INSTITUT NATIONAL DE RECHERCHE EN INFORMATIQUE ET EN AUTOMATIQUE

Team SWING

Smart Wireless NetworkinG

Grenoble - Rhône-Alpes

Theme : Networks and Telecommunications

Activity Report

2009

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SWING is a common project with INSA Lyon. The team has been created on January the 1^{st}, 2009.

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2. Overall Objectives

2.1. Overall Objectives

SWING is a joint team between INRIA Rhône Alpes and INSA Lyon that follows the end of the ARES project. Its research fields cover flexible radio node design, agile radio resource sharing, and autonomous wireless networking. These three main research axis are completed by three cross-layer actions that are optimization, security, and prototyping.

The primary era of radio networking is currently ending. Its success mostly relied on a robust but restrictive set of rules: i) protocols are completely defined beforehand, ii) resource allocation policies are mainly designed in a static manner and iii) access network architectures are planned and controlled. Such a model obviously lacks adaptability and hence suffers from a suboptimal behavior. SWING aims at supporting the extensive spawning of radio systems thanks to spontaneous, cooperative and self-organization mechanisms which have to offer higher system capacity, under the constraints of latency, energy and QoS requirements.

3. Scientific Foundations

3.1. Scientific Foundations

Future wireless networks will have to be adaptive, self-organized and possibly cooperative. These features can be referred to as smart wireless networking. To address this challenging topic, three main research fields are investigated by SWING: flexible radio node, agile resource sharing, and autonomous radio networking. Moreover, with the new development optimization security

Flexible radio node design – Designing a radio node is definitely not an all-analogue process. Since software defined radio principles were established, some new features such as adaptability and auto-reconfiguration are becoming mandatory for the terminal to adapt to its environment and to the application in use. This relies on doing an important part of the radio coding/decoding process in the digital world. Because a full software radio node is still an utopia, future architectures will have to cope with analogue and digital constraints and their co-design is a real challenge. New computation models are emerging, such as for instance, the concept of radio virtual machine or new hardware abstraction layers permitting to develop separately the radio protocols, the strategies for resource sharing, the operating systems and top-level applications.

Agile radio resource sharing – Radio resource sharing is very important in autonomous and spontaneous networks. This problem covers several research fields including signal processing and protocols. In various contexts from wireless sensor networks (WSNs) to cellular wireless networks, the problem of sharing the radio resource remains a challenging issue. Mitigating interference for multi-system environments, optimizing energy and capacity for high data rate access networks or increasing the life-time of WSNs all strongly rely on the resource sharing strategy. The complexity of this problem originates from the inherent properties of the radio channel which is subject to highly variable propagation phenomena and interference. Since the radio environments are dynamic, as well as the users' and QoS needs, future systems will have to integrate self-adaptive, real-time and distributed algorithms. More recently, a tremendous interest for cooperative techniques appeared which allow the nodes to do more than just coexist: they can cooperate. This is a very competitive issue especially for heterogeneous systems where nodes only have a partial view of their radio environment. This cooperation can be considered at the signal level (virtual MIMO) or at the coding level (network coding), in a strong relationship with the data link layer to ensure robustness of end-to-end communications.

Autonomous wireless networking – The previously described mechanisms allow to manage efficiently the radio resource in the neighborhood of a node by taking into account the different wireless interactions. Next, the objective is to route a data from a source to a destination. This well-known problem should be revisited in the context of distributed wireless networks, particularly if we want to take benefit from agile radio, opportunistic radio links, non-symmetric neighbors and so on. Because of the large-scale dimension of the networks we consider, centralized approaches should be dismissed to the benefit of the development of distributed and localized protocols: based on local information and local interactions, the aim is to synthesize a global behavior in terms of routing, data gathering, etc. The most important issues deal with activity scheduling, topology control and protocols adaptability to the evolution of the network topology. Because such features need to be human-free, they are often referred to as the self- * paradigm which will drive our research effort. Hence, cooperation among nodes is also a tool that can be considered at the networking layer. However, such cooperative techniques will be carefully designed since they can trigger additional overhead in the network and reduce the benefits of adaptability. Furthermore, since network topologies are constantly evolving due to the mobility of the nodes and the variability of the radio links properties, fault-tolerant protocols are needed to guarantee robustness and self-stabilization.

Performance and optimization Performance evaluation and global optimization define a cross-layer axis of our project. In this action, we will be able to merge our contributions on smart wireless networks modeling using combinatorial and stochastic modeling tools. Global optimization is meant to describe system-wide behaviors and provide theoretical bounds on its performance, both by benchmarking the existing solutions and by guiding their improvement which will foster new developments. Our global optimization framework will progressively account for the software radio capabilities of the radio nodes, the properties of resource sharing algorithms and new self-* protocols. Realistic models of the wireless medium will be included, as well as refined models of adaptive protocols. This action will lead to three results : realistic models of smart wireless networks properties, global optimization and performance bounds derivation as well as distributed sub-optimal but feasible algorithms. This cross-layer axis on optimization is a necessity for developing new approaches and tools that are both efficient, provably reliable and relevant to the inherent cross-layer, dynamic and statistical nature of the systems under study.

Security – Security is one of the main cross-layer challenges of the SWING project. Security must be envisioned at each level, from hardware to routing protocols, in order to guarantee an end-to-end comprehensive security strategy. Moreover, in the context of embedded architectures, security related processing must be maintained to the least acceptable energy cost. The main challenges will then be the design of new energy efficient cryptographic primitives (in hardware and in software), the design of security mechanisms for routing protocols in order to preserve the networks from some specific attacks. The band deregulation and the on-the-fly adaptation reduces dangerously the access security. If cooperative mechanisms have to be used, the security of the various applications must be simultaneously guaranteed. Thus, security must be considered from a cross-layer perspective to allow cooperation at the physical layer while still protecting from malicious data access.

Prototyping – In SWING, we aim at addressing the challenges of smart wireless networks not only from a theoretical point of view, but also from a practical one, using simulations and prototypes. From our past experience, we acquired and developed several simulation tools. The CITI laboratory is also equipped with up-to-date radio design platforms allowing to test the embedded software radio systems, evaluate MIMO communications and perform real radio channel measurements. These skills have been acquired thanks to strong partnerships with the industrial community, which we plan to expand via new cooperations with Orange Labs, Alcatel-Lucent and other partners.

4. Application Domains

4.1. Mobile radio access networks

The future mobile radio access network referred to as 4G (4th generation) is expected to provide a wireless access of 100 Mbps in extended mobility and up to 1Gbps in reduced mobility as defined by the group IMT-Advanced of the ITU-R(adiocommunication) section. On the road towards the 4G, IMT-2000 standards evolutions are driven by the work of the WiMAX forum (IEEE 802.16e) on the one hand and by those of the LTE (Long Term Evolution) group of the 3GPP on the other hand. Both groups announced some targeted evolutions that could comply with the 4G requirements, namely the Gigabit Wimax (802.16m) and the LTE-Advanced proposal from the 3GPP.

In both technologies, the scarcity of the radio spectrum is handled by the use of MIMO and OFDMA technologies combining the dynamic spatial and frequency multiple access. A dynamic allocation of the radio resources, and a complete reconfigurability of the terminals will be required to cope with these 4G requirements.

4.2. Femtocells and Fixed-Mobile convergence

Femtocells refer especially to Access Point-like Base Stations, typically designed for residential or small business environments to provide the local users with the broadband connection (such as DSL or cable) to the service provider network. WiFi access points are the most famous examples of femtocells from the classical point of view. Access points currently in use are working with a specific technology which completely differs from the mobile cellular technology. Hence, the roaming between access points and cellular networks is only possible for a mobile terminal equipped with the two appropriate radio interfaces.

Some recent works advocated for the deployment of UMTS based access points to allow a direct roaming between fixed and mobile networks. Such approach is based on the reuse of the radio resource allocated to the cellular network by the access points, providing that the access point is only using free resource and does not interfere with the cellular network. From the cellular system operator point of view, such a solution is very attractive since it will improve both coverage and capacity, especially indoor. There may also be the opportunity for new services and reduced costs triggered by a decrease in both capital expenditure and operating expenses. Femtocells are an alternative to deliver the benefits of Fixed Mobile Convergence (FMC). The distinction is that most FMC architectures require a new (dual-mode) handset which works with existing home/enterprise WiFi access points, while a femtocell-based deployment will work with existing handsets but requires the roll-out of new access points.

4.3. Green networking

Wireless technologies are mature enough to see, in the near future, the rise of high bandwidth ubiquitous connectivity, at least in dense urban centers. This evolution puts into focus the en- ergy consumption of communication infrastructures, stressed by one of the main societal and economical challenge that developed countries have to tackle. As a matter of fact, one can find in the literature studies pointing out the environmental impact of telecommunications, e.g. the Internet, and claiming that no future infrastructure will be deployed without a serious investiga- tion on its energetic footprint.

Two legitimate viewpoints foster distinct research fields. On the one hand, the societal view- point aims at minimizing the system-wide energetic footprint which necessitates multiobjective analysis and optimization. On the other hand, the viewpoint of telecommunication operators, public institutions or corporate companies assimilates the energetic consumption to an exploita- tion cost weighted by the cost of electricity being traded off by other economical variables (incomes, installation cost, scale effect on costs, etc.) when addressing dynamic adaptation of the network to the stochastic behavior of clients.

In particular, this application field is fundamentally different from traditional network designs as stated by preliminary studies, since non-linear (and seldom non-continuous) cost functions are involved. Furthermore, other new energy-aware optimization methods have to be considered (e.g. for survivable sensor networks), since some global metrics have to be accounted for.

4.4. Interacting with the real world

Sensor networks have been investigated and deployed for decades already; their wireless exten- sion, however, has witnessed a tremendous upsurge in recent years. This is mainly attributed to the unprecedented operating conditions of wireless sensor networks (WSNs), i.e. a potentially enormous amount of sensor nodes, reliably operating under stringent energy constraints. WSNs allow for an unbounded sensing of the environment. It is anticipated that within a few years, sensors will be deployed in a variety of scenarios, ranging from environmental monitoring to health care, from the public to the private sector, etc. They will be battery-driven and deployed in great numbers in an ad hoc fashion, requiring communication protocols and embedded system components to run in an utmost energy efficient manner. Prior to large-scale deployment, how- ever, a gamut of problems has to be solved which relates to various issues, such as the extraction of application scenarios, design of suitable software and hardware architectures, development of communication and organization protocols, validation and first steps of prototyping, etc. Our objective will be to explore new event-driven and asynchronous software and hardware architectures, tailored to extremely low power consumptions; to propose new communication and organization protocols, which are optimized in terms of energy consumption and robustness; to find new application protocols that are designed for data fusion and aggregation; to study new network structures which facilitate auto-configuration and auto-organization; to provide tools for modeling and validation, which also take into account the physical environment and the interaction with the wireless sensor nodes. A specific application field concerns on-body applications. Wireless Body Area Networks (BAN) are now a well known acronym which encompasses scenarios in which several sensors and actuators are located on or inside the human body to sense different data, e.g. physiological information at different places on the body, and transfer them wirelessly towards a remote co- ordination unit which processes, forwards, takes decisions, alerts, records, etc. The use of BAN spans a wide area, from medical and health care to sport through leisure applications, which definitely makes the definition of a standard air interface and protocol highly challenging. Since it is expected that such devices and networks would have a growing place in the society and become more stringent in terms of quality of service, coexistence issues will be critical. Indeed, the radio resource is known to be scarce. The recent regulation difficulties of UWB systems as well as the growing interest for opportunistic radios show that any new system have to make an efficient use of the spectrum. This also applies to short range personal and body area network systems which are subject to huge market penetrations.

5. Software

5.1. Introduction

SWING develops several tools supporting its research like SOCLIB and Wiplan. Moreover, SWING is an active contributor to WSnet (http://wsnet.gforge.inria.fr/) a multi-hop wireless network discrete event simulator. WSnet was created in the ARES team and it is now supported by the D-NET team of INRIA Rhône-Alpes. SWING is one of the most important contributor for the design of protocol libraries in WSnet.

5.2. SOCLIB

Participants: Tanguy Risset [correspondant], Ludovic L'Hours.

SocLib is a library of simulation models for virtual com- ponents (IP cores) for Systems on Chip. Many simulation models are under development, SocLib currently contains simulation models for processors (Mips, ARM), memories and network on chips (Spin and DSpin developed at LIP6 laboratory. SocLib permits to simulate at cycle accurate application running on embedded computing systems such as mobile phones. Swing use this platform to prototype design techniques either for embedded software or for hardware parts of signal processing applications.

See also the web page https://www.soclib.fr/trac/dev/wiki.

5.3. Wiplan

Participants: Jean-Marie Gorce [correspondant], Paul Flipo, Guillaume Villemaud.

Wiplan is a software including an Indoor propagation engine and a wireless LAN opti- mization suite, which has been registered by INSA-Lyon. The heart of this software is the propagation simulation core relying on an original method, MR-FDPF (multi-resolution frequency domain ParFlow). The discrete ParFlow equations are translated in the Fourier domain providing a wide linear system, solved in two steps taking advantage of a multi- resolution approach. The first step computes a cell-based tree structure referred to as the pyramid. In the second phase, a radiating source is simulated, taking advantage of the pre-processed pyramidal structure. Using of a full-space discrete simulator instead of classical ray-tracing techniques is a challenge due to the inherent high computation re- quests. However, we have shown that the use of a multi-resolution approach allows the main computation load to be restricted to a pre-processing phase. Extensive works have been done to make predictions more realistic. The network planning and optimization suite is based on a multi-criteria model relying on a Tabu solver.

See also the web page http://wiplan.citi.insa-lyon.fr.

6. New Results

6.1. Reconfigurable Radio

Software architecture:

[34] presents a software architecture based on the virtual machine concept for SDR implementation. A high level abstraction language for the specification of PHY layer configurations has been proposed. In order to validate our concept and prove its practicality we have implemented IEEE802.11a PHY transmit and receive functionalities on a software demonstrator based on the Lua VM. This experiment has shown that both programming and execution model.

Architecture multi-standards:

Multi-mode is a common feature in current generation terminals, enabling the user to stay connected at any time. By selecting an appropriate standard, multi-mode can reduce terminal power consumption. Software Defined Radio is an enabler towards multi-mode for the next generation of terminals. In such a radio, communication modes are implemented by a general processor through digital functions, instead of dedicated chips. Providing access to users in bad conditions through relays, is another solution to reduce power consumption. This work is supported by the thesis of Cédric Levy-Bencheton.

In [45], [26], we look at multi-mode relaying, where a mobile terminal, connected to an UMTS base station, acts as an 802.11g-relay for those users. In this paper, we evaluate the algorithmic complexity of 802.11g and UMTS to estimate the power consumption of a Software Defined Radio. We propose a multi-mode relay scheme using such terminals, with the purpose of minimizing the global power consumption. Finally, we enounce different rules to maximize the local and global power gain by implementing multi-mode relays.

Multi antenna architecture:

The design of radio front-end has been extensively considered in [42], [18], [16], [17], [21], [43], [21], [19], [20]. Two problems have been considered: multistandard front-end and diversity receiver. For instance, [16], [17] aim to reduce the complexity of the analog front-end for a multistandard simultaneous reception receivers. To this end, we propose an architecture using the double orthogonal translation technique in order to multiplex two signals received on different frequency bands. A study case concerning the simultaneous reception of 802.11g and UMTS signals is developed in this paper. Theoretical and simulation results show that this type of multiplexing does not significantly influence the evolution signal to noise ratio of the signals.

For the problem of antenna diversity, an innovative architecture is introduced based on code multiplexing in [21], [43], [21], [19], [20]. This architecture uses the direct sequence spread spectrum technique in order to multiplex the different antennas contributions through a single IQ demodulator. Simulation and measurement results show that, in a Gaussian case, the bit error rate does not increase so much with the multiplexing. The complexity evaluation shows that the proposed architecture significantly reduces the power consumption of the front-end. IQ imbalance study in [19], [20] shows that the new architecture has the same sensitivity to IQ mismatches than the classical stack-up architecture and he bit error rate does not increase significantly with the multiplexing and this increase is compensated for a high IQ imbalance. A major result of this contributions is the proposition of candidate architecture for LTE Advanced receiver [48].

6.2. Radio Link

Body Area Networks (BANETs):

It is expected that Body Area Networks will be deployed in various applications to instrument and support humans in many aspects of their life. Different standards actually compete to fulfill the constraints associated with possible applications. Among all possible applications, we focus in [49], [23] on multi-nodes monitoring applications. The body is thus equipped with a set of sensors transmitting in real-time their measures to a common sink. The underlying network topology is thus classical in the field of wireless sensor networks (WSN) and referred to as the star topology. The classical super-frame structure as proposed in 802.15.3 seems to comply with the needs of such an application. However, the specificities of the BAN channel can reduce the performance of such protocol. Indeed, the channel time variations make the star structure unstable and subject to a high level of packet loss. We investigate some cooperative mechanisms to address this problem and we evaluate their implementation in the superframe structure.

Multi-hop transmission with unreliable links:

During the last decade, many works were devoted to improving the performance of relaying techniques in ad hoc networks. One promising approach consists in allowing the relay nodes to cooperate, thus using spatial diversity to increase the capacity of the system. However, this approach introduces an overhead in terms of information exchange, increasing the complexity of the receivers. A simpler way of exploiting spatial diversity is referred to as opportunistic routing. In this scheme, a cluster of nodes still serves as relay candidates but only a single node in the cluster forwards the packet. [39] proposes a thorough analysis of opportunistic routing efficiency under different realistic radio channel conditions. The study aims at finding the best trade-off between two objectives: energy and latency minimizations, under a hard reliability constraint. We derive an optimal bound, namely, the Pareto front of the related optimization problem, which offers a good insight into the benefits of opportunistic routing compared with classical multi- hop routing. In [50], we emphasize the problem of energy consumption only. We put forward an analytical framework to optimize the opportunistic communication scheme in order to minimize the energy consumption. Meanwhile, the optimizations of node density and the transmission power are analyzed for different ranges of relay candidates in Rayleigh block fading and Additive White Gaussian Noise (AWGN) channels. In the energy consumption viewpoint, the analysis indicate that the opportunistic communication is more efficient in Rayleigh block fading channel than that in AWGN channel. These results were obtained during the thesis of Ruifeng Zhang [3]

[25], [38] address the problem of reliable transmission of sensed data through a vast field of small and vulnerable sensors towards a sink node. We concentrate in this paper on networks deployed rapidly in harsh environments as needed for instance in disaster-relief scenarios. Hence, emphasis has to be put on the minimization of the global energy consumption of the network and on providing both fast data transmissions and a rapid network setup. Therefore, we introduce a new gradient broadcasting routing algorithm for wireless sensor networks, U-GRAB, where the broadcasting decision is taken according to a utility-based policy. This policy favors the broadcasting of packets for nodes that experience non-congested channels and have a satisfactory energy level. Our simulation results show that this new forwarding strategy greatly improves the robustness/energy/delay trade-off of GRAB, the current state-of the art solution in gradient broadcasting techniques.

[11], [15] studies the impact of fountain codes in the context of wireless sensor networks. This impact has been previously studied for wireless network in which the MAC layer is considered perfect. In [11] the power consumption is considered in the case of realistic MAC layer: the acknowledgment messages used in fountain codes can be lost. We show that fountain codes provide more resiliency to the lost of acknowledgment messages than protocols without coding. Moreover, the use of fountain codes allow to reduce the energetic cost of point to point connection. In [15], a strategy is proposed to improve the classical decode and forward strategy. From a given set of received packet, a new set of packet is generated respecting the Soliton distribution. This strategy reduces the overall number of messages exchanged. These results are part of the thesis of Anya Apavatjrut.

Performance on wireless links:

Recent years have witnessed a tremendous growth of research in the field of wireless systems and networking protocols. Consequently, simulation has appeared as the most convenient approach for the performance evaluation of such systems and several wireless network simulators have been proposed in recent years. However, the complexity of the wireless physical layer (PHY) induces a clear tradeoff between the accuracy and the scalability of simulators. Thereby, the accuracy of the simulation results varies drastically from one simulator to another. In [4], we focus on this tradeoff and we investigate the impact of the physical layer modeling accuracy on both the computational cost and the confidence in simulations. We first provide a detailed discussion on physical layer issues, including the radio range, link and interference modeling, and we investigate how they have been handled in existing popular simulators. This work describes the backbone of WSNet.

Distributed consensus in WSN:

Gossip averaging algorithms are used in distributed systems to let the nodes sharing a common value. This year, we introduce an alternative to standard gossip averaging algorithms for wireless sensor networks [27]. The proposed algorithm takes opportunity of the intrinsic broadcasting nature of the wireless medium and copes well with the unreliability of radio links. Indeed, this algorithm works asynchronously and in a distributed manner using one-way exchanges (acknowledgements are not required). It relies on the regularization formalism as used in image processing, and we show that it provides a tunable approximation of distributed averaging. An extension of this approach was proposed in [28]. Sensor networks aim at monitoring events and phenomena occurring in their environment and providing useful information to one or several end users.When a global knowledge of sensed data is needed, techniques from data gathering, statistical estimation and parametric modeling can be used. While the two first methods require respectively a large amount of energy and a knowledge of statistical dependencies between measurements, a new simple algorithm for fitting a parametric model to sensed data was proposed. The novelty of this approach stands in its intrinsic robustness to packet losses and asynchronous data exchanges. Moreover, this algorithm is intuitively efficient as it uses the broadcasting nature of the wireless medium. These contributions were developed in strong cooperation with CEA LETI, and led to the PhD defense of Nicolas Maréchal [2].

MAC/PHY UWB for WSN design:

This work is done in the context of a Cooperation with Orange Labs. They are the subject of the thesis of Benoit Miscopein. We propose a MAC layer for sensor networks, including the physical layer is capable of UWB impulse. We propose in [33], [32] a specification and the performance study for a procedure for detecting UWB signal pulse. From the block detection signal, we then designed a protocol MAC based on preamble sampling ([31]). This type of protocol requires the sending of a preamble before a useful package to wake-up the destination node. However, the length of this preambule can exceed the maximum emission time defined in an UWB equipment, according to European regulation. To circumvent this problem, we propose a protocol that enables collaborative relay of a burst of preamble by neighboring recipient, so that the sum of the relay is sufficiently long for the recipient and to wake-up that each relay node not violating the regulation. This protocol was the object of the deposit of a patent and a talk within the standardization group 802.15.6. We have also studied the background interfering, and we derive a non-coherent receiver optimal in a multi-path and in the presence of interference.

6.3. Autonomous wireless networking

Optimization:
The capacity of a network is a fundamental characteristic of a network which depends on many criteria. [6] proposes a complete framework to compute the upper and the lower bounds of the network capacity according to a physical topology and a given routing protocol. The radio resource sharing principles of CSMA-CA is modeled as a set of linear constraints with two models of fairness. The first one assumes that nodes have a fair access to the channel, while the second one assumes that on the radio links. We then develop a pessimistic and an optimistic scenarios for radio resource sharing, yielding a lower bound and an upper bound on the network capacity for each fairness case. Our approach is independent of the network topology and the routing protocols, and provides therefore a relevant framework for their comparison. We apply our models to a comparative analysis of a well-known flat routing protocol OLSR against two main self-organized structure approaches, VSR and localized CDS.

self-organization in WSN:
The goal of the self-organization is to structure the wireless sensor networks (WSN) using a connected logical topology (backbone) or a non connected one (clusters) in order to introduce stability and robustness. More, networking protocols based on such virtual structures should lead to better performances than the classical flat approach. Two models of self-organization have been studied by SWING: virtual coordinates [10], [9], [36], [35] and graph-based organization [24].

[10], [9], [36], [35] introduce and analyze the concept of virtual coordinates. These coordinates are chosen randomly when a node is switched on, and are updated each time the node relays a packet. As this process goes on, the virtual coordinates of the nodes converge to a near-optimal state. When using a greedy geographic approach on top of these coordinates, we show that the number of hops to reach the destination exceeds the shortest path by a few percent only. Moreover, our approach guarantees delivery even when nodes appear/disappear in the network, and under realistic transmission models. We analytically prove the correctness of our protocol. Moreover, extensive simulations are used to show that our position-free solution outperforms existing geo- graphic protocols - such as Greedy-Face-Greedy (GFG) or Greedy Perimeter Stateless Routing (GPSR) - in terms of energy-efficiency, path length and robustness. [37] proposes three new simple and effective strategies for constructing virtual coordinate in wireless sensor networks with unreliable links. We simulate the greedy routing protocol which uses the virtual coordinate constructed by our proposed strategies under unreliable links. Simulation results show that the delivery ratio of our proposed strategies is higher than the delivery ratio of the existing one, and closer to the delivery ratio of the real coordinate under unreliable links, without introducing any additional cost.

During the thesis of Karel Heurtefeux [1], the qualitative location algorithm for topology control (QLoP) has been proposed and studied. QLoP computes a Relative Neighborhood Graph to define an efficient routing algorithm. Therefore, QLoP can classify its own neighborhood according to its logical distance. In [24], we show that QLoP offers a better delivery rate and a better average distance than solution based on flat routing.

Real-time and other works:
Duty-cycle prolongs the lifetime of battery-powered wireless sensor networks (WSNs). However, it incurs additional delay because the nodes may be asleep. In addition to energy constraints, many applications have real-time constraints, which means the sink has to be informed before a deadline when an event occurs. Moreover, wireless links among low power radios are highly unreliable. These pose big challenges to design protocols for real-time applications. In [13] , a novel forwarding scheme based on distributed wakeup scheduling is proposed which can guarantee bounded delay and have higher delivery ratio for ultra low duty-cycle WSNs under unreliable links. The proposed wakeup scheduling algorithm schedules the wakeup time of each node according to the hop number and expected delivery ratio to the sink. We model the forwarding scheme and analyze its properties. Simulation results show that the proposed algorithm has better performances in terms of delivery ratio and end-to-end delay.

[55] analyzed the Prophet dynamic address allocation protocol described at INFOCOM 2003. This protocol is based upon a family of pseudo-random generators. The goal of Prophet is to establish an addresses scheme free of conflict. The addressing capabilities of Prophet depend on the underlying properties of the pseudo-random generators. The different pseudo-random generators proposed in Prophet are analyzed and the limits of the scheme are exhibited. Most notably, the periods of the generators limit the addressing capabilities of a node and the fact that Prophet is collision-free. In this research report, we show that the underlying assumptions made in Prophet can not be met by pseudo-random generators.

6.4. Security

Cryptography:
[40], [46] There is currently a lack of cryptographic primitives for authentication of aggregated data. The theoretical background for Aggregated Message Authentication Codes (AMACs) has been proposed by Chan and Castelluccia at ISIT 08. In this paper, we propose a MAC design based on universal hash functions and more precisely on the Krawczyk's constructions. We show how those designs can be used for aggregation and how it can be easily adapted for WSNs. Our two AMAC constructions offer a small memory footprint and a signification speed to fit into a sensor. Moreover, when compared with scenarios without aggregation, the method proposed here induces a simulated energy gain between 3 and 9.

[12] have been proposed as an alternative to Linear Feedback Shift Registers (LFSRs) for the design of stream ciphers. FCSRs have good statistical proper- ties and they provide a built-in non-linearity. However, two attacks have shown that the current representations of FCSRs can introduce weak- nesses in the cipher. We propose a new “ring” representation of FCSRs based upon matrix definition which generalizes the Galois and Fibonacci representations. Our approach preserves the statistical properties and circumvents the weaknesses of the Fibonacci and Galois representations. Moreover, the ring representation leads to automata with a quicker diffu- sion characteristic and better implementation results. As an application, we describe a new version of F-FCSR stream ciphers. These new representations were extented a step further in order to obtain efficient software implementation of FCSRs in [14].

In [30], we give a natural formalization to capture the notion of known-key distinguishers in an effort to view block cipher security from an alternative perspective e.g. a block cipher viewed as a primitive underlying some other cryptographic construction such as a hash function. We applied this concept to construct a 7-round distinguisher for the AES and a 7-round Feistel cipher. We then use our model to construct known-key distinguishers for Rijndael with Large Blocks up to 7 and 8 rounds.

WSN security:
The security of WSNs is studied in the thesis of Wassim Znaidi. In [41], a solution to the replication attack is proposed. Due to the use of low-cost materials, hardware components are not tamper-resistant and an adversary could access a sensor's internal state. Thus, an adversary can easily capture even a single node and insert duplicated nodes at any location in the network for malicious purpose. We propose a hierarchical distributed algorithm for detecting node replication attacks using a Bloom filter mechanism and a cluster head selection. The problem of establishing key between the nodes to enforce confidentiality is addressed in [47]

7. Contracts and Grants with Industry

7.1. Orange Labs

SWING has developed a strong relationship with Orange Labs through several “Contrat de Recherche Extérieur” (CRE). In 2009, three CREs with Orange Labs are supporting the thesis of:

- Ahmed Benfarah,
- Ochirkhand Erdene-Ochir,
- Quentin Lampin.

8. Other Grants and Activities

8.1. National Actions

8.1.1. ANR/RNRT - Aresa - Embedded systems and sensor networks (2006-2009, 136 keuros)

Participants: Fabrice Valois, Isabelle Augé-Blum.

Aresa was a national initiative (ANR) led by Orange Lab. The project was focusing on large scale wireless sensor networks distributed in a monitoring area. Low energy consumption mechanism was the key goal of this research. Event-driven and asynchronous protocols were proposed for self configuration, self organization and data aggregation.

8.1.2. ANR VERSO ARESA2 - "Avancées en Réseaux de capteurs Efficaces, Sécurisés et Auto-Adaptatifs" (2009-2012, 160 keuros)

Participants: Fabrice Valois, Marine Minier.

Aresa2 is a national initiative (ANR) started in december 09 and focusing on IP and Security issues in wireless sensor networks. It follows the first ANR/RNRT - Aresa. Fabrice Valois is the leader of the workpackage about self-organisation and Marine Minier is involved in the workpackage on security. The leader of Aresa2 is Orange Labs and the others partners are: Coronis Systems, VERIMAG, LIG, TÃ©lÃ©com Bretagne and INRIA.

8.1.3. ANR Blanc UBIQUEST - Ubiquitous Quest : "approche déclarative pour la gestion intégrée de réseaux et de données dans des réseaux radio multi-saut" (2009-2012, 108 keuros)

Participant: Fabrice Valois.

The UBIQUEST project proposes to combine the network management and data management in a single framework. Our objective is to design a query language for ad hoc networks and to develop the distributed query evaluation techniques that will efficiently compute queries expressed in this language. The network is essentially hidden and perceived by each node as a database, with which it interacts through declarative expressions. The communication between nodes thus consists of queries, updates and data. Each node is equipped with a local database system, an hybrid router, and a distributed query engine, processing queries posed by the node itself or received from other nodes.

8.1.4. ANR - Banet - Body Area Networks and Technologies (2007-2010, 129 keuros)

Participants: Paul Ferrand, Jean-Marie Gorce, Claire Goursaud, Nikolaï Lebedev, Guillaume Villemaud.

Banet is a national initiative (ANR) started in January 2008 and focusing on Body Area Network (BAN) systems. Jean-Marie Gorce is the leader of the workpackage 'Standard air interface, network and protocol system design'. The budget for Swing is 120 keuros. Providing a framework for Body Area Networks (BAN), defining a reliable communica- tion protocol, optimizing BAN technologies and enhancing energy efficiency of network components are the major stakes of then National Project BANET, led by CEA-Leti. It aims at defining precise frameworks to design optimized and miniaturized wireless com- munication systems. These body area networks target a wide applications range, such as consumer electronics, medical care and sports.

8.1.5. ANR - ECOSCELLS - Efficient Cooperating Small Cells (2009-2012, 260 keuros)

Participants: Virgile Garcia, Jean-Marie Gorce, Nikolaï Lebedev, Anis Ouni, Hervé Rivano, Fabrice Valois.

ECOSCELLS is a national initiative (ANR) which aims at developing algorithms and solutions to ease Small Cells Network (SCN) deployment. Theoretical studies will provide models for understanding the impact of radio channels, and to permit the definition of new algorithms exploiting a full diversity (user, spatial, interferences, etc.) of such networks. The novelty of the project is not to consider the interference as a drawback anymore, but to exploit it in order to offer an optimal resource utilization. The algorithms will be based on most recent developments in distributed algorithms, game theory, reinforcement learning. Architecture and algorithms for the backhauling network will also be proposed.

8.1.6. ANR - Rapide - Design and analysis of stream ciphers for constrained environments (2006-2010, 47 keuros)

Participants: Cédric Lauradoux, Marine Minier.

Rapide is a national initiative (ANR). Marine Minier is responsible of the work package “MACs construction”. Stream ciphers are less popular than their block ciphers counterparts, due to the lack of real standards. However, they become essential as soon as we want to reach important flows for limited costs in software or hardware. The aim of this national project is to study, construct and evaluate new stream ciphers built upon a non-linear transition function and to better evaluate the properties of the filtering function to discard known attacks, especially the algebraic ones.

8.1.7. ANR - SocLib - System on Chip simulation library (2007-2010, 121 keuros)

Participants: Tanguy Risset, Ludovic L'Hours.

The SocLib is a national platform initiative (ANR platform). Its objective is to build an open platform for modeling and simulation of multiprocessors system on chip that can be used by both universities and industrial companies. The core of the platform is a library of simulation models for virtual components (IP cores), with a guaranteed path to silicon. SoClib objective is also to create the largest possible cooperation project at European level, in order to share the development costs.

8.2. Actions Funded by the EC

8.2.1. Projet iPLAN - FP7-PEOPLE-IAPP-2008 (2009-2012, 440 keuros)

Participants: Jean-Marie Gorce, Guillaume Villemaud.

iPLAN (is a FP7 project of the FP7-PEOPLE-IAPP-2008 call. iPLAN (Indoor Planning) The iPlan consortium is made of the Ranplan Company, the CITI Lab- oratory and the University of Bedfordshire and proposes the study of Indoor planning and optimization models and tools. The aim is to develop fast and accurate radio propagation models, investigate various issues arising from the use of femtocells, develop an automatic indoor radio network planning and optimization and facilitate knowledge integration and transfer between project partners, to enable cross-fertilization between radio propagation modeling, wireless communications, operations research, computing, and software engi- neering.

8.2.2. DistMo4wNet - FP6 fellowship (2006-2010, 240 keuros)

Participants: Jean-Marie Gorce, Katia Jaffrès-Runser.

DistMo4wNet is a FP6 project labelled in the FP6 framework in the outgoing fellowship program. Jean-Marie Gorce is the scientific responsible of the program, and Katia Jaffres-Runser is the applicant. She was supported from January 2007 through June 2009, for two years at the Stevens Institute of Technology where she works with Pr. Cristina Comaniciu on distributed optimization of wireless networks protocols.

9. Dissemination

9.1. Leadership within the scientific community

9.1.1. Participation in Committees

Jean-Marie Gorce: member of the “Expert for recruiting committees of 27^{e} section” in INSA Lyon and 61^{e} section of the University of Savoie, Chambéry and for University of Nice; expert reviewer for the French National Agency for Research (ANR); expert reviewer for the “fond de recherche sur la nature et les technologies” of Québec, Canada.

Marine Minier: member of the “Expert for recruiting committees of 27^{e} section” of the Université de Limoges and Université de Saint-Etienne; member of the CR2 and CR1 recruiting committees of INRIA Rhône-Alpes.

Guillaume Villemaud: expert reviewer for the ANRT, on behalf of the French Ministry of Higher Education and Research; expert reviever for the CIFRE; expert reviewer for the “fond de recherche sur la nature et les technologies” of Québec, Canada.

Fabrice Valois: president of the “recruiting committees of 27e section” in INSA Lyon ; member of the "Expert for recruiting committees of 27e section" in University of Nice Sophia-Antipolis ; expert reviewer for the "fonde de recherche sur la nature et les technologies" of Québec, Canada.

9.1.2. Editorial Boards

Jean-Marie Gorce: Telecommunication Systems.
Tanguy Risset: Integration, the VLSI Journal.

9.1.3. Steering Committees

9.1.4. Conferences and workshops organization

Fabrice Valois: co-chair of IP et les Réseaux de capteurs (December, Lyon, France).

9.1.5. Participation in program committees

Jean-Marie Gorce: GRETSI 2009, EuMW 2009, IEEE VTC spring 2009.
Marine Minier: Indocrypt 2009, CIS 2009, ICDIM 2009.
Tanguy Risset: ASAP 2009, IEEE SIES 2009.
Fabrice Valois: PIMRC 2009, WSNperfs 2009, SensorComm 2009, ICC 2009, IWCMC 2009, EUC 2008, WSAN 2008, WiMob 2009, WINSYS’09, JDIR’09 .
Guillaume Villemaud: VTC Spring 2009, WiMob 2009.

9.2. HdR, Theses, Internships

9.2.1. Theses

9.2.1.1. Theses defended in 2009

Karel Heurtefeux: “*Self-organisation of wireless sensors networks*”, PhD thesis from INSA LYON, ARESA Grant, 26/11/2009.

Nicolas Maréchal: “Connectivity in WSN with applicative constraints”, PhD thesis from INSA LYON, CEA grant, since 10/2009.

Ruifeng Zhang: “*Realistic Modelling and Simulation of the PHY layer in Multi-* Sensor Networks*”, PhD thesis from INSA Lyon, CSN grant, 09/2006.

9.2.1.2. Theses in preparation

Ibrahim Amadou: “Towards zero control packets in WSN for energy saving”, MENRT grant since 11/2008.

Anya Apavatjrut: “Cooperative techniques and distributed coding for multi-hop networks”, Thailand grant, since 11/2007.

Riadh Ben Abdallah: “Virtual machine for software defined radio”, Inria/CEA grant, since 11/2007.

Ahmed Benfarah: “*Security of an UWB-IR radio link PHY/MAC layers approach*”, Orange labs grant, since 11/2009.

Ioan Burciu: “Design of radio front-end for simultaneous multi-band receiver”, Orange labs grant, since 10/2006.

Ochirkhand Erdene-Ochir: “Resilient secure networking for wireless sensor networks”, Orange labs grant, since 10/2009.

Paul Ferrand: “Cooperative communications in BANET”, MENRT, since 10/2009.

Virgile Garcia: “Opportunistic radio resource sharing for next-gen cellular networks”, INRIA/Alcatel-Lucent grant, since 12/2008.

Ahmad Kassem Ahmad: “High level abstraction for network programming”,UBIQUEST project grant, since 11/2009.

Quentin Lampin: “QOS and time-constrained WSN Networks”, Orange labs grant, since 01/10/2009.

Cédric Levy-Bencheton: “Adaptability and reconfigurability of a multi-* physical layer in ad-hoc and sensor networks”, MENRT grant, since 09/2007.

Laurent Maviel: “Wireless heterogeneous networks dynamic planning in urban and indoor non-stationary environments”, CIFRE grant with SIRADEL, since 11/2009.

Benoit Miscopein: “PHY/MAC approach for UWB wireless sensor networks”, PhD thesis from INSA Lyon, Orange labs grant, since 04/2006.

Anis Ouni: “Optimization of capacity and energy consumption in wireless mesh networks”, ECOSCells project grant, since 10/2009.

Bilel Romdhani: “Energy-efficient networking protocols for Wireless Sensors and Actuators Networks”, Orange labs grant, since 10/2008.

Fei Yang: “Real-time communication in Wireless Sensor Networks”, CSN grant, since 10/2007.

Wassim Znaidi: “*Risk management and securization of constrained systems in ambient environments*”, Rhône-Alpes grant, since 10/2007.

9.2.2. Participation in HDR Committees

Tanguy Risset: HDR of Loic Lagadec (September, Brest, UBO)[reviewer]

9.2.3. Participation in thesis Committees

Jean-Marie Gorce: thesis of Tuan-Duc Nguyen (May, Rennes, University of Rennes 1)[reviewer], thesis of Elyès Ben Hamida (September, Lyon, INSA Lyon)[chair], thesis of Jeremy Hamon (October, Grenoble, INPG)[chair], thesis of Nicolas Maréchal (October, Lyon, INSA Lyon)[supervisor], thesis of Adil Belhouji (November, Limoges, University of Limoges)[reviewer], thesis of Laurent Clavier (November, Lille, Institut Telecom Lille)[examinator], thesis of Rémy Vannier (December, Lyon, ENS Lyon)[chair], thesis of Ruifeng Zhang (December, Lyon, INSA-Lyon)[supervisor].

Tanguy Risset: thesis of Muhammad RASHID (October, Brest, UBO)[reviewer].

Fabrice Valois: thesis of Rahim Kacimi (September, Toulouse, IRIT)[reviewer], thesis of Christelle Molle (October, Nice, University of Nice-Sophia Antipolis)[reviewer], thesis of Michael Boc (November, Paris, LIP6)[reviewer], thesis of Karel Heurtefeux (November, Lyon, INSA-Lyon)[supervisor], thesis of Alexander Pelov (December, Strasbourg, LSIIT)[reviewer], thesis of Salim Nahle (December, Paris , LIP6)[reviewer].

9.2.4. Internships

Anis Ouni: ARC Carma (Fabrice Valois)

Clement Reboul: Hybrid network relay in meshed or sensor networks (Guillaume Villemaud, Tanguy Risset)

Doreid Ammar: Optimization of multi-protocol energy consumption in hydrid networks (Tanguy Risset)

Irfana Memon: Data aggregation techniques for wireless sensor network (Isabelle Augé-Blum)

Jorge Federico Aguirre: Design and implementation of a demonstration of MIMO transmission coupled with simulation measure (Guillaume Villemaud)

Julien Antoine Da Vela: Positionning in sensor network (Jean-Marie Gorce)

Paul Ferrand: Aggregation message authentication codes for wirless sensor networks (Marine Minier)

Sebastien Blanchard: Setup of a MIMO demonstration plateform (Guillaume Villemaud)

Stephane Poignant: Experimental study of network protocols for wireless sensors (Isabelle Augé-Blum)

9.3. Teaching

The members of SWING are heavily involved in teaching activities at Telecommunications department of INSA Lyon (master 1 and 2 level). Tanguy Risset, Jean-Marie Gorce and Fabrice Valois are professor in the Telecommunications department of INSA Lyon. Claire Goursaud and Isabelle Augé-Blum are associate professor in the Telecommunications department of INSA Lyon. Jean-Marie Gorce was the vice-head of the Telecommunications department of INSA Lyon until september 2009, and since he has been replaced by Tanguy Risset. The teaching is carried out by members of INSA Lyon as part of their teaching duties, and for INRIA/CNRS or PhD's as extra work.

Some members are involved in the teaching activity of other departments of INSA Lyon. Marine Minier is associate professor in the Computer Science department of INSA Lyon. Jacques Verdier and Guillaume Villemaud are associate professor in the Electrical Engineering department of INSA Lyon.

Nikolaï Lebedev is associate professor in the engineering school in Chemistry, Physics and Elec- tronics, Lyon.

Some members are also involved in administrative duties related to teaching at University of Lyon. Tanguy Risset is the responsible for the Networking program of the Master Mastria from University of Lyon, and Jean-Marie Gorce is the responsible for the Telecommunications program of the future Master EEAP from University of Lyon.

Moreover, the SWING team is involved in international teaching program. Fabrice Valois is the head of a Special program of Engineering in Telecommunications between INSA Lyon and Shanghaï - Jiao Tong University.

The members of SWING also supervise several student projects and internships at all levels (Master 1 and 2, Engineering Schools).

Altogether that represents more than 2250 hours per year.

9.4. Participation in conferences and workshops

9.4.1. Invited talks

Marine Minier: CAV 2009 (MITACS 2009 workshop) (June, Grenoble, France,).

Fabrice Valois: invited talk at Shanghaï Jiao Tong University (february, Shanghaï, China).

9.4.2. Participation in scientific meetings

Virgile Garcia: COST2100 MCM (September, Vienna, Austria).

Jean-Marie Gorce: COST2100 MCM (May, Valencia, Smain).

9.4.3. Participation in conferences

Riadh Ben Abdallah: IDPSP 2009 (May, Roma, Italy).

Anya Apavatjrut: GRETSI 2009 (September, Dijon, France).

Marco Fiore: IEEE MASS'09 (October, Macao, China).

Virgile Garcia: COGIS'09 (November, Paris), CWIND (November, Luton, UK).

Jean-Marie Gorce: PIMRC'09 (September, Tokyo, Japan), GRETSI 2009 (September Dijon, France).

Claire Goursault: GRETSI 2009 (September Dijon, France).

Cédric Lévy-Bencheton: EuWiT '09 (September, Roma, Italy).

Nicolas Maréchal: SPAWC 2009 (June, Perugia, Italy), DCOSS 2009 (June, Marina Del Rey, USA), ALGOTEL 2009 (June, Carry Le Rouet, France).

Marine Minier: SecureComm 2009 (September Athenes, Greece).

Benoit Miscopein: ICUWB'09 (September, Vancouver, Canada), PIMRC'09 (September, Tokyo, Japan).

Fabrice Valois: ACM Sigcomm (August, Barcelona, Spain), IEEE WiMob (October, Marrakech, Marocco).
Jacques Verdier: VTC Spring (april, Barcelone, Spain), EuMw (September, Roma, Italy).

Guillaume Villemaud: EUCAP (Mars, Berlin, Germany), VTC Spring (april, Barcelone, Spain), PIMRC'09 (September, Tokyo, Japan), EuMw (September, Roma, Italy), Femtocell Workshop (December, Luton).

Fei Yang: IWCMC (June, Leipzig, Germany), MASCOTS (September, London, England).

Ruifeng Zhang: ICC 2009 (June, Dresden, Germany), WCNC 2009 (April, Budapest, Hungary).

Wassim Znaidi: SARSSI 2009 (June, Luchon, France), PIMRC'09 (September, Tokyo, Japan).

9.4.4. Participation in schools

Ibrahim Amadou: Summer School RESCOM (June 09, La Palmyre, France).
Isabelle AugÃ©-Blum : Summer School RESCOM (June 09, La Palmyre, France).
Isabelle Augé-Blum: ResCom'09 (Mars, Paris, France), Summer School RESCOM (June 09, La Palmyre, France), ETR'09 (September, Paris,France).
Cédric Lévy-Bencheton: JDIR '09 (February, Belfort, France).
Bilel Romdhani: ResCom'09 (Mars, Paris, France), 2ème journée ARC (Mars, Paris, France), Summer School RESCOM (June 09, La Palmyre, France), Première journée du projet SEMBA (October, Annecy, France), IP et les Réseaux de capteurs (December, Lyon, France).
Fabrice Valois: ResCom'09 (Mars, Paris, France), Summer School RESCOM (June 09, La Palmyre, France), IP et les Réseaux de capteurs (December, Lyon, France).
Wassim Znaidi: Summer School RESCOM (June 09, La Palmyre, France).

10. Bibliography

Year Publications

Doctoral Dissertations and Habilitation Theses

[1] K. HEURTEFEUX. *Self-organisation of wireless sensors networks*, INSA-LYON, 2009, Ph. D. Thesis.

[2] N. MARÉCHAL. *Connectivity in WSN with applicative constraints*, INSA-LYON, 2009, Ph. D. Thesis.

[3] R. ZHANG. *Realistic Modelling and Simulation of the PHY layer in Multi-* Sensor Networks*, INSA-LYON, 2009, Ph. D. Thesis.

Articles in International Peer-Reviewed Journal

[4] E. BEN HAMIDA, G. CHELIUS, J.-M. GORCE. *Impact of the Physical Layer Modeling on the Accuracy and Scalability of Wireless Network Simulation*, in "Simulation", vol. 85, 09 2009, p. 574-588, http://hal.inria.fr/inria-00412150/en/ES.

[5] P. MARY, M. DOHLER, J.-M. GORCE, G. VILLEMAUD, M. ARNDT. *M-ary Symbol Error Outage Over Nakagami-m Fading Channels in Shadowing Environments*, in "IEEE Transactions on Communications", 2009, http://hal.inria.fr/inria-00405203/en/ES.

[6] H. RIVANO, F. THEOLEYRE, F. VALOIS. *A Framework for the Capacity Evaluation of Multihop Wireless Networks*, in "Ad Hoc and Sensor Wireless networks (AHSWN)", 2009, to be published, http://hal.archives-ouvertes.fr/hal-00371161/en/.

[7] G. VILLEMAUD, P.-F. MORLAT, J. VERDIER, J.-M. GORCE, M. ARNDT. *Coupled Simulation-Measurements Platform for the Evaluation of Frequency-Reuse in the 2.45 GHz ISM band for Multi-mode Nodes with Multiple Antennas*, in "EURASIP Journal on Wireless Communications and Networking", 2009, http://hal.inria.fr/inria-00436622/en/.

[8] T. WATTEYNE, I. AUGÉ-BLUM, M. DOHLER, S. UBÉDA, D. BARTHEL. *Centroid virtual coordinates: A novel near-shortest path routing paradigm*, in "Computer Networks", vol. 53, n^{o} 10, 2009, p. 1697-1711, http://hal.inria.fr/inria-00404280/en/ES.

[9] T. WATTEYNE, I. AUGÉ-BLUM, M. DOHLER, S. UBÉDA. *Centroid virtual coordinates - A novel near-shortest path routing paradigmé*, in "International Journal of Computer and Telecommunications Networking", vol. 53, n^{o} 10, 2009, p. 1697-1711, http://hal.archives-ouvertes.fr/hal-00405087/en/ES.

Articles in National Peer-Reviewed Journal

[10] F. THEOLEYRE, F. VALOIS. *Conception d'une plate-forme d'expérimentation pour réseaux ad hoc et hybrides - Application é l'évaluation d'un protocole d'auto-organisation et de routage*, in "Techniques et Sciences Informatiques", 2009, http://hal.inria.fr/inria-00406131/en/.

International Peer-Reviewed Conference/Proceedings

[11] A. APAVATJRUT, C. GOURSAUD, J.-M. GORCE. *Impact des Codes Fontaine sur la consommation d'énergie dans les réseaux de capteurs avec prise en compte d'une couche MAC réaliste*, in "GRETSI 2009, France Dijon", 2009, http://hal.inria.fr/inria-00406340/en/.

[12] F. ARNAULT, T. P. BERGER, C. LAURADOUX, B. POUSSE, M. MINIER. *A New Approach for FCSRs*, in "Selected Areas in Cryptography - SAC 2009, Canada Calgary", S. VERLAG (editor), vol. 5867, 2009, p. 433-448, http://hal.archives-ouvertes.fr/hal-00436558/en/BE.

[13] I. AUGÉ-BLUM, F. YANG. *On maximizing the delivery ratio of ultra low duty-cycle WSNs under real-time constraint*, in "17th IEEE International Symposium on Modelling, Analysis and Simulation of Computer and Telecommunication Systems (MASCOTS'09), Royaume-Uni londres", 2009, p. 1-3, http://hal.archives-ouvertes.fr/hal-00405110/en/.

[14] T. P. BERGER, M. MINIER, B. POUSSE. *Software Oriented Stream Ciphers Based upon FCSRs in Diversified Mode*, in "Progress in Cryptology - INDOCRYPT 2009", Lecture Notes in Computer Science 5922, Springer, 2009, p. 119-135.

[15] S. BLANCHARD, S. RERBAL, A. APAVATJRUT, C. GOURSAUD, J.-M. GORCE. *Étude du relayage de codes fontaine sur un lien de transmission multi-sauts*, in "GRETSI 2009, France Dijon", 2009, http://hal.inria.fr/inria-00406341/en/.

[16] I. BURCIU, M. GAUTIER, G. VILLEMAUD, J. VERDIER. *A 802.11g and UMTS Simultaneous Reception Front-End Architecture using a double IQ structure*, in "IEEE VTC Spring 2009, Espagne Barcelona", 2009, http://hal.inria.fr/inria-00412042/en/.

[17] I. BURCIU, J. VERDIER, G. VILLEMAUD. *Low Power Multistandard Simultaneous Reception Architecture*, in "European Wireless Technology Conference 2009, Italie Rome", 2009, http://hal.inria.fr/inria-00412028/en/.

[18] I. BURCIU, G. VILLEMAUD, J. VERDIER. *Multiband Simultaneous Reception Front-End with Adaptive Mismatches Correction Algorithm*, in "IEEE Personal, Indoor and Mobile Radio Communications Symposium, Japon Tokyo", 2009, http://hal.inria.fr/inria-00412059/en/.

[19] M. GAUTIER, I. BURCIU, G. VILLEMAUD. *New antenna diversity front-end using code multiplexing*, in "European Conference on Antennas and Propagation, Allemagne Berlin", 2009, http://hal.inria.fr/inria-00412047/en/.

[20] M. GAUTIER, P.-F. MORLAT, G. VILLEMAUD. *IQ imbalance reduction in a SMI multi-antenna receiver by using a code multiplexing front-end*, in "IEEE VTC Spring 2009, Espagne Barcelona", 2009, http://hal.inria.fr/inria-00412044/en/.

[21] M. GAUTIER, G. VILLEMAUD. *Low complexity antenna diversity front-end: Use of code multiplexing*, in "IEEE Wireless Communications and Networking Conference, Hongrie Budapest", 2009, http://hal.inria.fr/inria-00412053/en/.

[22] G. GAVIN, M. MINIER. *Oblivious Multi-variate Polynomial Evaluation*, in "Progress in Cryptology - INDOCRYPT 2009", Lecture Notes in Computer Science 5922, Springer, 2009, p. 430-442.

[23] J.-M. GORCE, C. GOURSAUD, G. VILLEMAUD, R. D'ERRICO, L. OUVRY. *Opportunistic relaying protocols for human monitoring in BANs*, in "IEEE PIRMC, Japon Tokyo", 2009, http://hal.inria.fr/inria-00406343/en/.

[24] K. HEURTEFEUX, F. VALOIS. *Localisation distribuée pour routage en environne- ment bruité dans les réseaux de capteurs*, in "CFIP'2009, France Strasbourg", 2009, http://hal.inria.fr/inria-00419468/en/.

[25] K. JAFFRÉS-RUNSER, C. COMANICIU, J.-M. GORCE, R. ZHANG. *U-GRAB: A Utility-based Gradient Broadcasting Algorithm for Wireless Sensor Networks*, in "IEEE Military Communications (MILCOM), états-Unis d'Amérique Boston, MA", General Dynamics, 2009, http://hal.inria.fr/inria-00406350/en/US.

[26] C. LÉVY-BENCHETON, G. VILLEMAUD. *Power Consumption Optimization in Multi-mode Mobile Relay*, in "European Wireless Technology Conference 2009, Italie Rome", 2009, http://hal.inria.fr/inria-00412025/en/.

[27] P. MARY, M. DOHLER, J.-M. GORCE, G. VILLEMAUD. *Symbol Error Outage for Spatial Multiplexing Systems in Rayleigh Fading Channel and Lognormal Shadowing*, in "10th IEEE International Workshop on on Signal Processing Advances in Wireless Communications, Italie Perugia", IEEE, 2009, http://hal.inria.fr/inria-00405202/en/ES.

[28] N. MARÉCHAL, J.-M. GORCE, J.-B. PIERROT. *A new distributed algorithm for parametric data modeling in wireless sensor networks*, in "10th IEEE International Workshop on on Signal Processing Advances in Wireless Communications, Italie Perugia", 2009, http://hal.inria.fr/inria-00405201/en/.

[29] N. MARÉCHAL, J.-B. PIERROT, J.-M. GORCE. *Asynchronous and distributed nonlinear regularization for wireless sensor networks*, in "3rd International Workshop on Localized Algorithms and Protocols for Wireless Sensor Networks (LOCALGOS), états-Unis d'Amérique Marina del Rey", 2009, http://hal.inria.fr/inria-00405199/en/.

[30] M. MINIER, R. PHAN, B. POUSSE. *Distinguishers for Ciphers and Known Key Attack against Rijndael with Large Blocks*, in "Africacrypt 2009", Lecture Notes in Computer Science 5580, Springer, 2009, p. 60-76.

[31] B. MISCOPEIN, J.-M. GORCE. *Energy efficient TH-UWB Preamble Detection*, in "IEEE International conference on ultra wideband (IC-UWB), Canada Vancouver", 2009, http://hal.inria.fr/inria-00406347/en/.

[32] B. MISCOPEIN, J. SCHWOERER, J.-M. GORCE. *Cooperative beacon-free MAC layer for body area networks*, in "IEEE PIRMC, Japon Tokyo", 2009, http://hal.inria.fr/inria-00406346/en/.

[33] B. MISCOPEIN, J. SCHWOERER, J.-M. GORCE. *Multipath Decision Fusion For Low Complexity UWB-IR Non-Coherent Receivers*, in "IEEE PIRMC, Japon Tokyo", 2009, http://hal.inria.fr/inria-00406344/en/.

[34] T. RISSET, R. BEN ABDALLAH, A. FRABOULET, D. YVES. *The Radio Virtual Machine: A Solution for SDR Portability and Platform Reconfigurability*, in "16th Reconfigurable Architectures Workshop, Iles Féroé Rome", 2009, ..., http://hal.archives-ouvertes.fr/hal-00410747/en/.

[35] T. WATTEYNE, D. BARTHEL, M. DOHLER, I. AUGÉ-BLUM. *Using virtual coordinates for wireless sensor networks: Proof-of-concept experimentation*, in "TRIDENTCOM 5th International Conference on Testbeds and Research Infrastructures for the Development of Networks&Communities and Workshops, états-Unis d'Amérique", 2009, p. 1-8, http://hal.archives-ouvertes.fr/hal-00405108/en/ES.

[36] T. WATTEYNE, K. PISTER, D. BARTHEL, M. DOHLER, I. AUGÉ-BLUM. *Implementation of Gradient Routing in Wireless Sensor Networks*, in "IEEE Global Telecommunications Conference (GLOBECOM), états-Unis d'Amérique Honolulu, Hawaii", 2009, ??, http://hal.archives-ouvertes.fr/hal-00415839/en/USES.

[37] F. YANG, I. AUGÉ-BLUM. *Constructing Virtual Coordinate for Routing in Wireless Sensor Networks under Unreliable Linksé*, in "Constructing Virtual Coordinate for Routing in Wireless Sensor Networks under Unreliable Linksé, Allemagne Leipzig", 2009, 1, http://hal.archives-ouvertes.fr/hal-00405109/en/.

[38] R. ZHANG, J.-M. GORCE, R. P. DONG, K. JAFFRÉS-RUNSER. *Energy Efficiency of Opportunistic Routing with Unreliable Links*, in "IEEE Wireless Communications and Networking Conference (WCNC), Hongrie Budapest", IEEE, 2009, http://hal.inria.fr/inria-00405196/en/US.

[39] R. ZHANG, J.-M. GORCE, K. JAFFRÉS-RUNSER. *Low Bound of Energy-Latency Trade-off of Opportunistic Routing in Multi-hop Networks*, in "IEEE International Conference on Communications (ICC), Allemagne Dresde", IEEE, 2009, http://hal.inria.fr/inria-00405198/en/US.

[40] W. ZNAIDI, C. LAURADOUX, M. MINIER. *Aggregated Authentication (AMAC) using Universal Hash Functions*, in "International ICST Conference on Security and Privacy in Communication Networks - SecureComm 2009, Gréce Athens", vol. 19, Springer, 2009, p. 248-264, http://hal.archives-ouvertes.fr/hal-00436559/en/BE.

[41] W. ZNAIDI, M. MINIER, S. UBÉDA. *Hierarchical Node Replication Attacks Detection in Wireless Sensors Networks*, in "International Symposium on Personal, Indoor and Mobile Radio Communications (PIMRC'09)", IEEE, 2009.

National Peer-Reviewed Conference/Proceedings

[42] I. BURCIU, G. VILLEMAUD, J. VERDIER. *Architecture de front-end multistandard é réception simultanée*, in "JNM, France Grenoble", 2009, http://hal.inria.fr/inria-00412111/en/.

[43] M. GAUTIER, I. BURCIU, G. VILLEMAUD. *Analyse du PAPR pour un récepteur multi-antennes à multiplexage par code*, in "GRETSI, France Dijon", 2009, http://hal.inria.fr/inria-00412109/en/.

[44] M. GAUTIER, I. BURCIU, G. VILLEMAUD. *Frontal d'un récepteur à diversité d'antenne*, in "JNM, France Grenoble", 2009, http://hal.inria.fr/inria-00412110/en/.

[45] C. LÉVY-BENCHETON, G. VILLEMAUD. *Optimisation de la Consommation dans les Relais Mobiles Multi-modes*, in "JDIR, France Belfort", 2009, http://hal.inria.fr/inria-00412113/en/.

[46] W. ZNAIDI, C. LAURADOUX, M. MINIER. *Une proposition d'agrégation de MACs pour les réseaux de capteurs utilisant des fonctions de hachage universelles*, in "Conférence sur la Sécurité des Architectures Réseaux et des Systêmes d'information - SAR/SSI'2009, France Luchon", 2009, p. 1-12, http://hal.archives-ouvertes.fr/hal-00402755/en/US.

[47] W. ZNAIDI, M. MINIER. *Proposition de gestion des clés et de contrôle d'accès dans un réseau de capteurs*, in "10ème Journées Doctorales Informatique et Réseau (JDIR'09), France Belfort", 2009, p. 1-10, http://hal.archives-ouvertes.fr/hal-00402758/en/.

Workshops without Proceedings

[48] I. BURCIU, G. VILLEMAUD, J. VERDIER. *Candidate Architecture for MIMO LTE-Advanced Receivers with Multiple Channels Capabilities and Reduced Complexity and Cost*, in "COST2100 Pervasive Mobile & Ambient Wireless Communications, Espagne Valence", 2009, http://hal.inria.fr/inria-00412103/en/.

[49] J.-M. GORCE, C. GOURSAUD, C. SAVIGNY, G. VILLEMAUD, R. D'ERRICO, F. DEHMAS, M. MAMAN, L. OUVRY, B. MISCOPEIN, J. SCHWOERER. *Cooperation mechanisms in BANs*, in "COST 2100, 9th management meeting, Espagne Valencia", COST 2100, 2009, http://hal.inria.fr/inria-00412557/en/.

[50] R. ZHANG, J.-M. GORCE. *Low Bound of Energy-Latency Trade-off of Opportunistic Routing in Multi-hop Networks*, in "COST 2100 6th management committee meeting, France Lille", COST 2100, 2009, http://hal.inria.fr/inria-00412558/en/.

Scientific Books (or Scientific Book chapters)

[51] I. AUGÉ-BLUM, F. YANG, T. WATTEYNE. *Real-Time Communications in Wireless Sensor Networks*, in "Handbook of Research on Next Generation Networks and Ubiquitous Computing", S. PIERRE (editor), IGI Global, 2009, ?, http://hal.archives-ouvertes.fr/hal-00405300/en/.

[52] J.-M. GORCE, G. VILLEMAUD, P. MARY. *Couche physique et antennes*, in "Réseaux de capteurs, héorie et modélisation", H. LAVOISIER (editor), Eyrolles, 2009, http://hal.inria.fr/inria-00406339/en/.

[53] T. RISSET, A. FRABOULET, A. SCHERRER. *On-chip Processor Traffic Modeling for NoC Design*, in "Networks-on-Chips: Theory and Practice", CRC Press, 2009, p. 95-122, http://hal.archives-ouvertes.fr/hal-00410688/en/.

[54] T. WATTEYNE, M. DOHLER, I. AUGÉ-BLUM, D. BARTHEL. *Beyond localization: communicating using virtual coordinates*, in "Localization Algorithms and Strategies for Wireless Sensor Networks: Monitoring and Surveillance Techniques for Target Tracking", G. MAO, B. F. EDS. (editors), IGI Global, 2009, p. 1-30, http://hal.archives-ouvertes.fr/hal-00405294/en/ES.

Research Reports

[55] C. LAURADOUX, M. MINIER. *A Mathematical Analysis of Prophet Dynamic Address Allocation*, INRIA, 2009, http://hal.inria.fr/inria-00429480/en/, RR-7085, Rapport de recherche.