INSTITUT NATIONAL DE RECHERCHE EN INFORMATIQUE ET EN AUTOMATIQUE

Project-Team POPS

System & Networking for Portable Objects Proved to be Safe

Futurs

THEME COM

Activity Report

2005

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1. Team

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2. Overall Objectives

2.1. Overall Objectives

Keywords: *Embedded operating system*, *POPS*, *ad hoc networks*, *exo-kernel*, *mobility*, *smart card*, *wireless networking*, *wireless sensor networks*.

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) [46], wireless sensors (see Fig. 2) [44] or personal digital assistants. Such small devices are characterized by limited resources, high mobility, frequent disconnection, low-bandwidth communication, passive (no battery) or limited battery life and reduced storage capacity. Moreover, in spite of these constraints and the use in 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 [41], 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 disconnection, long roundtrip times, high bit error rates and small bandwidth. Hence, POPS systems have to adapt themselves to application requirements or modification of the environment. One can also point out that:

- First, "the POPS adjustment to the environment" reverses the current habits in which POPS are typically deployed in an environment prepared to host POPS according to the requirements imposed by the device interface such as its communication protocol.

[1] since October 1, 2005, Damien occupies a postdoctoral position in Seattle, USA

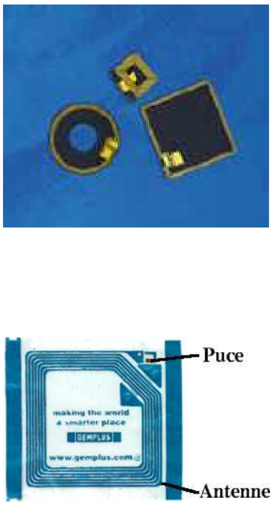


Figure 1. Example of RFID tags.

On the top of that, the environmental software is typically tailored to interact with POPS applications according to requirements imposed by the functionality provided by the POPS after it has been issued. Here, one part of our motivation is to focus on the adaptability of the POPS network means and operating system that are essential to enable POPS applications to adjust their behavior to the environment.

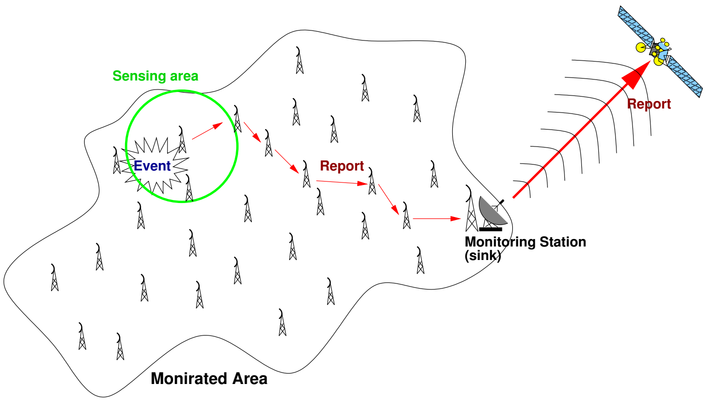
- Second, "the environment in which POPS find themselves operating" highlights the fact that POPS will play a key role in future infrastructures if they are generic enough to be able to discover their environment and to inter-operate with it.
  Here, the other part of our motivations is to focus on the generic nature and the maintainability of POPS network means and operating system that are essential to enable POPS devices to persist in a changing environment.

POPS research action takes advantage of its strong partnership with Gemplus since more than 14 years. This collaboration brings both partner (the RD2P research group of LIFL and Gemplus) 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 RD2P research group) smart card was the only valuable and industrially deployed POPS. Smart card integration in databases 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 RD2P research. More recently we have focused our attention (according to our industrial inputs) on embedded operating systems 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

Event-driven model



On-demand model

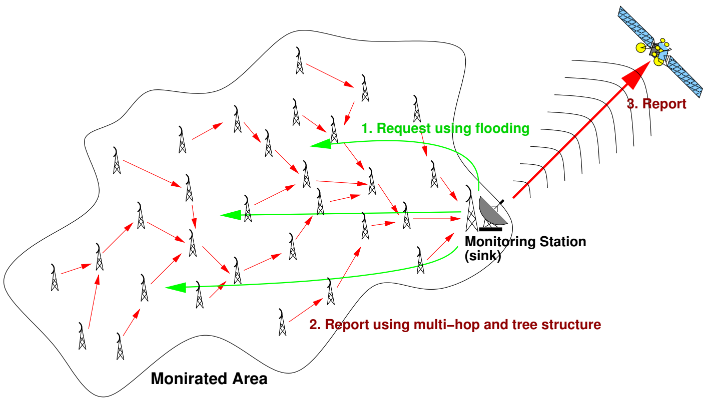


Figure 2. Example of sensor network with event-driven and on-demand models.

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 three 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 ensure 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 communication with other entities. This fact motivates our focussing on the ad hoc network communication model which is the most flexible model.

Indeed wireless ad hoc networks [51], [42], [43], [40] cover 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 has 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 power consumption by battery operated POPS. In service access problem, such as multi-hop wireless Internet (hybrid network, see Fig. 3), 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 problem (detecting neighboring nodes located within transmission radius) and network organization problem (deciding what communication links to establish with neighboring nodes, sleeping period operations 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.

3. Scientific Foundations

3.1. Scientific Foundations

Keywords: *Embedded operating system*, *POPS*, *ad hoc networks*, *exo-kernel*, *mobility*, *smart card*, *wireless networking*, *wireless sensor networks*.

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

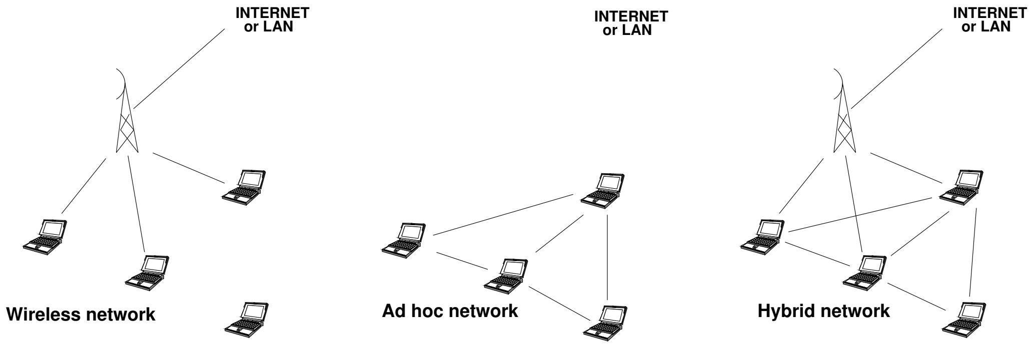


Figure 3. From wireless network to hybrid networks.

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 roundtrip times, high bit error rates and small bandwidth. Hence, POPS systems have to adapt themselves to applications requirements or modifications of their environment. In this context, we are conducting research in the two following connected areas:

- **Embedded Operating Systems**, focusing on operating systems and virtual machines scalability (in terms of memory, microchip performance and energy) where smart cards are our reference target. Our main activities deal with the scalability of Java abstractions (the "Java in the Small" sub-project) and efficient, extensible and safe hardware management (the "Camille NG" sub-project).
- **Mobile Networking**, focusing on communication protocols on wireless network architectures, in ad hoc or wireless LAN mode, using or not fixed infrastructure. Our protocols aim to ensure secure connectivity and QoS enhancement of dense large networks which are constituted of small devices with high mobility.

POPS software architecture has never stopped evolving. Since birth of smart cards (for instance) in the early eighties, we can distinguish four different generations of software architectures, from the rough, monolithic "smart card mask" to the ultra light "post-issuance" open kernel. Nevertheless, all software generations are still used today. A rough monolithic smart card OS is the only way (known by the industry) to product low-end/low-cost smart cards. "Post-issuance OS" like Java Card are sold for the high-end market.

The smart card example has shown that embedded software is a huge family. In fact, according to the limited capabilities provided by the hardware, an embedded application offers "limited" functionality. Nevertheless the omnipresence of the POPS (over 10^9 smart card around the world today) implies a great diversity of software. And the Subscriber Identification Module (SIM) inserted in our GSM, is very different from sensors used in wireless sensor networks. All of them are supported by a powerless hardware with limited resources (memory, CPU and energy). They all suppose the use of dedicated APIs and tools. They are built over dedicated underlying operating systems...

Supporting at the same time the whole set of abstractions used by each possible embedded application is obviously impossible. To overcome this technological lock our research group has proposed to embed the use of Exo-Kernel architecture [45]. Exo-kernel architecture consists in suppressing any abstraction consideration in the (Operating System) kernel design.

Basically if we consider the conception of a conventional file system, we can define three internal layers (see Fig. 4). In a conventional "monolithic OS" The bottom layer manages the hardware, allocating sectors, or flash memory pages, programming the burn of data, etc...The second layer implements basic software to simulate a virtual device easier to administrate and to use: “the file system”. The top layer manages the software security by controlling the files access. In a μ-kernel, the ‘kernel’ of the operating system does not support a preferred abstraction but only manage (in a preferred way) the hardware and offer a safe and secure access for different abstractions implementations. In this way, μ-kernels allows the coexistence of multiple hardware abstractions. But recent results contest the performances of such OS architectures. In an operating system the performances of provided abstractions are greatly improved when they are correlated to the adequate hardware management. That’s why Exo-Kernels architects claim that “the exo-kernel must offer a safe hardware exposition without any abstraction”. Software applications must be able to access the hardware and manage it according to their own goals. It is the best way to ensure dynamic adaptability to the applications requirement.

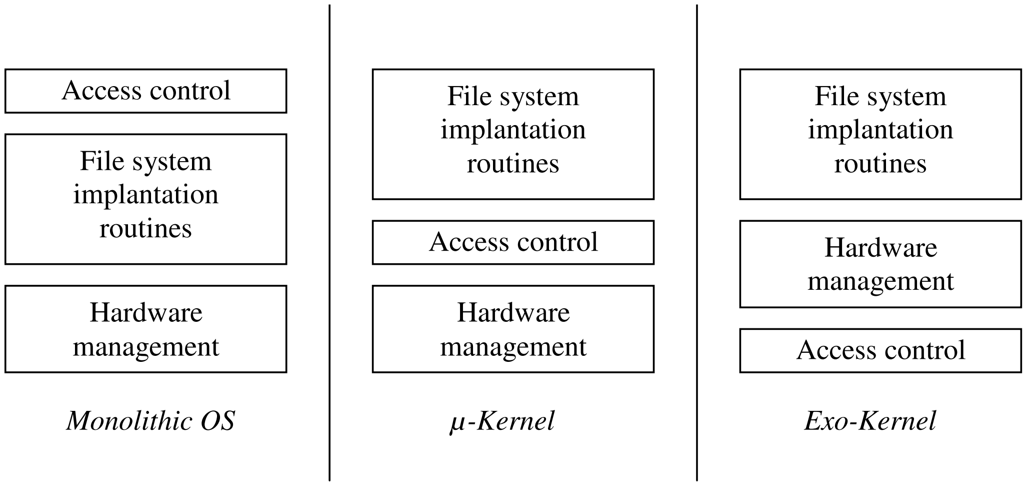


Figure 4. From monolithic OS to exo-kernel architecture.

We have proved the feasibility of this kind of kernel in a tiny device. However, it is an incomplete purpose because some hot OS topics can be loaded in a safe way. Safety is ensured statically, while the OS component is loaded. The Kernel Trusted Computing Base uses the “Proof Caring Code” principles [50]. Nevertheless, the current Camille OS defines security in terms of confidentiality and integrity, not in term of availability. Problems are related to Real Time software and Resource Control. These goals are one of our next actions called Camille NG.

Smart card is probably one of the most limited devices in the POPS family. Important industrial efforts were made to invite Java developers to deploy Java software on cards. Nevertheless tiny operating systems like Java Card OS does not really satisfy Java developers. In this way, our work around Camille (supporting dynamic extensions of the embedded OS) looks insufficient. In fact Camille enables multiple hardware abstractions justified by multiples applications needs. However, real powerful abstractions, like those proposed by Java technologies, were clearly not deployed in POPS. To invite conventional software designer to deploy they work on POPS we propose to study new OS approach to deploy Java In The Small.

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

The most suitable kind of network for POPS are wireless ad hoc networks which cover a wide range of self-organized network types. Ad hoc networks are multi-hop networks consisting of wireless autonomous hosts, where each host may serve as a router to assist traffic from other nodes. Wireless ad hoc networks cover a wide range of network scenarios, including sensor, mobile ad hoc, personal area, and rooftop/mesh networks. Sensors provide service to monitoring stations. Mobile ad hoc networks are pure infrastructure-less networks used in disaster relieves, conferences, hospitals, campus and battlefield environments, with laptops, palmtops, cellular phones or other devices serving as nodes. Rooftop/mesh networks provide high-speed wireless Internet access to homes and offices.

Nodes (hosts) in an ad hoc network can be static or mobile, and can switch between active and sleeping modes. The control is distributed, thus each POPS makes independent decisions following a common pre-established protocol. An ad hoc network may be linked to a fixed infrastructure (to receive or provide service) or can function on its own. Wireless networks of sensors are likely to be widely deployed in the near future because they greatly extend our ability to monitor and control the physical environment from remote locations and improve our accuracy of information obtained via collaboration among sensor nodes and online information processing at those nodes. Networking these sensors will revolutionize information gathering and processing in many situations (*e.g.* monitoring and reporting fires, chemicals, intruders etc.). Home or office appliances can be networked in a personal area network, with input from a fixed station or mobile human. Rooftop networks are static networks with nodes placed on top of buildings. They are applied in the mesh-networking approach, where the neighborhood is 'seeded' by the installation of a 'neighborhood access point' (NAP), a radio base-station connected to the Internet via a high-speed connection. Homes and offices within range of this NAP install antennas of their own, enabling them to access the Internet at high speed. Each of these homes and offices can also act as a relay for other homes and offices beyond the range of the original NAP. As the mesh grows, each node communicates only with its neighbors, which pass Internet traffic back and forth from the NAP. It is thus possible to cover large area quickly and cheaply. For providing fixed-wireless access, the mesh approach is technically superior to the traditional 'point-to-multipoint' radio approach. It requires much less power, offers multiple paths for choosing the quickest route, is robust and scales up easily. Ad hoc networks will make communications technology useful for people everywhere regardless of nature and availability of backbone infrastructure.

In a crowded environment, such as sport arena, phones could pass traffic from other phones to base stations in adjacent cells, thus boosting capacity. Reduced power also reduces the interferences when a call is multi-hopped to the same base station instead of being directly transmitted. Calls between users within the arena could be handled locally, without loading the cellular network.

Commercial developments of wireless networks have been so far basically limited to the single hop scenarios, with one link between a mobile node and the fixed infrastructure (*e.g.* cellular telephony), or between two mobile/wireless nodes (*e.g.* Bluetooth short range technology). Single-hop wireless networks already pose significant challenges due to limited bandwidth and battery power restrictions. Multi-hop wireless networks can be modeled as a graph, with two nodes joined by an edge if and only if they are able to directly communicate with each other. The most popular model in literature is the model of a unit graph. In a unit graph, a message sent by any node reaches simultaneously all its neighbors whose distance to the transmitting node is no more than the transmission radius, which is equal for all nodes. Variations of the model includes adding obstacles, having different transmission radii for each node, or introducing minimum and maximum transmission radii, where nodes closer than minimum radius receive message, farther than maximum radius, do not receive message, and uncertain reception in between the two radii.

The selections of best data communication protocols at the network layer are certainly affected by developments, current and future, on other layers below and above the network layer. For instance, the physical layer decides whether omni directional or directional antennas are used. If antennas are omni directional, which is a typical assumption, then a message sent by one node can be simultaneously received by all its neighbors (so called one-to-all model). Some recent developments exploit the use of directional 'smart' antennas, fixed narrow beam (reaching only one neighbor, one-to-one model), wide fixed beam, or variable angular size beam antennas (one-to-many models). The ultra-wideband (UWB) transmission involves transmitting very short pulses on a wide range of frequencies simultaneously at low power. Such pulses, less than billionth of a second long, pass unnoticed by conventional radio receivers, but can be detected by a UWB receiver. Information is encoded into streams of pulses, millions of which can be sent every second, by varying their polarity or their timing relative to an apparently random but pre-arranged schedule. UWB received a massive boost in February 2002, when it received limited approval for transmissions up to about ten meters. UWB is capable of data rate of over 100 megabits per second on such short distances. Work is well advanced on the standard to enable UWB devices to locate and communicate with each other. Ad hoc networking is expected to receive further boost after adopting UWB

transmission. Infrastructure-less, ad hoc UWB networks are also called 5G.

The current ‘popular’ choices, or dilemmas, at the medium access control (MAC) layer is between IEEE 802.11 where all POPS communicate on the same channel, and the Bluetooth that uses frequency hopping and master-slave relations. The design of medium access layer for UWB transmission is under way. UWB supports existing 802.11, 802.15.3 and HiperLan MAC standards but they do not exploit position-aware information enabled by UWB.

The research on wireless ad hoc, sensor and local area networks is booming recently within both computer science and electrical engineering communities. Both ACM and IEEE organize symposia exclusively dedicated to ad hoc networks, now in the second and third years of existence. This is in addition to increasing number of papers on ad hoc networks at main events such as IEEE INFOCOM, ACM MOBICOM, IEEE ICC, IEEE Int. Symp. on Computers and Communications, IEEE Parallel and Distributed Symposium, and IEEE Int. Conf. Distributed Computing. Despite of the enormous interest in ad hoc networks (due to upcoming commercial applications), satisfactory solutions for some fundamental problems in their operation, such as routing, broadcasting, multicasting, and network organization, are still not found.

4. Application Domains

4.1. Application Domains

Keywords: *Telecommunication*, *ambient computing*, *banking application*, *environment..*, *military area*.

Application domain of our research activities is very wide since it concerns domains commonly addressed by smart object issues:

- individual authentication in information systems, like in banking system (bank smartcards), mobile phone system (SIM cards) or wireless networking (smartcard for Wi-Fi),
- adaptable and robust networking, like in infrastructure less communication system (military communication system or emergency communication system),
- ambient computing which uses intensively POPS,
- environment surveillance systems which can use wireless sensor networks.

5. Software

5.1. Java In The Small

Keywords: *Java-OS*, *embedded system*.

Participants: Alexandre Courbot [Corresponding author], Gilles Grimaud, Kevin Marquet, David Simplot-Ryl.

Java's initial goal 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 restrains 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 doesn'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://www.lifl.fr/RD2P/JITS.

5.2. CAMILLE NG

Keywords: *Exo-kernel*, *embedded system*, *extensibility*, *real-time*.

Participants: Nadia Bel Hadj Aissa [Correspondig author], Damien Deville, Gilles Grimaud.

The Camille operating system (a dedicated exo-kernel) aims at supporting the various hardware resources used in smart cards, without specializing abstractions. The architecture principle is very similar to the MIT Exo-Kernel principles and concepts. The Camille OS provides the following three basic characteristics. Portability is inherited from the use of an intermediate code and by a limited set of hardware primitives. Security is ensured by a code-safety checking (which uses a PCC-like algorithm) at loading time. Extensibility is provided through a simple representation of the hardware that at the root of the system does not predefine any abstraction. Thus, applications have to build or import abstractions which match their requirements. The Camille splitted architecture is described Fig. 5.

The usual downside of extensibility is performance. For some parts of the OS that require efficiency, Camille uses Just-in-Time techniques to compile intermediate code into native one. Increased performance also comes from the exo-kernel approach that does not introduce abstraction penalties in the core of the OS. Because smart cards have limited computing power, additional hardware independent optimizations are also performed out of the card, while the source code is translated to FACADE. A more precise description of Camille, and experimental results as well can be found in [5]. The Camille prototype demonstrates the feasibility of an extensible smart card OS that has reasonable footprint: 17 KB of native code in which 3.5 KB for code verification, 8.5 KB for native code generation, and the rest for hardware multiplexing.

CAMILLE NG platform can be found at the URI http://www.lifl.fr/RD2P/CAMILLE.

5.3. SimTag: a simulator for anti-collision protocol design for RFID Tags

Keywords: *RFID tags*, *anti-collision*.

Participant: David Simplot-Ryl.

SimTag is a simulator dedicated to anti-collision protocols. It includes protocols from ISO-18000-3 standard [47] and allows to test numerous parameters. It has been used by engineers from Gemplus and TagSys to tune their own protocols that are now included in standards.

SimTag can be found at the URI http://www.lifl.fr/RD2P/SimTag/Index.

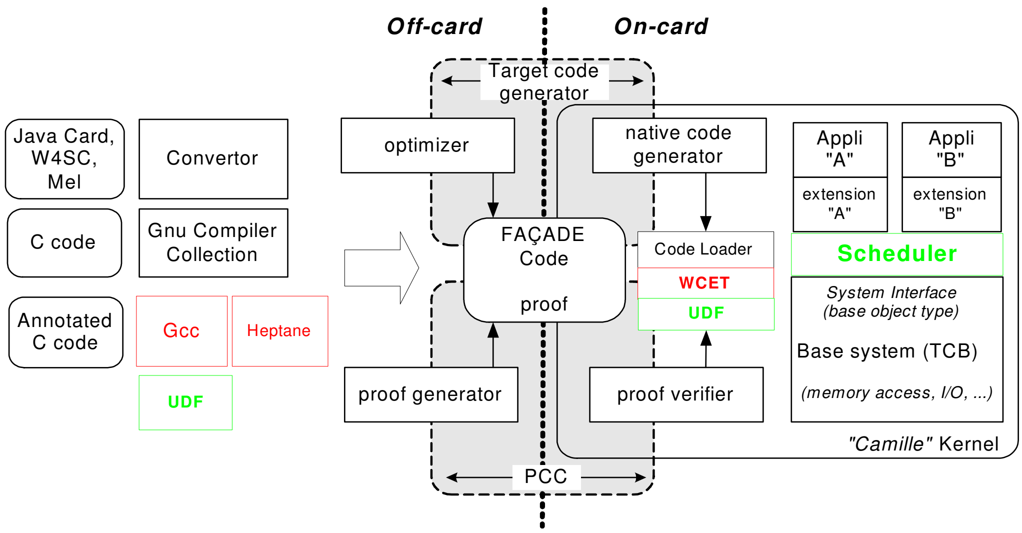


Figure 5.

6. New Results

6.1. Activity Scheduling in Wireless Sensor Networks

Keywords: *Networked sensors, activity scheduling, energy conservation*.

Participants: Jean Carle, Antoine Gallais, David Simplot-Ryl.

Sensor networks consist of autonomous nodes with limited battery powers. Nodes have to be turned off to extend the lifespan of the network without compromising neither area coverage nor network connectivity. This paper addresses this area coverage problem assuming communication range is greater or equal to sensing range. The goal is to minimize the number of active sensors and also to reduce the amount of messages needed to make decisions. Our solution is fully localized, and each sensor is able to make decision on whether to sleep or to be active based on two messages sent by each sensor. The first message is a ’hello’ message to gather position of all neighboring nodes. Then each node computes its own relay area dominating set, by taking the futhest neighbors as the first node, and then adding neighbors farthest to the center of mass of already selected neighbors, until the area covered by neighbors is fully covered. the second message broadcasts this relay set to neighbors. Each node decides to be active if it has smallest priority (which could depend on energy) among its neighbors or is a relay node for its neighbor with the smallest priority. Our experiments show that our algorithm performs better than competing ones that use low number of messages per each node [23][22].

In [28], we propose several localized sensor area coverage protocols, for arbitrary ratio of sensing and transmission radii. Sensors are assumed to be time synchronized, and active sensors are determined at the beginning of each round. The approach has a very small communication overhead since prior knowledge about neighbor existence is not required. Each node selects a random timeout and listens to messages sent by other nodes before the timeout expires. Sensor nodes whose sensing area is not fully covered (or fully covered but with a disconnected set of active sensors) when the deadline expires decide to remain active for the considered round, and transmit a message announcing their activity status. There are four variants in our approach, depending on whether or not negative and retreat messages are transmitted. Covered nodes decide to sleep, with or without transmitting a negative acknowledgment to inform neighbors about the status. After hearing from more neighbors, active sensors may observe that they became covered, and may decide to alter their original decision and transmit a retreat message. Experimental results with ideal MAC layer show that, for a similar number of selected active sensors, our methods significantly reduce number of messages to decide activity compared to existing localized protocol, where nodes send hello message followed by negative acknowledgments from passive nodes. We also consider a MAC layer with collisions, and show that existing compared method, for dense networks, fails to cover the area reasonably (nodes may decide to sleep since some withdrawal messages are not received, creating coverage holes). Our methods, however, still remain robust in terms of high area coverage with reasonable amount of active nodes, despite some message collisions.

A survey about energy efficient backbone construction, broadcasting, and area coverage in sensor networks has been written for the *Handboo of Sensor Networks* [20].

6.2. Efficient MAC Layers for Wireless Devices

Keywords: *MAC layer*, *RFID*, *Wireless communication*, *fairness*.

Participants: Farid Naït-Abdesselam, Hervé Meunier, David Simplot-Ryl, Mahmoud Taïfour.

The first result in this area concerns anti-collision protocols for RFID tags. RFID is a technology for tracking objects that is expected to be widely adopted in very near future. A reader device sends probes to a set of RFID tags, which then respond to the request. A tag is recognized only when it is the only one to respond to the probe. Only reader has collision detection capability. The problem we consider here is to minimize the number of probes necessary for reading all the tags, assuming that the number of tags is known in advance. Well known binary and n-ary partitioning algorithms can be applied to solve the problem for the case of known number of tags. In [36], [18] , we propose a new randomized hybrid tag identification protocol which combines the two partitioning algorithms into a more efficient one. The new scheme optimizes the binary partition protocol for small values of n (*e.g.* $n = 2, 3, 4$). The hybrid scheme then applies n-ary partition protocol on the whole set, followed by binary partition on the tags that caused collision. We proved analytically that the expected number of time slots in the hybrid algorithm with known number of users is $< 2.20 \cdot n$. Performance of these algorithms was also evaluated experimentally, and an improvement from $e.n$ to approximately $2.15 \cdot n$ was obtained.

The last results in MAC layer address the fairness and efficiency of medium access in wirelessa ad hoc network. The IEEE 802.11 MAC layer is known for its low performances in wireless ad hoc networks. For instance, it was shown in the litterature that two independent emitters nodes can easily monopolize the medium, preventing other nodes to send packets. The protocol we introduce in this article is a simple variation of the original 802.11 MAC layer which significantly increases the fairness while maintaining a high effective bandwidth. Its principle consists in avoiding systematic successive transmissions by the same emitter through the probabilistic introduction of a waiting time, a virtual NAV, after each emission. The probability to set a NAV is adaptively computed depending on the perceived utility of the previous virtual NAV. This protocol, called PNAV (Probabilistic NAV) [24], [13], is shown to be effi- cient by simulation and is compared to another 802.11 adaptation.

Another aspect of enhancements designed for IEEE 802.11 CSMA/CA scheme is its capacity improvement. In fact, we have found that a large bandwidth capacity is wasted due to many collisions. To improve the channel capacity, we have designed a new Backoff algorithm named Neighborhood Backoff Algorithm (NBA). A novel feature of the NBA scheme is its neighborhood consideration, in which every node modifies its Backoff interval according to the number N of its neighbors. In order to find the optimum parameters for NBA, we have studied the Backoff intervals as function of different number of active nodes (N) in a single transmission area. We have found that the minimum contention window is proportional to the number of neighbors. Our experiments show a better behavior of the NBA scheme in comparison to the BEB (Binary Exponential Backoff) scheme defined in IEEE 802.11 CSMA/CA [38].

Because ad hoc networks deploy multi-hop routing protocols, where each node, in addition to its own packets, has to forward packets belonging to other nodes, selfish behavior may represent a significant advantage for a node, saving his battery power and reserving more bandwidth for its own traffic. However, if a large number of nodes start to misbehave, the network may break down completely, depriving all users from communicating. To avoid possible misbehaviors in wireless ad-hoc networks, compensation has to be made in order to encourage all the nodes in routing other nodes' packets without any degradation of their own data transmission.

While there has been a lot of research work on improving fairness in the presence of hidden terminals or high load of congestion, to the best of our knowledge there is no research work focusing on the differentiation between the own and routed data traffic to achieve fairness improvement. In our previous work [49], we have designed a routing-aware adaptive MAC (RAMAC) for IEEE 802.11 technology, which uses a routing based Backoff algorithm instead of the legacy binary exponential Backoff, to take into account the routing role of a given node. This new mechanism has showed all its effectiveness in the presence of nodes participating in routing and other nodes which are only using the routing service of intermediate nodes. However, the proposed RAMAC mechanism favors too much the routing nodes in comparison to the non routing nodes. In order to minimize this problem, we introduced enhancements to RAMAC by (1) differentiating between routed and own packets on top of the MAC layer, and (2) by smoothing the multiplicative factor involved in the computation of the new contention window value, in order to reach a better fairness in sharing the bandwidth [19].

6.3. Energy Efficient Networking for Small Devices

Keywords: *Energy efficiency*, *broadcasting*, *hybrid networks*, *multi-hop wireless communications*, *routing*.

Participants: François Ingelrest, David Simplot-Ryl.

In ad hoc and sensor networks, the simplest and most widely used approach to broadcast is blind flooding, which lets every node in the network to rebroadcast a receiving packet to all its neighbors. This causes redundancy of broadcast packets and results in unnecessary collision and bandwidth waste. To overcome these problems, a number of research groups have proposed more efficient broadcasting schemes with the goal of minimizing the re-transmissions, while still guaranteeing that a broadcast packet is delivered to all the nodes in the network. Multipoint relay (MPR) and dominating set (DS) based broadcasting schemes can effectively improve the broadcasting efficiency while providing reliable broadcasting. The neighbor elimination scheme (NES) can improve any broadcasting protocol as an added feature. In [32], we evaluate the performance of MPR (source dependent),MPR-DS (sourceindependentMPR), and DS based broadcasting protocols.We add NES to these three schemes separately and evaluate the performance of the resulted protocols. In our experiments, we use the random unit graphs to model the ad hoc and sensor networks. Each of the studied protocols has scenarios under which it has the best performance. Our experiments demonstrate that, without applying neighbor elimination scheme, MPR based protocol requires fewest retransmissions (however, each retransmission is with a longer message including list of forwarding neighbors). DS and MPR-DS schemes benefit significantly from the neighbor elimination technique in terms of the ratio of re-broadcasting nodes and the message redundancy on both transmitting and non-transmitting nodes, while MPR benefits marginally. After adding the neighbor elimination scheme, three new protocols behave almost equally well in terms of rebroadcast message counts. MPR-NES method is narrowly the best when the message that is broadcasted is very large one, and the network is dynamic. MPR-DS-NES is narrowly the best when the broadcast message is not very large, and the network is stable (this method requires the third round of preprocessing HELLO messages). Overall, DS-NES appears to be the most robust, taking all measurements and parameters into acount, because it remains competitive under all scenarios, and has significant advantages over MPR-DS-NES in dynamic scenarios, and significant advantages over MPR-NES when the broadcast message is not very large, because MPR has overhead in packet lengths.

In the minimum energy broadcasting problem, each node adjust its transmission power to minimize the total energy consumption while still guaranteeing the full coverage of the network. We consider both topology control and broadcast oriented protocols, for which all existing solutions require global network information.

In [12], we describe new localized protocols where nodes require only local informations about their neighborhood (distances or geographic positions). In addition to this, our protocols are shown experimentally to be comparable to the best known globalized BIP solution. Our solutions are based on the use of neighbor elimination scheme applied on the relative neighborhood graph (RNG) and local minimum spanning tree (LMST) which preserve connectivity and are defined in localized manner. Two variants are proposed, one with timeout applied on nodes receiving message from non-RNG (non-LMST) neighbor and retransmitting immediately otherwise (unless list of RNG or LMST neighbors in need of the message is empty), and one with timeout applied on all the nodes. We proved that LMST is a subset of RNG, which explains why LMST always performs better among the two.

In [17], we focus on the question of range adjustment. Indeed, the energy consumption of an emission highly depends on the chosen radius r, as the most commonly accepted energy model defines it to be equal to $r^\alpha + c_e$, α and c_e being two environment dependent constants. We first show that, when $c_e > 0$, it is not an optimal behavior to minimize the range at each node since more transmissions are needed to perform the broadcasting. Furthermore, we demonstrate the existence of an optimal transmission radius and theoretically compute its value, which is experimentally confirmed. We also consider the energy consumption upon reception of a message (which is equal to a constant c_r regardless of the distance between the two nodes) and demonstrate that there still exists an optimal radius. Then, we present two localized broadcasting protocols that make use of the concept of an optimal radius, by using a target radius as a parameter: the first one, TR-LBOP, computes the minimal radius needed for connectivity and increases it up to the target one after having applied a neighbor elimination scheme on a reduced subset of direct neighbors. The second one, TRDS, adapts the network topology and computes a connected dominating set, so that the distance between direct dominant neighbors is as near as possible to the optimal radius. The latter can take any arbitrary value in these two protocols, depending on the chosen constants for the considered energy model (which mainly depends on the environment). Finally, some experimental results for both protocols are given, as well as comparisons with other existing efficient protocols, localized or not. Those comparisons show that our protocols are efficient and correctly take the given target radius into account.

One of the best known algorithm, named BIP (Broadcast Incremental Power), constructs a spanning tree rooted at a given node. This protocol offers very good results in terms of energy savings, but its computation is unfortunately centralized, as the source node needs to know the entire topology of the network to compute the tree. Many localized protocols have since been proposed, but none of them has ever reached the performances of BIP. Even distributed versions of the latter have been proposed, but they require a huge transmission overhead for information exchange and thus waste energy savings obtained thanks to the efficiency of the tree. In [33], we propose and analyze a localized version of this protocol. In our method, each node is aware of the position of all the hosts in the set of its 2-hop neighborhood and compute the BIP tree on this set, based on information provided by the node from which it got the packet. That is, a tree is incrementally built thanks to information passed from node to node in the broadcast packet. Only the source node computes an initially empty tree to initiate the process. We also provide experimental results showing that this new protocol has performances very close to other good ones for low densities, and is very energy-efficient for higher densities with performances that equal the ones of BIP.

In [34], we consider hybrid ad hoc networks, which are composed of two kinds of nodes, regular ones and nodes with additional capabilities. For example, multi-hop cellular and wireless Internet networks consist of static or mobile nodes, and fixed access points which provide an access to an infrastructure. In such a network, each node may use direct or multihop link to connect to an access point, allowing a greater mobility. The goal of this paper is to provide protocols for broadcasting data in such an environment, by taking advantage of the presence of access points to optimize the broadcast, either from an energy consumption or from a latency point of view. We thus consider known protocols for pure ad hoc networks and adapt them to hybrid ad hoc networks. These protocols are the Blind Flooding, the Neighbor Elimination Scheme, the Multipoint Relay protocol and the generalized Self-Pruning Rule (algorithm that elects some dominant nodes to relay messages). We give some experimental data for these modified protocols to compare them to their original version, so that we are able to emphasize the gain obtained thanks to our proposed modifications.

A survey about routing and broadcasting in hybrid ad hoc and sensor networks has been written for the *Handbook on Theoretical and Algorithmic Aspects of Sensor, Ad Hoc Wireless, and Peer-to-Peer Networks* [15].

It has been recently highlighted that the standard unit disc graph (UDG) used to model the physical layer in ad hoc networks does not reflect real radio transmissions, and that the log-normal shadowing (LNS) model better suits to experimental simulations. Therefore, many existing communication protocols must be adapted in order to still be efficient using the LNS model. In [39], we consider broadcasting using this model and especially focus on the Multipoint Relay protocol (MPR). In the latter, each node has to choose a set of neighbors to act as relays in order to cover the whole 2-hop neighborhood. We give experimental results which show that the original heuristics provided to select the set of relays does not give good results with the LNS model. We also provide three new heuristics in replacement and their performances which demonstrate that they better suit to the LNS model. The first one maximizes the probability of correct reception between the node and the considered relays multiplied by their coverage in the 2-hop neighborhood. The second one replaces the coverage by the average of the probabilities of correct reception between the considered neighbor and the 2-hop neighbors it covers. Finally, the third heuristics keeps the same concept as the second one, but tries to maximize the coverage level of the 2-hop neighborhood: 2-hop neighbors are still being considered as uncovered while their coverage level is not higher than a given coverage threshold, many neighbors can thus be selected to cover the same 2-hop neighbors.

Current routing protocols use a best effort strategy to select the path between a source and a destination. Recently, mobile ad hoc networks are facing a new challenge, quality of service (QoS) routing. QoS is concerned with choosing paths that provide the required performances, specified mainly in terms of the bandwidth and the delay. In [37] we propose a QoS routing protocol. Each node forwards messages to their destination based on the information received during periodically broadcasts. It uses two different sets of neighbors: one to forward QoS compliant application messages and another to disseminate local information about the network. The former is built based on 2-hop information knowledge about the metric imposed by the QoS. The latter is selected in order to minimize the number of sent broadcasts. We provide simulation results to compare the performances with similar QoS protocols.

6.4. Security for Mobile Devices

Keywords: *Access control, Networked sensors, Security*.

Participant: David Simplot-Ryl.

Ubiquitous computing is referring to scenarios in which computing is omnipresent, and particularly in which devices that do not look like traditional computers are endowed with computing capability. In ubiquitous computing environments, context information (such as users location, time, etc) can have an impact on business applications and can be used to adapt the security parameters of such applications, e.g. an application can adapt the permission for accessing system files depending on the location of the user. In [29], we propose a framework which addresses the contrast between the easy of use of XML and conventional mechanisms of securing data. Context information is integrated into access control decisions by extending XACML [48] , a generic, XML derived language, used for building security policies. The evaluation of policies takes into account both identity/role of a requester and the environmental context. This way, access is restricted

6.5. Security for Mobile Code and Software Extensions

Keywords: *Mobile code, Proof carrying code, System software components*.

Participants: Damien Deville, Nadia Bel Hadj Aissa, Gilles Grimaud.

Most of classical WCET techniques rely on the fact that all the system is known during conception phase, i.e. hardware and software parts. In the context of mobile code for small devices like smartcards or RFID tags, these assumptions cannot be true because of heterogeneous hardware and unknown software environment. On the other hand, these small devices have not enough computation power to compute themselves the WCET of loaded applications. In [21], we propose a distributed method which allows to generate a portable WCET precomputation, including automatic loop detection, which is given with the mobile code. This pre-computation – which is automatic and do not use annotations – is veri- fied by the mobile host by using a lightweight proof which is embedded in the mobile in PCC manner. We present experimental results by applying our method on the kernel of a smartcard dedicated operating system that proves the validity of the proposed method.

In [14], we propose a solution to guarantee safe interaction to components that are willing to collaborate in an extensible operating system that guaranties isolation. We focus on components used in extensible operating systems for smart objects. We propose a simple way to verify the behaviour of some components using an extension of the type system by addition of argument passing mode information to the method signatures (is the argument read, written, or remembered as reference?). We present a formalization of a PCC-like algorithm (off-card proof generator and on-card proof verifier) to statically check the mode type of the components in the CAMILLE exokernel for smart cards. We apply our technique to ensure trust between collaborative real time extensions with the aim of supporting *safe* dynamic loading of scheduling policy.

We present in [30] an extensible system for small secure embedded devices. We advocate the use of a typed intermediate language as a transformation of various high level languages. We present an extensible type system that unifies in a unique hierarchy some type systems from various source languages and ensures integrity and confidentility. To increase execution efficiency and use flexibility, we propose a dynamic binding mechanism that allows the programmer to describe the bindings of his code without breaking the type system. We also design the whole type system so that future addition of new kinds of objects has as little impact as possible.

6.6. Costumization of JavaOS for Small Devices

Keywords: *Code specialization*, *JVM costumization*, *JavaOS*.

Participants: Alexandre Courbot, Gilles Grimaud, Kevin Marquet, David Simplot-Ryl.

In a first time we have studded the smart card and small device evolution to refine our vision of the new technological lock for dedicated operating system. This case-study is a central element allowing us to concentrate our effort on real innovations rather than on inapplicable results. It was made possible by an effective and efficient partnership with the industry. The quality of this preliminary work is now attested by our significant technological transfer and by the success of our accepted patents.

According to our preliminary studies we have work on dynamic class loading of “real java” binaries. We show that it is possible to reduce the memory consumption of bytecoded classes loaded in an embedded Java virtual machine without reducing its functionalities. Our work related to this topic focus on the constant pool packing by deleting entries which are only used during the loading process. This work conclude the existing digressions about the definition of dedicated binaries formats that reduce software portability while increase the complexity of software deployment schemes [25].

In a second time we have focus our attention on the use of pre-deployment also called the romization process. In this context pre-deployment means deployment on a virtual environment and projection of this virtual environment on the real hardware. This specific kind of deployment allows us to apply dedicated, static and aggressive customizations of the deployed software and under laying operating system. We succeed to apply this principle to reduce the memory footprint of the target virtual machine. In fact, today, embedded virtual machines are defined as a subset of the real one, unfortunately this subset is empirically selected by the industry and failed to match very specific applications. With our technology we can automatically produce an embedded virtual machine base on a subset of the basic one. Each subset is defined according to the pre-deployed applications and so it perfectly matches with supported software. That why our technology is intrinsically better than the handmade one [26].

More recently we have started some additional works on memories management. In a first hand, java platforms provided a homogeneous memory abstraction based on objects allocation an automatic garbage collection. In another hand, embedded hardware provides a large diversity of RAM (Internal and External) EEPROMs, FlashROM, and so one with a lot of specificities. In an embedded virtual machine the memory manager have to fit the hardware and existing work on Object Oriented memory management failed when we apply them on EEPROM for example. A first lock is related to the garbage collection over heterogeneous memories (ROM and RAM for example). We have show new algorithms that deal efficiently with this diversity and in this way we permits a real benefit of the embedded memories without wasting time of the software engineer in charge of development for a dedicated device [35][31].

To experiment our proposal we have build a dedicated platform called JITS (Java In The Small). We succeed to dynamically load and pack "on the fly" a class in the JITS platform. We have also succeeded to reduce the virtual machine for dedicated applications. Finally we are implementing our memory management units to increase the platform performances.

7. Contracts and Grants with Industry

7.1. Gemplus partnership

Participants: Alexandre Courbot, Damien Deville, Gilles Grimaud, Kevin Marquet, David Simplot-Ryl [Scientific responsible].

Since its creation RD2P has been supported by Gemplus within the framework of a partnership agreement that lasts since 14 years. Gemplus has been continuously supported the RD2P research activities though fundings and the sharing of experiences and problems between RD2P and Gemplus Labs researchers.

RD2P has been a provider of innovative technologies for Gemplus 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 Tags), the card system CAMILLE (2000), or the card with multiple execution contexts.

Gemplus and RD2P 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. IST-2002-507894 INSPIRED "Integrated Secure Platform for Interactive Personal Devices" (IP)

Participants: Nadia Bel Hadj Aissa, Gilles Grimaud [contact], David Simplot-Ryl [INRIA representative].

More than other IT domains, the smart card industry is facing the challenge to reinvent itself in the fast moving high-tech area where seamless connection, mobility and security are key aspects. This breakthrough is only possible by changing the fundamentals of the smart card and by creating a new and open technology platform.

The smart card has been successful in providing a first generation of secure, personalized and portable device to millions of users principally in off-line applications such as bank and telecom. INSPIRED will develop the second generation called Trusted Personal Device (TPD) to provide Trust and Security to users and on-line services in the future ambient intelligence and ubiquitous computing environments.

The concept of an individual object representing the root of trust is the paradigm which definitely made the success of the smart card. INSPIRED intends to rely and it and to extend it for the next generation of secure communicating devices.

These devices will have different form factors and features depending of the targeted applications. INSPIRED aims at defining the common technical foundations to allow cost-efficient product developments of devices with extended features and performances that can better be integrated in heterogeneous networks.

The INSPIRED consortium gathers the large majority of the stakeholders in the European smart card arena including the major smart card manufacturers, vendors of chips and sensors for smart cards and leading research institutes. The consortium also includes companies representing users from dynamic market segments such as telecom, electronic ID, on-line services and digital rights management for requirements and concept definition and the validation of the project results.

INSPIRED is in-line with the RTD requirements identified by the RESET roadmap and will deliver the industry standard architectures for next generation devices that will overcome current technology heterogeneity and limitations.

List of participants: Gemplus (France), Schlumberger (France), Giesecke & Devrient (Germany), Oberthur Card Systems (France), Orga (Germany), Philips Semiconductors (Germany), Orange (France), Universidad Rovira i Virgili (Spain), Atmel (France), University of Twente (Netherlands), INRIA (France), Universite Catholiques de Louvain (Belgium), Infineon (Germany), NDS (Israel), Activcard (France) and Everbee (France).

8. Other Grants and Activities

8.1. ACI Sécurité Informatique SPOPS “Système pour POPS” (2003-2005)

Participants: Damien Deville, Gilles Grimaud [contact], David Simplot-Ryl.

List of participants: LIFL Univ. Lille 1 RD2P (G. Grimaud), INRIA Sophia Antipolis (G. Barthe) and Université de Rennes (C. Bidan)

8.2. ACI Sécurité Informatique “models and Protocols for SEcuRity in wireless Ad hoC networks (SERAC)” (2004-2007)

Participants: Farid Naït-Abdesselam [contact], David Simplot-Ryl.

The ACI Project SERAC, funded by the French Ministry of Education and Research, conducts research activities on security in the context of Mobile Ad Hoc Networks. The area of security in ad hoc networks steel partly or not completely explored. High level security requirements for ad hoc networks are basically identical to security requirements for any other communication systems, and include the following services: authentication, confidentiality, integrity, non-repudiation, access control, and availability. However, similar to wireless communication systems (like GSM), which have additional challenges for the implementation of aforementioned services when compared to fixed networks, ad hoc networks can be viewed as an even more extreme case, requiring even more sophisticated, efficient and well designed security mechanisms.
List of participants: USTL (F. Naït-Abdesselam), INRIA Rocquencourt (D. Augot, P. Mühlethaler) and GET (J. Leneutre, A. Cavalli).

8.3. Regional project “Home Communications (COM’DOM)” (2005-2007)

Participants: François Ingelrest, Hervé Meunier, Farid Naït-Abdesselam [contact], David Simplot-Ryl.

The COM’DOM project, funded by the region Nord Pas de Calais, conducts research for designing high data rate radio interface, operating at the 60 Ghz frequencies, for high speed wireless communications in wireless ad

hoc networks. At the same time it focuses in desinging a coupled radio-fiber optics switches to extend indoor connectivity of a wireless ad hoc networks. Beside, the hardware conception and developpement, researchers involved in this project think in the design of new medium access protocol suitable for smart antennas, as well as the desing of new routing and optimization protocols for ad hoc networks.
List of participants: LIFL (F. Naït-Abdesselam) and IEMN (N. Rolland).

8.4. Regional Project "MOdèles et InfraStructures pour Applications ubIQUitairES (MOSAIQUES)" (2005-2007)

Participants: Alexandre Courbot, Gilles Grimaud [contact], David Simplot-Ryl.

Proliferation of hardware and software sensors and others pervasive technologies, motivates the Mosaiques studies on software context-awareness. Context-based software conception and deployment seems the most natural substrate for theses technologies, because it provides the right separation of concerns. However, context-aware software needs to be supported by efficient, distributed, extensible and scalable software technologies. In Mosaiques we studies different ways to overcome theses technological locks.

Combining methodological principles (first axe), dedicated infrastructure supports (second axe), and adaptability validation (last axe) will satisfy the required ability to perform execution of a pervasive software environment over heterogeneous ubiquitous computing supports. In this context the POPS contribution is related to extensible and scalable software infrastructure for constrained devices.
List of participants: LIFL (L. Duchien), LAMIH (S. Lecomte), TRIGONE (A. Derycke), INRETS (C. Gransart), Ecole des Mines de Douai (N. Bouraqadi).

8.5. ARC INRIA "Radio Interface for multi-hop wireless nertworks (IRAMUS)" (2005-2006)

Participants: Jean Carle [contact], Antoine Gallais, François Ingelrest, Hervé Meunier, David Simplot-Ryl.

We participate at the Cooperative Research Initiative from INRIA called IRAMUS (Radio Interface for multi-hop networks). This action aims to propose new trends in the two following axes:

- Realistic modelling and simulation of the MAC-PHY layers for ad-hoc and sensor networks. The solutions should be integrated in standard network simulators.
- Assessment of of PHY-MAC interface in different applicative scenarios. Indeed, low rate sensor networks or high rate ad-hoc networks do not require the same constraints on the PHY-MAC layers.

List of participants: INRIA ARES (J.-M. Gorce), INRIA POPS (J. Carle), IREENA (J.-F. Diouris), FT R&D (P. Senn).

8.6. CNRS national platform "Sensor and Self-Organized Networks (RECAP)"

Miniaturization in micro-electro-mechanical systems (MEMS) has enabled the development of a new kind of networks: Sensor Networks. Sensor networks use small objects able to monitor their close environment such as obtaining a temperature, an air or water pollution level, to detect movements or vibrations, etc. These networks also use one or more monitoring stations (also called sink stations) responsible to collect information from sensors. Using a large number of small inexpensive sensors increases the dependability of surveillance and reconnaissance systems and also decreases the vulnerability of the system to failure. To forward their data (monitoring information, request, etc.), all these nodes use multi-hop wireless communication.

Self-adaptive and self-organized are questions of active research in a number of different research communities, ranging from hardware to applications. Many topics must be study such as topology control (addressing, localization, etc.), data communication (broadcasting, routing, gathering, etc.), architecture (hardware, system -OS-, network -communication stacks-, etc.), applications (service lookup, distributed database, etc.). The RECAP project is a CNRS national platform which aims to support research activities in this area. RECAP is organized in four sub-projects: Applications, Data Communication, Topology Control, and System Architecture.

List of participants: CITI INSA Lyon (E. Fleury), LAAS (M. Diaz), LIFL (J. Carle), LIP6 (M. Dias de Amorim), IRISA (P. Quinton), LSIIT (T. Noël), LSR (A. Duda).

8.7. International Relationship

We have research activities with international partners as:

- Anthony Watson, Univ. Edith Cowan, Australie,
- Peter Honeyman, Univ. Michigan, USA,
- Piet Demeester, Univ. Gent, Belgium.

8.8. Visits and Invitations of Researchers

- Prof. Ivan Stojmenovic from the Univerty of Ottawa was invited in Lille for two month in May and June 2005.
- Prof. Brahim Bensaou from the Hong Kong University of Science and Technology was invited in Lille in December 2005.

9. Dissemination

9.1. Editorial Activities

- **Gilles Grimaud** is member of the program committee of a special issue of the *Ingénierie des Systèmes d'Informations* (Hermes) on "mobility, operating system and data bases".
- **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). He is guest-editor of several special issues:
  - *International Journal on Wireless Mobile Computing* (Inderscience) on "Wireless Ad Hoc Networking" (vol. 1 No. 2-3, April 2005),
  - *Ad Hoc Networks* (Elsevier) on "Topology Control and Energy Efficient Network Protocols in Ad Hoc Networks" (vol. 3 No. 5, September 2005),
  - *IEEE Transactions on Parallel and Distributed Systems* (IEEE Computer Society) on "Localized communication and topology protocols for ad hoc networks" to appear in 2006,
  - *International Journal of Parallel, Emergent and Distributed Systems* (Taylor & Francis) on "System and Networking for Smart Objects" to appear in 2006, and
  - *Journal of Computer Communications* (Elsevier) on "Sensor-Actuator Networks (SANETs)" to appear in 2007.
- **David Simplot-Ryl** and **Gilles Grimaud** are guest-editors of a special issue of *International Journal on Computers and Applications* (IASTED/Acta Press) on "System and Networking for Smart Objects" (vol. 27 No. 1, January 2005).

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

- **David Simplot-Ryl** is chairman of:

  - *2nd International Workshop on Wireless Ad Hoc Networking (WWAN 2005)*, (Colombus, Ohio, USA, 2005) organized in conjunction with *25th IEEE International Conference on Distributed Computing Systems (ICDCS-2005),*
  - *1st International Workshop on System and Networking for Smart Objects (SaNSO 2005)*, (Fukuota, Japan, July 20-22, 2005) organized in conjunction with *The 11th International Conference on Parallel and Distributed Systems (ICPADS-2005),*
  - *1st International Workshop on Localized Communication and Topology Protocols for Ad hoc Networks (LOCAN 2005)*, (Washington, USA, November 7-10, 2005) organized in conjunction with the *2nd IEEE International Conference on Mobile Ad Hoc and Sensor Systems (MASS-2005),*
  - *International Workshop on Wireless Ad hoc and Sensor Networks (WWASN2006)*, (Lisboa, Portugal, July 4-7, 2006) organized in conjunction with the *26th International Conference on Distributed Computing Systems (ICDCS-2006)*.
  - *2nd International Workshop on System and Networking for Smart Objects (SaNSO 2005)*, (Minneapolis, USA, July 12-15, 2006) organized in conjunction with *The 12th International Conference on Parallel and Distributed Systems (ICPADS-2006)*.

  He was publicity chair of the *1st International Workshop On Foundations And Algorithms For Wireless Networking (FAWN'2006)*, (Pisa, Italy, March 13, 2006) organized in conjunction with the *4th Annual IEEE International Conference on Pervasive Computing and Communications (PerCom 2006)*.
  He is member of the steering committee and general vice-chair of the *1st International Conference on Integrated Internet Ad hoc and Sensor Networks (InterSense 2006)*, (Nice, France, May 29-31, 2006).

- **Jean Carle** was program committee member of several international events such as (recent only):

  - *IFIP Int. Conf. on Embedded And Ubiquitous Computing (EUC'2005)*, (Nagasaki, Japan, December 6-9, 2005),
  - *2nd Int. Workshop on Wireless Ad Hoc Networking (WWAN 2005),*
  - *Int. Conf. on Mobile Ad-hoc and Sensor Networks (MSN05)*, (Wuhan, China, December 13-15 2005),
  - *Int. Conf. on Wireless Networks, Communications, and Mobile Computing (WirelessCom 2005)*, (Hawaii, USA, June 13-16, 2005),

- **Gilles Grimaud** is involved in the program committee of national and international events:

  - 4th French conference on operating system (CFSE05) organized in conjunction with RenPar16 and SympA2005 (April 6-10, Le Croisic, France).
  - *IADIS International Conference on Applied Computing 2006 (IADIS AC 2006)* (San Sebastien, Spain, February 25-26).

- **Farid Naït-Abdesselam** is or have been a program committee member of several international events:
  - *2nd International Workshop on Wireless Ad Hoc Networking (WWAN 2005)*, (Colombus, Ohio, USA, 2005) organized in conjunction with the *25th IEEE International Conference on Distributed Computing Systems (ICDCS-2005)*,
  - *3rd IEEE International Workshop on Mobility Management and Wireless Access (IEEE MobiWac 2005)*, (Maui, Hawaii, USA, June 13-16) organized in conjunction with Wirelesscom 2005,
  - *IADIS International Conference on Applied Computing 2006 (IADIS AC 2006)* (San Sebastien, Spain, February 25-26, 2006),
  - *IEEE International Conference on Local Computer Networks (IEEE LCN 2006)* (Tampa, Florida, USA, November 12-16, 2006), and
  - *IEEE Global Telecommunications Conference (IEEE Globecom 2006)*, (San Francisco, California, USA, Nov. 27, 2006).
- **David Simplot-Ryl** is program committee member of several international and national events:
  - *2nd Annual Conference on Wireless On demand Network Systems and Services (WONS 2005)* (St.Moritz, Switzerland, January 19-21, 2005),
  - *First International Workshop on Ubiquitous Smart Worlds (USW 2005)*, (Taipei, Taiwan, March 28-30, 2005), in conjunction with the *19th IEEE International Conference of AINA2005*,
  - *First IEEE Workshop on Information Assurance in Wireless Sensor Networks (WSNIA 2005)* (Phoenix, Arizona, USA, April 7-9, 2005), to be held in conjunction with the *24th IEEE International Performance Computing and Communications Conference (IPCCC 2005)*,
  - *7th Rencontres Francophones sur les Aspects Algorithmiques de télécommunication (AlgoTel 2005)*, (Presqu'île de Giens, France, May 11-13, 2005),
  - *4th Mediterranean Workshop on Ad-Hoc Networks (MED-HOC-NET 2005)*, (Ile de Porquerolles, France, June 21-24, 2005),
  - *11th International Conference on Parallel and Distributed Systems (ICPADS-2005)*, (Fukuota, Japan, July 20-22, 2005),
  - *11th ECOOP Workshop on Mobile Object Systems (ECOOP MOS-11)*, (Glasgow, UK, July 25-29, 2005) in conjunction with the *19th European Conference on Object Oriented Programming (ECOOP 2005)*,
  - *2005 International workshop on Wireless and Sensor Networks Security (WSNS'05)*, (Washington, USA, November 7-10, 2005) organized in conjunction with the *2nd IEEE International Conference on Mobile Ad Hoc and Sensor Systems (MASS-2005)*,
  - *5th International IEEE Workshop on Wireless Local Networks (IEEE WLN 2005)*, (Sydney, Australia, November 15-17, 2005) organized in conjunction with the *30th Annual IEEE Conference on Local Computer Networks (LCN 2005)*,
  - *2nd International Conference on Intelligent Sensors, Sensor Networks and Information Processing (ISSNIP 2005)*, (Melbourne, Australia, December 5-8, 2005),

  - *2nd IFIP TC8 Working Conference on Mobile Information Systems (MOBIS 2005)*, (Leeds, UK, December 6-7, 2005),
  - *2nd International Symposium on Ubiquitous Intelligence and Smart Worlds (UISW2005)*, (Nagasaki, Japan, December 6-7, 2005) organized in conjunction with the *IFIP International Conference on Embedded And Ubiquitous Computing (EUC'2005)*,
  - *International Conference on Mobile Ad-hoc and Sensor Networks (MSN05)*, (Wuhan, China, December 13-15, 2005).
  - *3rd Annual Conference on Wireless On demand Network Systems and Services (WONS 2006)*, (Les Ménuires, France, January 18-20, 2006).
  - *1st International Workshop On Foundations And Algorithms For Wireless Networking (FAWN'2006)*, (Pisa, Italy, March 13, 2006) organized in conjunction with the *4th Annual IEEE International Conference on Pervasive Computing and Communications (PerCom 2006)*,
  - *20th IEEE International Conference on Advanced Information Networking and Applications (AINA 2006)*, (Vienna, Austria, April 18-20, 2006),
  - *2nd IEEE Workshop on Dependability and Security in Sensor Networks and Systems (DSSNS 2006)*, (Maryland, USA, April 24-28, 2005) organized in conjunction with the *2nd NASA/IEEE Systems and Software Week* and the *30th NASA/IEEE Software Engineering Workshop (SEW 2006)*,
  - *8th Rencontres Francophones sur les Aspects Algorithmiques des Télécommunications (AlgoTel 2006)*, (Trégastel, France, 9-12 mai 2006),
  - *7th ACM International Symposium on Mobile Ad Hoc Networking and Computing (MobiHoc 2006)*, (Florence, Italy, May 22-26, 2006),
  - *14th Internation Conference on Real-Time and Network Systems (RTNS'2006)*, (Poitiers, France, May 30-31, 2006),
  - *IFIP 1st International Conference on Ad-Hoc Networking*, (Santiago, Chile, August 20-25, 2006) organized in conjunction with the *19th IFIP World Computer Congress 2006 (WCC 2006)*,
  - *3rd International Conference on Ubiquitous Intelligence and Computing (UIC-06)*, (Wuhan and Three Gorges, China, September 3-6, 2006),
  - *3rd International Conference on Mobile Computing and Ubiquitous Networking (ICMU 2006)*, (London, U.K, October 11-13, 2006), and
  - *IEEE International Conference on Local Computer Networks (IEEE LCN 2006)* (Tampa, Florida, USA, Nov. 12-16).

- The POPS research group organized the *9th Summer School Next Generation Internet* in Montreuil in June 2005.

9.3. Invited Talks and Seminars

- **Gilles Grimaud** gave an invited talk:
  - Evolution récentes des systèmes d'exploitation pour cartes à puces. *Sixième Journée Cryptographie et Sécurité de l'Information* (Limoges, France, 2005).
- **David Simplot-Ryl** gave a number of invited talks:
  - From smart labels to sensor networks. *Rencontres IrisaTech, L'informatique diffuse*, (Rennes, France, 2005).
  - Last research advances in energy-efficient broadcasting for wireless ad hoc networks. *7èmes Rencontres Francophones sur les aspects Algorithmiques des Télécommunications (AlgoTel 2005)*, (Presqu'Ile de Giens, France, 2005).
  - Energy-efficient broadcast protocols for wireless ad hoc networks. *III Workshop on Wireless Networks and Mobile Computing*, (Mexico-City, Mexico, 2005).
  - Anti-collision protocols for RFID tags. *RFID 2005*, (Paris, France, 2005).
  - Active RFID tags and sensor networks. *RFID 2005*, (Paris, France, 2005).
  - From smart labels to smart dusts. *Colloquium Jacques Morgenstern*, (Sophia Antipolis, France, 2005).
  - Localized Algorithms for Energy Efficient Wireless Ad Hoc Networking. *France Telecom Scientific College Seminar: "Ad Hoc Networks: Problems, Applications and Perspectives"*, (Paris, France, 2005).
  - Real-time Issues in Wireless Sensor Networks. *Ecole d'Eté Temps Réel (ETR'05)* (Nancy, France, 2005).
  - JavaOS for Sensor Networks. *First CNRS-RECAP Workshop on Sensor Networks*, (Nice, France, 2005).

9.4. Teaching

- **Jean Carle** is in charge of lecture in Mobile Networking for research masters in computer science (ex-DEA), of lectures in Networking and Data Communication to under degree in computer science and vocational degree in computer science (IUT 2nd year/licence professionnelle).
- **Gilles Grimaud** is in charge of lecture in *Embedded Systems* for research master (DEA), of lecture in *Security of Networks and Systems* for professional master (DESS), of lecture in *Operating Systems Architecture* for master of computer science (maîtrise), and of lecture in *Networking* in computer science degree (licence).
- **Farid Naït-Abdesselam** was responsible of numerous lectures in *Network engineering* and *Mobile Networking* for research and professional masters in computer science (DEA, DESS, ENIC).
- **David Simplot-Ryl** is director of vocational master in computer science applied to enterprise management (IUP MIAGE) in continuous training. He is in charge of lecture in *Computer Organization and Architecture* for computer science degree (licence) and of lecture in *Mobile Networking* for research and professional masters in computer science (maîtrise, DEA, DESS).

9.5. Miscellaneous Scientific Animation

- **Gilles Grimaud** was in the PhD examination committee of Gaël Thomas (LIP6, Univ. Paris 6, directed by Bertil Folliot).
- **David Simplot-Ryl** was referee or examiner for several PhD thesis and Habilitation thesis:
  - Houda Labiod (HDR, ENST Paris), referee,
  - Michaël Hauspie (LIFL, Univ. Lille 1), advisor,
  - Antoine Galland (LIP6, Univ. Paris VI, directed by Bertil Folliot), referee,
  - Mounir Achir (CEA-INPG, directed by Joël Lienard and Laurent Ouvry), referee,
  - Aline Vianna (LIP6, Univ. Paris VI, directed by Serge Fdida and Marcelo Dias di Amorim), referee,
  - Jean Lorchat (LIPC, Univ. Strasbourg I, directed by Jean-Jacques Pansiot and Thomas Noël), chair,
  - Amina Naimi-Meraihi (INRIA Rocquencourt, UVSQ, directed by Philippe Jacquet), referee,
  - Katia Runser (CITI, INSA-Lyon, directed by Stéphane Ubéda and Jean-Marie Gorce), chair,
  - Françoise Sailhan (INRIA Rocquencourt, Univ. Paris 6, directed by Valérie Issarny), referee,
  - Hakim Badis (LRI, Univ. Paris XI, directed by Philippe Jacquet and Khaldoun Al Agha), referee,
  - Julien Ridoux (LIP6, Univ. Paris VI, directed by Serge Fdida and Anne Fladenmüller), referee.
- **Gilles Grimaud** is member of steering committee of French Chapter of ACM SigOps. He is also is a member of the IFIP Working group 8.8 (SmartCards) and a member of the CSE of Lille university and Valenciennes University.
- **David Simplot-Ryl** is member of the working group of OFTA (Observatoire Français des Technologies Avancées) on Ambient Computing directed by Valérie Issarny. He is member of steering committee of EPCGlobal France and RFID 2005.

10. Bibliography

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[2] J. CARTIGNY, D. SIMPLOT, I. STOJMENOVIĆ. *Localized Minimum-Energy Broadcasting in Ad-hoc Networks*, in "Proc. IEEE INFOCOM 2003, San Francisco, USA", 2003.

[3] A. COURBOT, G. GRIMAUD, J.-J. VANDEWALLE, D. SIMPLOT-RYL. *Application-Driven Customization of an Embedded Java Virtual Machine*, in "Proc. Second International Symposium on Ubiquitous Intelligence and Smart Worlds (UISW2005), Nagasaki, Japan", Lecture Notes in Computer Science, Springer-Verlag, Berlin, 2005.

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[6] D. DEVILLE, G. GRIMAUD. *Building an 'Impossible' verifier on a Java Card*, in "Proc. 2nd USENIX Workshop on Industrial Experiences with Systems Software (WIESS'02), Boston, USA", 2002.

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