exist). Definitions are extended toward local k-connectivity. The false positives mostly occur when alternative routes exist but are relatively long, and therefore may not provide satisfactory service in applications. Therefore, localized protocols provide faster and often more reliable partition warnings for possible timely replication decisions. This conceptual advance provides ingredients for establishing and restoring bi-connectivity.

Planarization of communication graph in wireless ad hoc networks. In [19], we propose a radically new family of geometric graphs, i.e., Hypocomb, Reduced Hypocomb and Local Hypocomb. The first two are extracted from a complete graph; the last is extracted from a Unit Disk Graph (UDG). We analytically study their properties including connectivity, planarity and degree bound. All these graphs are connected (provided the original graph is connected) planar. Hypocomb has unbounded degree while Reduced Hypocomb and Local Hypocomb have maximum degree 6 and 8, respectively. To our knowledge, Local Hypocomb is the first strictly-localized, degree-bounded planar graph computed using merely 1-hop neighbor position information. We present a construction algorithm for these graphs and analyze its time complexity. Hypocomb family graphs are promising for wireless ad hoc networking. We report our numerical results on their average degree and their impact on FACE routing. We discuss their potential applications and some open problems.

6.4. RFID systems

In RFID systems, ordinary applications such as inventories need the support of new technologies to fit the scalability of companies. More and more servers and databases are deployed to store information and connected in networks to become accessible from every place [29], [28]. These databases are now supplied through the reading of bar-codes or RFID tags hold by objects. We propose a novel self-organizing stock management structure [23]. SENSATION (SElf-orgaNizing Structures for mAnagemenT In stock Oriented Networks) is based on a double DHT mechanism and is inspired from existing works such as SOLIST and Tribe. It proposes an efficient unique structure which can be used for different purposes such as data replication, distributed storing and request managements in stock management. These features help in the scalability and reliability of new storing warehouse management which tends to increase in scale and to be more and more interconnected. Results show that SENSATION provides interesting and promising results in terms of reliability and scalability.

6.5. Software security

E-cash security based on risk management. Electronic cash is an attempt to replace and reproduce paper cash in electronic transactions that faces competing challenges when used either online or offline. In effect, while effective protection against double spending for e-cash can be achieved in online payment environments through real-time detection, this comes at the expense of efficiency, the bank representing in such case a performance bottleneck and single point of failure. In contrast, in offline payment environments, while efficiency is improved, double spending can be detected only after the fact, which can be very costly. We have proposed a risk management approach for double spending protection which allows suitable tradeoffs between efficiency and effectiveness [12]. This involves using the service of a *trader*, who is a trusted third party that will cover the risk involved in offline payment transactions, against some remuneration. The main goal is to provide full coverage to users against losses related to invalid coins while avoiding or minimizing interactions with the bank. Since the trader will incur some risk by guaranteeing coins while she cannot communicate with the bank, a winning strategy is devised for the trader to mitigate such risk.

Application of contract-based security assertion monitoring framework for telecommunications software engineering. Telecommunication software systems, containing security vulnerabilities, continue to be created and released to consumers. We need to adopt improved software engineering practices to reduce the security vulnerabilities in modern systems. Contracts can provide a useful mechanism for the identification, tracking, and validation of security vulnerabilities. In this work [5], we propose a new contract-based security assertion monitoring framework (CB SAMF) that is intended to reduce the number of security vulnerabilities that are exploitable across multiple software layers, and to be used in an enhanced systems development life cycle (SDLC). We show how contract-based security assertion monitoring can be achieved in a live environment on Linux. Through security activities integrated into the SDLC we can identify potential security vulnerabilities in telecommunication systems, which in turn are used for the creation of contracts defining security assertions. Our contract model is then exercised, as runtime probes, against two common security related vulnerabilities in the form of a buffer overflow and a denial of service.

On-Device Control Flow Verification for Java Programs. While mobile devices have become ubiquitous and generally multi-application capable, their operating systems provide few high level mechanisms to protect services offered by application vendors against potentially hostile applications coexisting on the device. In [13], we tackle the issue of controlling application interactions including collusion in Java-based systems running on open, constrained devices such as smart cards or mobile phones. We present a model specially designed to be embedded in constrained devices to verify at install-time that interactions between applications abide by the security policies of each involved application without resulting in runtime computation overheads; this models deals with application (un)installations and policy changes in an incremental fashion. We show the feasibility of our approach and its security enhancements on a multi-application use case for GlobalPlatform/Java Card smart cards.

6.6. Software optimization for small devices

Efficient off-board deployment and customization of virtual machine-based embedded systems. We define a new way to deploy and customize embedded virtual machine based operating systems for very restrained devices [4]. Due to the specificity of restrained embedded devices (large usage of read-only memory, very few writable memory available,...), these systems are typically deployed on-board, in a process called romization. However, current romization solutions do not allow a complete deployment to take place outside of the execution device: they are capable of converting system components and applications into their executable form, but are unable to perform any operation that would require the system to be running. This results in a good part of the deployment being performed by the target device, at the cost of longer startup times, bloat with code and data that are only executed once at startup, and sub-optimal memory placement of data structures. Hence, we propose a new romization scheme that allows the system to be started within a virtual execution environment, and thus to be fully deployed on-board before being transferred it to its real execution support. We then take advantage of all the information provided by the deployed state in order to analyze and customize it, resulting in a very low-footprint, custom-tailored embedded system. The Java platform is used as a support to implement our romization architecture and perform our experiments. For the evaluated set of embedded applications, we were able to obtain embedded systems which memory footprint was lower than their J2ME counterpart, while being based on a full-fledged J2SE environment.

Code execution using demand paging and NAND flash at smart card scale. Nowadays, the desire to embed more applications in systems as small as Smart Cards or sensors is growing. However, physical limitations of these systems, like very small main memory, and their cost of production make it very difficult to achieve. One solution is to execute code from a secondary memory, cheaper, denser, but slower, as NAND Flash. Solutions based on Demand Paging and using a cache in main memory, began to be proposed and implemented in the domain of mobile phones, but consume too much RAM yet, compared to what a Smart Card can provide. We have shown [9], [8] that we can dramatically increase performance by reducing the size of pages in the cache. This solution then allows a more intelligent access to the NAND. We also show that our solution allows to use Demand Paging within the limits of Smart Cards memories, where a conventional approach, offering too low bandwidth, makes code execution impossible from this kind of secondary memory. Finally, we present important future keys to optimize our proposal even more, and specially off-line code specialization aware of NAND characteristics and advanced cache properties.

Efficient requests scheduling for embedded web servers. Requests scheduling in Web servers is a hot research topic. Many works aim at providing optimal algorithms according to various metrics. Most of these works are based on classical scheduling metrics, considering jobs completion times, but ignoring intermediate states. We claim that this choice conduces to the design of algorithm that do not efficiently share the system resources. Indeed, Web servers have some properties that make them different than the system considered in usual scheduling theory. The classical round-robin policy, used in most production Web servers, has intrinsic qualities: it shares equally the system resources and avoids any job starvation. We introduce a novel parameterizable algorithm proposing a compromise between the benefits of the round-robin and the policies that provide the best performances [11]. Then, we discuss the appropriate choice of the parameter depending in the requirements and the context of the Web server.

7. Contracts and Grants with Industry

7.1. Gemplus/Gemalto partnership

Participants: Gilles Grimaud [contact], Simon Duquennoy, Michaël Hauspie, Geoffroy Cogniaux.

Since its creation, POPS has been supported by Gemplus/Gemalto within the framework of a partnership agreement that lasts since 19 years. Gemplus/Gemalto has been continuously supported the POPS research activities though fundings and the sharing of experiences and problems between POPS and Gemplus/Gemalto Labs researchers.

POPS has been a provider of innovative technologies for Gemplus/Gemalto thanks to several major patents (including those for a secure interpreter, a database card, a loader-linker of code, or communication protocols for tags), and thanks to thesis and projects such as: the card interpreter CAVIMA (1991), the “blank card” model (1991 and 1995), the CQL card and its integration in ODBC (from 1991 to 1994), a 32-bit RISC architecture for smart cards (1996), a programmable open card and its integration in object-oriented systems (1996), the language for the GemXplore 98 cards (1997), the integration of smart cards in transactional systems (1999), optimized communication protocols for tags (from 1999 to 2001 with Gemplus/Gemalto Tags), the card system CAMILLE (2000), or the card with multiple execution contexts.

Gemplus/Gemalto and POPS have also gained benefits from this partnership through National or European projects in which they participate altogether: CASCADE (IST 4th framework), CESURE (RNRT), COMPiTV (RNTL), RESET (IST 5th framework), and INSPIRED (IST 6th framework).

At that present time, their partnership is mainly focused on embedded operating system research activities (JITS, Camille, and OS customization).

7.2. European FP6 IST IP “Wirelessly Accessible Sensor Populations” (WASP) 2006-2010

Participants: Jean Carle [contact], Gilles Grimaud, Michaël Hauspie, Fadila Khadar, Nathalie Mitton, David Simplot-Ryl.

An important class of collaborating objects is represented by the myriad of wireless sensors, which will constitute the infrastructure for the ambient intelligence vision. The academic world actively investigates the technology for Wireless Sensor Networks (WSN). Industry is reluctant to use these results coming from academic research. A major cause is the magnitude of the mismatch between research at the application level and the node and network level.

The WASP project aims at narrowing this mismatch by covering the whole range from basic hardware, sensors, processor, communication, over the packaging of the nodes, the organization of the nodes, towards the information distribution and a selection of applications. The emphasis in the project lays in the self-organization and the services, which link the application to the sensor network. Research into the nodes themselves is needed because a strong link lies between the required flexibility and the hardware design. Research into the applications is necessary because the properties of the required service will influence the configuration of both sensor network and application for optimum efficiency and functionality. All inherent design decisions cannot be handled in isolation as they depend on the hardware costs involved in making a sensor and the market size for sensors of a given type. Three business areas, road transport, elderly care, and herd control, are selected for their societal significance and large range of requirements, to validate the WASP results. The general goal of the project is 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.

The tangible results of the project are:

- A consistent chain of energy-sensitive software components.
- Sets of cross optimized software stacks.
- Benchmarks and a set of measurements on energy- and code- efficiency.
- Rules for the design of configurable sensor nodes.
- A prototype implementation in one of the three chosen business areas.

List of participants: Philips Research Eindhoven, Philips Forschung Laboratorium, IMEC, CSEM, TU/e, Microsoft Aachen, Health Telematic Network, Fraunhofer IIS, Fokus, IGD, Wageningen UR, Imperial College London, STMicroelectronics, INRIA, Univ of Lille, Ecole Polytechnique Federale Lausanne, Cefriel, Centro Ricerce Fiat, Malaerdalen University, RWTH Aachen, SAP, Univ of Paderborn

http://www.wasp-project.org/.

7.3. European FP7 ICT IP “Advanced Sensors and lightweight Programmable middleware for Innovative Rfid Enterprise applications” (ASPIRE) 2008-2010

Participants: Nicolas Debray, Nathalie Mitton [contact], Loïc Schmidt, David Simplot-Ryl, Lei Zhang.

ASPIRE will research and provide a radical change in the current RFID deployment paradigm through innovative, programmable, royalty-free and privacy friendly middleware. This new middleware paradigm will be particular beneficial to European SME, which are nowadays experiencing significant cost-barriers to RFID deployment.

European networked enterprises in general and SME in particular are still reluctant to adopt RFID, since they perceive RFID as unprofitable or too risky. This is largely due to the fact that the adoption of RFID technology incurs a significant Total Cost of Ownership (TCO). ASPIRE will significantly lower SME entry costs for RFID technology, through developing and providing a lightweight, royalty-free, innovative, programmable, privacy friendly, middleware platform that will facilitate low-cost development and deployment of innovative RFID solutions. This platform will act as a main vehicle for realizing the proposed swift in the current RFID deployment paradigm. The ASPIRE middleware platform will take into account innovative European developments in the area of ubiquitous RFID-based sensing (i.e., physical quantities sensing (temperature, humidity, pressure, acceleration), mobile sensing) towards enabling novel business cases that ensure high ROI (Return on Investment). The ASPIRE RFID middleware paradigm, as well as the unique and novel characteristics of the ASPIRE middleware platforms are thoroughly described in this proposal.

List of participants: Aalborg University - CTiF (Danemark), INRIA-ObjectWeb (France); INRIA-POPS (France), Université Joseph Fourrier - Grenoble University - LIG Laboratory (France), Research and Education Laboratory in Information Technologies - Athens Information Technology (Greece), Melexis technologies SA (Switzerland), Open Source Innovation Ltd (United Kingdom), NORMAPME European Office of Crafts, Trades and SMEs for Standardisation (Belgium), Dimitropoulos - VICOP LTD (Greece), Pole Traceability Valence PV (France), Instituto Telecomunicaoes (Italy).

http://www.aspire-project.eu/.

7.4. ANR RNRT "Réseaux hétérogènes Intelligents pour Situations de Risques" (RISC) 2007-2010

Participants: Jean Carle [contact], Sylwia Romaszko.

This project is a RNRT project (Réseau National de la Recherche en Télécommunications http://www.telecom.gouv.fr/rnrt/).

The RISC project (Réseaux hétérogènes Intelligents pour Situations de Risques) focuses on heterogeneous networks in the context of civil safety. The goal is to study and define the communication from physical to network layer process in a crosslayer optimization. This network is heterogeneous since it contains mobile and static nodes, with variable bandwidth. Furthermore, some nodes have the ability to monitor the environment. This heterogeneity comes from realistic deployment where different kind of nodes must operate in the same global network. For example, in safety operation context, mobile nodes are human with portable radio in the field of operations, fixed nodes correspond to radios infrastructure link to external world (i.e. headquarters). Sensors are also used to support current action: Static sensors are used to monitor the environment. Mobile sensors could be placed on human to monitor either environmental constants or human biological constants during operation.

The project is organized around two axes:

- Research and implementation of innovative technical methods taking into account heterogeneity of the network and in-use constraints.
- Crosslayer optimization which guaranty significant improvement for the performances. In the context of mobile ad hoc wireless environment, heterogeneity tighten up the need of crosslayering methods.

List of participants: CRESTIC, ENST Paris, ETIS, LIFL, RTS Electronics, Thales Communication.

http://risc.univ-reims.fr/.

7.5. "Infrastructure pour le COMmerce du futur" (ICOM) 2007-2009

Participants: Roudy Dagher, Grégory Guche, Nathalie Mitton [contact], Loïc Schmidt, David Simplot-Ryl.

This project is lead in the framework of the competitiveness cluster of trade industry of Nord-Pas de Calais PICOM (Pôle des Industries du COMmerce). Trade industry are being in constant evolution. The massive apparition of the Internet, the increasing exigence of quality of service, the ubiquitous and pervasive informatics shatter the traditional trade practices, their economical and organizational models.

ICOM (Infrastructure pour le COMmerce du futur) aims at helping enterprises regarding a fast and easy deployment of new applications using new technologies and infrastructures from ubiquitous informatics. It will provide a smart infrastructure which hides the heterogeneity of identifiers (RFID, NFC, bar code) and manages data storage and request routing to provide scalability.

List of participants: Atos Origin (H. Jost), Auchan (B. Courouble), Décathlon (E. Lecointe), La Poste (J. Estienne), La Redoute (F. Gitton), INRIA-ASAP (A. Viana), INRIA-ADAM (L. Duchien), INRIA-POPS (N. Mitton), GS1 (N. Pauvre), ORANGE France (D. Dufresne).

7.6. ANR TLCOM “Very large open wireless sensor networks” (SensLab) 2008-2010

Participants: Tony Ducrocq, Nathalie Mitton [contact], David Simplot-Ryl, Julien Vandaële.

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. Ambient and sensor networks have recently emerged as a premier research topic. Sensor networks are a promising approach and a multi-disciplinary venture that combines computer networks, signal processing, software engineering, embedded systems, and statistics on the technology side. On the scientific applications side, it covers a large spectrum: safety and security of buildings or spaces, measuring traffic flows, environmental engineering, and ecology, to cite a few. Sensor networks will also play an essential role in the upcoming age of pervasive computing as our personal mobile devices will interact with sensor networks dispatched in the environment.

The SensLab platform will be distributed among 4 sites and will be composed of 1,024 nodes. Each location will host 256 sensor nodes with specific characteristics in order to offer a wide spectrum of possibilities and heterogeneity. The four test beds will however be part of a **common global test bed** as several nodes will have global connectivity such that it will be possible to experiment a given application on all 1K sensors at the same time.

When deployed, SensLab would be a unique scientific tool for the research on wireless sensor networks.

List of participants: INRIA-ARES, INRIA-ASAP, INRIA-POPS, Thales Communication S.A. (V. Conan), UPMC-LIP6, ULP-LSIIT. http://www.senslab.info/.

7.7. INRIA ADT "Software and Hardware Toolbox for the Wireless Sensor Network Testbed" (SensTools) 2008-2009

Participants: Nathalie Mitton [contact], David Simplot-Ryl, Julien Vandaële.

The main and most important goal of the SensTOOLS ADT project is to foster the design, development, tuning, and experimentation of real large scale sensor network applications. Sensor networks have recently emerged as a premier research topic. However, due to their massively distributed nature, the design, implementation, and evaluation of sensor network applications, middleware, and communication protocols are difficult and time-consuming tasks. The purpose of the SensTOOLS is to provide both software and hardware toolboxes in order to offer to the developer appropriate tools and methods for designing, testing and managing his/her large scale large scale wireless sensor network applications.

List of participants: INRIA-ARES, INRIA-ASAP, INRIA-POPS.

7.8. FUI “DEveloppement de CARTon Electronique” (DECARTE) 2008-2010

Participants: Grégory Guche, Nathalie Mitton [contact], David Simplot-Ryl.

The DECARTE project, labelized by the competitiveness clusters MAUD (Matériaux Utilisations et Développement Durable), of the Trade Industry PICOM (Pôle de compétitivité de l’Industrie et du COMmerce), PFA (Pôle de compétitivité Filiaire Aquatique) and Textil (Uptex Pôle de compétitivité textile innovant) consists in demonstrating the technical feasibility and economic integration of a RFID system printed on packaging during their manufacturing process in mass production. So with a new feature of a non-visual low unit cost, these new electronic packages will offer the opportunity to develop communicating solutions all along the distribution chain.

List of participants: Cartonneries de Gondardennes (Bertrand Helle), Cascades Blendecques, Etik Ouest, Gic, Cartonneries de Gondardennes, CTP, INRIA POPS, IEMN and IFTH.

7.9. ANR SESUR 2007 “Securing Flow of INformation for Computing pervasive Systems” (SFINCS) (2008-2010)

Participants: Arnaud Fontaine, Gilles Grimaud [contact], Samuel Hym, Isabelle Simplot-Ryl.

The upsurge of a globally interconnected network of devices have had a deep impact on the environment, habits and even typology of computing devices end-users. These advances changed our behavior in a lot of beneficial ways but also gave way to new threats that feed decades-old fears about liberty. Preserving privacy and security are thus more than ever at the heart of service users and providers concerns.

In an open, heterogeneous and highly concurrent context, enforcing private and business data confidentiality requires, beyond basic access control, fine-grained control over data usage by the various actors. This problem is known from the literature as information flow control. Information flow analysis has been actively investigated for several years, leading to a rich theory. This problem has usually been tackled from a type-checking or static analysis viewpoint. However, it appears that this rich theory has been scarcely applied in the industry.

The SFINCS project aims at studying application of this theory on practical use-cases to identify bottlenecks that prevent wider industrial adoption of information flow control techniques. To this end, project SFINCS brings together complementary partners: From case studies provided by industrial partners, academic partners shall enrich information flow theory to take into account practical issues preventing thorough analysis of ubiquitous software systems. Provided case studies come from distance selling services and mobile telephony and thus will provide a wide array of the diverse problems encountered in the enforcement of needed security and privacy properties.

This project addresses varied problems:

- Software engineering and programming problems, like analysis of programs using shared libraries through public APIs or external streams (eg. XML),
- Theoretical problems about information analysis, like tracking information in arrays or collections,
- Security engineering problems, like expressing of security rules or selective authorization of information leaking through safe channels (eg. using cryptography).

List of participants: LIFL (G. Grimaud, S. Hym, I. Simplot-Ryl), LIF, Univ. of Provence (J.-M. Talbot), VERIMAG (Laurent Mounier, Michael Périn, Yassine Lakhnech, Pascal Lafoucarde), NORSYS/SI3SI (Pascal Flamant, Arnaud Bailly), Trusted Labs (Anthony Ferrari, Erci Vétillard).

http://sfincs.gforge.inria.fr/.

7.10. ANR VERSO 2009 “Widening Interoperability for Networking Global Supply Chains” (WINGS) (2009-2011)

Participants: Nathalie Mitton [contact], Roberto Quilez, Loïc Schmidt, David Simplot-Ryl.

As we move forward towards ambient intelligence environments where most devices are connected to seamless, ubiquitous networks, inter-enterprise interoperability becomes an essential condition. The next phase of the supply chain development will improve robustness and increase reach. Such a shift of focus from small localized activities to large cross-company and cross-country networks will require both more complete and more comprehensive data sets. This implies efficient data synchronization, guaranteed data availability and improved data security. The exciting opportunities come from the fact that this scenario will integrate complex networks composed of a huge amount of different types of objects - forming the so-called Internet of things or rather Intranet of Goods as it can be designed in a networked business-to-business world.

This increase in scale for the network also demands the development of an architecture framework that will allow an open governance model. The WINGS project focuses on the large scale EPCGlobal network as being part of the Internet of Things and in which, as designed, a single ONS (Object Naming Service) root is in existence today. What's more, the operation of this root has been entrusted to an US-based company by EPCGlobal Inc. Given the importance of ONS systems in a near future, it is becoming urgent to develop alternative solutions to break the current centralized architecture and the monopoly of a single company.

For ensuring the further interconnection and the interoperability of these roots, the project partners propose to design and evaluate a multi-root ONS system that will take into consideration security, stability, performance as well as interaction with DS (Discovery Services). The aim is to show that several ONS roots can work together and safely share the management and the governance of the network.

List of participants: GS1 France (Nicolas Pauvre), INRIA POPS, PMC (Marcelo Dias de Amorim), AFNIC (Mohsen Souissi), Orange Labs (Dominique Le Hello), GREYC (Jacques Madelaine). http://sfincs.gforge.inria.fr/.

7.11. FP7-ICT "Security Engineering for lifelong Evolvable Systems" (SecureChange) (2009-2011)

Participants: Donia El Kateb, Arnaud Fontaine, Gilles Grimaud [contact], Samuel Hym, Isabelle Simplot-Ryl.

Software-based systems are becoming increasingly long-living. This was demonstrated strikingly with the occurrence of the year 2000 bug, which occurred because software had been in use for far longer than its expected lifespan. At the same time, software-based systems are getting increasingly security-critical since software now pervades the whole critical infrastructures dealing with critical data of both nations and also private individuals. There is therefore a growing demand for more assurance and more verified security properties of IT systems both during development and at deployment time, in particular also for long living systems. Yet a long lived system also needs to be flexible, to adapt to changes and adjust to evolving requirements, usage and attack models. However, using today's system engineering techniques we are forced to trade flexibility for assurance or vice versa.

The objective of the project is thus to develop techniques and tools that ensure "lifelong" compliance to evolving security, privacy and dependability requirements for a long-running evolving software system. This is challenging because these requirements are not necessarily preserved by system evolution.

The project will develop techniques, tools, and processes that support design techniques for evolution, testing, verification, re-configuration and local analysis of evolving software. The project results will be applied and evaluated in particular in the industrial application domains of mobile devices, digital homes, and large scale air traffic management which all offer both great research challenges and long-term business opportunities.

List of participants: Università degli Studi di Trento (Italia), Budapest University of Technology and Economics (Hungary), Gemalto (France), INRIA (France), Katholieke Universiteit Leuven (belgium), Smartesting (France), Open University (United Kingdom), Stiftelsen for industiell og teknisk forskning ved Norges Tekniske Hogskole (Norway), Thales (France), Telefonica Investigacion y Desarrollo Sociedad Anonima Unipersonal (Spain), University of Innsbruck (Austria), Deep Blue (Italia), Technische Universität Dortmund (Germany)

7.12. INRIA ARC "MobIle SubStItution Networks" (MISSION) (2010-2011)

Participants: Nathalie Mitton, Enrico Natalizio, Tahiry Razafindralambo [contact], David Simplot-Ryl.

A fleet of mobile routers could be used to deploy a substitution network in order to help an already existing network (called base network hereafter) that is faced to difficulties (like, for instance, an equipment failure, a power failure, or a high traffic increase). Due to its autonomous mobile components and to the use of wireless links, the substitution network is very likely to have a limited capacity compared to the base network. Therefore a very careful deployment and management of the substitution network is required.

list of participants: POPS (Tahiry Razafindralambo), RESO (Isabelle Guérin-Lassous), UPMC/Paris 6 (Marcelo Dias de Amorim).

7.13. INRIA ADT "SENSor network ApplicationS" (SENSAS) (2010-2013)

Participants: Lucie Jacquelin, Nathalie Mitton [contact], Tahiry Razafindralambo, David Simplot-Ryl.

The objectives of the SENSAS action is to support innovative application development of several project-teams in the field of sensor/actuator and/or robot fleets. From the strong experience gained in the area of sensor networks, we will capitalize on hardware and software in order to speed-up the achievement of components which will facilitate the set-up of new applications.

list of participants: ALIEN, AMAZONES, DEMAR, D-NET, MADYNES, NECS, POPS.

7.14. ANR VERSO "Federating Computing Resources (F-Labs) (2010-2013)

Participants: Nathalie Mitton [contact], Tahiry Razafindralambo, David Simplot-Ryl.

The F-Lab project works towards enabling an open, general-purpose and sustainable large-scale shared experimental facility that fosters the emergence of the Future Internet. F-Lab builds on a leading prototype for such a facility: the OneLab federation of testbeds. F-Lab will enhance the OneLab federation model with the addition of SensLAB's unique sensor network and LTE-based cellular systems, and develop tools to conduct experiments on these enriched facilities.

Project partners include some of France's top industrial academic and industrial research institutions, working together to develop experimental facilities on the Future Internet.

F-Lab presents an unique opportunity for the French community to play a stronger role in the design of federation systems; for the SensLAB testbed to reach an international visibility and use; and for the pioneering of testbeds based on LTE technology.

List of participants: UPMC/Paris 6, INRIA (D-NET, PLANETE, POPS), Thalès, Alcatel-Lucent.

7.15. ANR ECOTECH "Bin That Thinks" (2010-2013)

Participants: Tony Ducrocq, Michaël Hauspie, Nathalie Mitton [contact], David Simplot-Ryl.

Pervasive Computing, also known as Ambient Computing, aims at a tight integration of computing into the real world in such a way as being invisible to the users. Pervasive computing enable common real world activities to impact directly and implicitly information systems, and enable information systems to be sensitive to events of the real world. As such, pervasive computing is especially relevant in the current trends of public policies to reduce the environmental impact of human activities. Pervasive computing offers innovative solutions to some of the current ecological challenges, combining technologies such as RFID or sensors networks, computing systems supporting application and services, and actuators able to generate actions into the real world (adapting lighting, activate a fire-extinguisher or simply signaling information with a LED light or a screen). In the Ecotech framework, several tracks are interesting to explore in order to propose innovative solutions to to waste management and waste recycling challenges. BinThatThinks introduces a global approach spanning eco-design to industrial developments. This requires to deploy pervasive sensing systems while preserving privacy. A first on the field application would be developed in the context of waste selective collecting. This application would enable to reject non compliant waste which today increase dramatically the cost for waste management operators. In addition, it would improve the feedback regarding the waste management process and products lifecycles for both waste management operators, the public collectivities, and ultimately the citizen.

List of participants: Etinéo, INRIA (ACES, POPS), Véolia.

7.16. ANR VERSO "RESeau Coordonné de sUbstitution mobilE" (RESCUE) (2010-2013)

Participants: Nathalie Mitton, Tahiry Razafindralambo [contact], David Simplot-Ryl.

Access and metropolitan networks are much more limited in capacity than core networks. While the latter operate in over-provisioning mode, access and metropolitan networks may experience high overload due to evolution of the traffic or failures. When no backup networks are available, it would be interesting to deploy, for a limited time corresponding to the period of the problem (i.e., failure or traffic overload), a substitution network to help the base network keep providing services to users. In the RESCUE project, we will investigate both the underlying mechanisms and the deployment of a substitution network composed of a fleet of dirigible wireless mobile routers. Unlike many projects and other scientific works that consider mobility as a drawback, in RESCUE we use the controlled mobility of the substitution network to help the base network reduce contention or to create an alternative network in case of failure.
List of participants: UPMC/Paris 6, INRIA (POPS, RESO), LAAS, Orange Labs.

7.17. European CATRENE Project eGo (2010-2013)

Participants: Gilles Grimaud [contact], Michaël Hauspie, Isabelle Simplot-Ryl.

The eGo project offers an innovative way to establish wireless bidirectional channels of communication between objects and users. Using signal transmission via the user's body, every eGo-compliant object you touch is "paired" with the eGo device you carry on you, close to your skin. The objective is to enable very intuitive, very simple applications where touching a device turns into a personalization of such a device to install, for example, the user's rights and credentials. "what you touch is yours".

eGo offers a vast horizon of new intuitive applications, making user interfaces as simple as possible.

eGo will be prototyped, integrated in several form factors in miniaturized system (System In Package) for new sensors, new batteries, ultra low-power transmitters for intrabody communication (via a natural connector: human skin), a highly secure micro controller comparable to those embedded in smart cards, a large data storage capacity and a high performance, high-speed wireless (Ultra Wide Band) transmitters.

Embedded software, including JavaCard technology and secure remote management (Trusted Service Management) for managing services will also be integrated.
List of participants: CIT, Continental Automotive, Decawave, Gemalto, IDEX ASA, INRIA, Lincor Solutions Ltd, Precise Biometrics, STMicroelectronics, Tyndall, Yougetitback Ltd.

7.18. International Relationship

We have research activities with international partners as:

- Edgar Chavez, Univ. Morelia, Mexico,
- Essia Hamouda, Riverside University, Los Angeles, USA,
- Ivan Stojmenović, Univ. Ottawa, Canada.
- Issa Traoré, Univ. of Victoria, Canada.

Isabelle Simplot-Ryl is guest scientist of the EMERGENCY project (Mobile decision support in emergency situations) funded by the Research Council of Norway under the VERDIKT research program (2008–2012)

8. Dissemination

8.1. Editorial Activities

- **David Simplot-Ryl** is managing editor of *Ad Hoc & Sensor Wireless Networks: An International Journal (AHSWN)* (Old City Publishing), associate editor of *International Journal of Computers and Applications (IJCA)* (ACTA Press), member of editorial board of *International Journal of Wireless and Mobile Computing (IJWMC)* (Inderscience) and of editorial board of *International Journal of Parallel, Emergent and Distributed Systems (IJPEDS)* (Taylor & Francis).

8.2. Organization Committees and Program Committees (Conferences, Workshops, Schools)

- **Gilles Grimaud** is a program committee member of CARDIS 2010 and Sponsorship Co-Chair of EuroSys 2010.
- **Michael Hauspie** is a program committee member of *The 8th ACS/IEEE International Conference on Computer Systems and Applications 2010* and *International Conference on Mobile Communications and Pervasive Computing (MCPC 2010)*.
- **Nathalie Mitton** is a program committee member of WWANS 2011, AdHocNets 2011, SETIT 2011, Algotel 2011, WiSARN 2011, CMC 2011, MSN 2010, ADHOCNOW 2010, DCA-WSN 2010, AdHocNets 2010, WiSARN 2010. She is publicity chair of MASS 2011, AdHocNow 2011, SPECTS 2011, WiSARN 2010, SPECTS 2010.
- **Tahiry Razafindralambo** is a program committee member of 2010, PE-WASUN 2010, MSWIM 2010, JDIR 2010. He is publicity chair for PE-WASUN 2010.
- **David Simplot-Ryl** is member of several program committees like AdHocNets 2010, IEEE MASS 2010-2011, IEEE INFOCOM 2011, IEEE WOWMOM 2011.
- **Isabelle Simplot-Ryl** is a program committee member of several international events like IEEE ICC 2010, IEEE LCN 2010, DEPEND 2010, HumanCom 2010, FTfJP 2010, SAR-SSI 2010, IMIS 2010, PST2010, UIC2010, IEEE GLOBECOM 2010, IEEE ICC 2011

8.3. Teaching

- **Jean Carle** is director of a vocational degree in computer sciences (licence professionnelle). He is also in charge of lecture in Mobile Networking for master degree in computer science, of lectures in *Networking and Data Communication* to under degree in computer science (IUT 1^{st} and 2^{nd} year) and in *Algorithm* to under degree in computer science (IUT 1^{st} year).
- **Gilles Grimaud** is in charge of lectures in *Embedded Systems* for research master (Master Recherche), of lecture in *Security of Networks and Systems* for professional master (Master TIIR), of lecture in *Operating Systems Architecture* for master of computer science (maîtrise), and of lecture in *Networking* in computer science degree (licence).
- **Michael Hauspie** is in charge of lectures in *Software engineering*, *Networking*, *Operating Systems* and *Network services administration* in under degree in computer science and vocational degree in computer science (IUT 1^{st} and 2^{nd} year/licence professionnelle).
- **Samuel Hym** is in charge of lectures in *Introduction to Programming* to first-year students and *Operating systems* to continuing education students.
- **Nathalie Mitton** is in charge of lectures in *Mobile Networking* for research master (DEA), in *Networking for Autonomous Systems* for professional master (DESS) and in *Transmission and Protocols* for vocational degree in computer science (licence professionnelle).

- **Tahiry Razafindralambo** is in charge of lecture in *Networking for Autonomous Systems* for professional master (DESS) and an Introduction to Computer Networks for (IUT 2nd).
- **Isabelle Simplot-Ryl** is in charge of lectures in systems programming to vocational degree in computer science (licence professionnelle), and of Lectures in Security in master.
- **Marie-Emilie Voge** is in charge of lectures in *Algorithms and simulations for wireless networks* to research master students (master TAC), in *Algorithmics* in computer science applied to enterprise management degree (licence MIAGE) and in *Algorithmics* to second-year students.

9. Bibliography

Publications of the year

Doctoral Dissertations and Habilitation Theses

[1] S. DUQUENNOY. *Smews : un système d'exploitation dédié au support d'applications Web en environnement contraint*, Universite Lille1 – Sciences et Technologies, Lille, France, July 2010, in french.

[2] L. SCHMIDT. *Passage Ã l'échelle des intergiciels RFID pour l'informatique diffuse*, Universite Lille1 – Sciences et Technologies, Lille, France, December 2010, in french.

[3] T. SOETE. *Couche logicielle bas niveau efficace pour interface radio Ã faisceaux agiles*, Universite Lille1 – Sciences et Technologies, Lille, France, December 2010, in french.

Articles in International Peer-Reviewed Journal

[4] A. COURBOT, G. GRIMAUD, J.-J. VANDEWALLE. *Efficient Off-board Deployment and Customization of Virtual Machine-based Embedded Systems*, in "ACM Transactions on Embedded Computer System", 2010, vol. 9, n° 3, p. 160–175, http://dx.doi.org/10.1145/1698772.1698779.

[5] A. M. HOOLE, I. TRAORÉ, I. SIMPLOT-RYL. *Application of Contract-based Security Assertion Monitoring Framework for Telecommunications Software Engineering*, in "Mathematical and Computer Modelling", 2011, to appear.

[6] N. MITTON, B. SERICOLA, S. TIXEUIL, E. FLEURY, I. GUÉRIN-LASSOUS. *Self-Stabilization in Self-Organized Multi-Hop Wireless Networks*, in "Ad Hoc & Sensor Wireless Networks", 2011, vol. 11, n° 1-2, p. 1–34, to appear.

[7] I. STOJMENOVIC, D. SIMPLOT-RYL, A. NAYAK. *Toward Scalable Cut Vertex and Link Detection with Applications in Wireless Ad hoc Networks*, in "IEEE Network", 2011, to appear.

International Peer-Reviewed Conference/Proceedings

[8] G. COGNIAUX, G. GRIMAUD. *Key-Study to Execute Code Using Demand Paging and NAND Flash at Smart Card Scale*, in "Proc. Int. Conf. Complex, Intelligent and Software Intensive Systems (CISIS 2010)", Los Alamitos, CA, USA, IEEE Computer Society, 2010, p. 794–799, http://doi.ieeecomputersociety.org/10.1109/CISIS.2010.175.

[9] G. COGNIAUX, G. GRIMAUD. *Key-Study to Execute Code Using Demand Paging and NAND Flash at Smart Card Scale*, in "Proc. 9th IFIP Int. Conf. Smart Card Research and Advanced Application Conference (CARDIS 2010)", Passau, Germany, Lecture Notes in Computer Science, Springer, 2010, vol. 6035, p. 102–117, http://hal.archives-ouvertes.fr/inria-00529489/.

[10] T. DUCROCQ, J. VANDAELE, N. MITTON, D. SIMPLOT-RYL. *Large Scale Geolocalization and Routing Experimentation with the SensLAB Testbed*, in "Proc. 7th IEEE International Conference on Mobile Ad-hoc and Sensor Systems (IEEE MASS 2010)", San Francisco, USA, 2010, Demo.

[11] S. DUQUENNOY, G. GRIMAUD. *Efficient Web Requests Scheduling Considering Resources Sharing*, in "Proc. 18th IEEE/ACM Int. Symp. Modeling, Analysis and Simulation of Computer and Telecommunication Systems (MASCOTS'2010)", Miami Beach, FL, USA, 2010, p. 410–412, Poster paper, http://hal.archives-ouvertes.fr/inria-00514501/en/.

[12] P. EVERAERE, I. SIMPLOT-RYL, I. TRAORÉ. *Double Spending Protection for E-Cash based on Risk Management*, in "Proc. 13th Information Security Conference (ISC 2010)", Boca Raton, FL, USA, M. BURMESTER, G. TSUDIK, S. MAGLIVERAS (editors), Lecture Notes in Computer Science, Springer, 2010, vol. 6531, p. 394–408, http://hal.inria.fr/inria-00544937/.

[13] A. FONTAINE, S. HYM, I. SIMPLOT-RYL. *On-Device Control Flow Verification for Java Programs*, in "Proc. Engineering Secure Software and Systems (ESSoS 2011)", Madrid, Spain, Lecture Notes in Computer Science, Springer, 2011, to appear.

[14] A. GHADDAR, T. RAZAFINDRALAMBO, I. SIMPLOT-RYL, D. SIMPLOT-RYL, S. TAWBI. *Towards Energy-Efficient Algorithm-Based Estimation in Wireless Sensor Networks*, in "Proc. 6th International Conference on Mobile Ad-hoc and Sensor Networks (MSN'10)", Hangzhou, China, 2010, http://www.computer.org/portal/web/csdl/doi/10.1109/MSN.2010.12.

[15] A. GHADDAR, T. RAZAFINDRALAMBO, I. SIMPLOT-RYL, S. TAWBI, A. HIJAZI. *Algorithm for Data Similarity Measurements to Reduce Data Redundancy in Wireless Sensor Networks*, in "Proc. 1st Int. Workshop on Wireless Sensor, Actuator and Robot Networks (WiSARN 2010)", Montreal, Canada, IEEE Computer Society, 2010, p. 1–6.

[16] A. GHADDAR, T. RAZAFINDRALAMBO, I. SIMPLOT-RYL, S. TAWBI, A. HIJAZI. *Algorithm for Temporal Anomaly Detection in WSNs*, in "Proc. IEEE Wireless Communications & Networking Conference (WCNC 2011)", Cancun, Mexico, IEEE Communications Society, 2011, to appear.

[17] A. A. KASSEM, N. MITTON. *Adapting Dynamically Neighbourhood Table Entry Lifetime in Wireless Sensor Networks*, in "Proc. 10th International Conference on Wireless Communications and Signal Processing (WCSP 2010)", Suzhou, China, 2010, Best paper award.

[18] F. KHADAR, N. MITTON, D. SIMPLOT-RYL. *Towards an Efficient QoS based Selection of Neighbors in QOLSR*, in "Proc. 3rd Int. Workshop on Sensor Networks (SN 2010)", Genoa, Italy, 2010, p. 152–160, http://hal.archives-ouvertes.fr/hal-00504964/en/.

[19] X. LI, N. MITTON, I. SIMPLOT-RYL, D. SIMPLOT-RYL. *A Novel Family of Geometric Planar Graphs for Wireless Ad Hoc Networks*, in "Proc. 30th IEEE Int. Conf. Computer Communications (INFOCOM 2011)", Shanghai, China, 2011, to appear.

[20] T. RAZAFINDRALAMBO, N. MITTON, A. C. VIANA, M. DIAS DE AMORIM, K. OBRACZKA. *Adaptive Infrastructure Deployment for Data Gathering in Intermittently Connected Networks*, in "Proc. IEEE Int. Conf. Pervasive Computing and Communication (PerCom 2010)", Mannheim, Germany, 2010, p. 51–59, http://hal.archives-ouvertes.fr/hal-00472656/en/.

[21] T. RAZAFINDRALAMBO, D. SIMPLOT-RYL. *Connectivity Guarantee during Wireless Sensor Networks Deployment*, in "Proc. 1st Int. Workshop on Wireless Sensor, Actuator and Robot Networks (WiSARN 2010)", Montreal, Canada, 2010, p. 1–6, http://dx.doi.org/10.1109/WOWMOM.2010.5534951.

[22] S. ROMASZKO, J. CARLE, F. NOLOT. *Ad Hoc Routing Protocol Analysis in Civil Safety Context*, in "Proc. 9th IFIP Mediterranean Ad Hoc Networking workshop (Med-Hoc-Net 2010)", Juan les Pins, France, 2010, p. 1–6, http://dx.doi.org/10.1109/MEDHOCNET.2010.5546873.

[23] A. C. VIANA, N. MITTON, L. SCHMIDT, M. VECCHIO. *A k-layer self-organizing structure for product management in stock-based networks*, in "Proc. 7th IEEE International Conference on e-Business Engineering (ICEBE 2010)", Shanghai, China, 2010, http://hal.inria.fr/inria-00544752/.

[24] G. YAN, N. MITTON, X. LI. *Reliable Routing in Vehicular Ad hoc Networks*, in "Proc. 7th Workshop on Wireless Ad hoc and Sensor Networks (WWASN 2010)", Genoa, Italy, 2010, p. 263–269, http://hal.archives-ouvertes.fr/hal-00504715/en/.

National Peer-Reviewed Conference/Proceedings

[25] E. HAMOUDA, N. MITTON, B. PAVKOVIC, D. SIMPLOT-RYL. *Vers un Protocole de Routage Géographique Économe en Énergie de Bout en Bout avec Garantie de Livraison*, in "Proc. 12-iemes Rencontres Francophones sur les Aspects Algorithmiques de Télécommunications (Algotel 2010)", Belle Dune, France, 2010, http://hal.archives-ouvertes.fr/inria-00472651/fr/.

Scientific Books (or Scientific Book chapters)

[26] X. LI, A. NAYAK, D. SIMPLOT-RYL, I. STOJMENOVIC. *Sensor Placement in Sensor and Actuator Networks*, in "Wireless Sensor and Actuator Networks: Algorithms and Protocols for Scalable Coordination and Data Communication", Wiley & Sons, 2010, http://eu.wiley.com/WileyCDA/WileyTitle/productCd-0470170824.html.

[27] N. MITTON, T. RAZAFINDRALAMBO, D. SIMPLOT-RYL. *Position-Based Routing in Wireless Ad Hoc and Sensor Networks*, in "Theoretical Aspects of Distributed Computing in Sensor Networks", Springer, 2010, http://www.springer.com/computer/theoretical+computer+science/book/978-3-642-14848-4.

[28] N. MITTON, L. SCHMIDT, D. SIMPLOT-RYL. *RFID Middleware: Concepts and Architecture*, in "RFID Systems: Research Trends and Challenges", Wiley, 2010, p. 155–177, http://eu.wiley.com/WileyCDA/WileyTitle/productCd-0470746025.html.

Books or Proceedings Editing

[29] M. BOLIC, D. SIMPLOT-RYL, I. STOJMENOVIC (editors). *RFID Systems: Research Trends and Challenges*, Wiley, 2010, http://eu.wiley.com/WileyCDA/WileyTitle/productCd-0470746025.html.

Research Reports

[30] A. FONTAINE. *Integration of XML streams in information flow analysis for Java*, INRIA, 08 2010, n^o 0387, http://hal.inria.fr/inria-00511118/en/.

[31] X. LI, N. MITTON, I. SIMPLOT-RYL, D. SIMPLOT-RYL. *Planarisation de Graphes dans les Réseaux Ad-hoc*, INRIA, 07 2010, n^o 7340, http://hal.archives-ouvertes.fr/inria-00504683/fr/.

[32] S. ROMASZKO, J. CARLE. *QoS Ad Hoc Routing Protocol Analysis in Civil Safety Context*, INRIA, 07 2010, n^o RR-7358, http://hal.archives-ouvertes.fr/inria-00506968/en/.

[33] L. SCHMIDT, R. DAGHER, R. QUILEZ, N. MITTON, D. SIMPLOT-RYL. *DHT-based distributed ALE engine in RFID Middleware*, INRIA, 06 2010, n^o 7316, http://hal.archives-ouvertes.fr/inria-00491795/en/.

[34] A. C. VIANA, N. MITTON, L. SCHMIDT, M. VECCHIO. *SElf-orgaNizing Structures for mAnagemenT In stock Oriented Networks*, INRIA, 02 2010, n^o 7192, http://hal.archives-ouvertes.fr/docs/00/45/41/09/PDF/RR-7192.pdf.

References in notes

[35] M. ILYAS (editor). *The Handbook of Ad Hoc Wireless Networks*, CRC Press, 2003.

[36] *Java Card Web Site*, http://java.sun.com/products/javacard.

[37] C. PERKINS (editor). *Ad Hoc Networking*, Addison Wesley, 2001.

[38] I. STOJMENOVIĆ (editor). *Handbook of Wireless Networks and Mobile Computing*, John Wiley & Sons, 2002.

[39] I. AKYILDIZ, W. SU, Y. SANKARASUBRAMANIAM, E. CAYIRCI. *Wireless Sensor Networks: a Survey*, in "Computer Networks", 2002, vol. 38, p. 393–422.

[40] K. FINKENZELLER. *RFID Handbook: Radio-Frequency Identification Fundamentals and Applications*, John Willey & Sons, 1999.

[41] C.-K. TOH. *Ad Hoc Mobile Wireless Networks: Protocols and Systems*, Prentice Hall, 2001.