INSTITUT NATIONAL DE RECHERCHE EN INFORMATIQUE ET EN AUTOMATIQUE

Team swing

Smart Wireless Networking

Grenoble - Rhône-Alpes

Theme : Networks and Telecommunications

Activity Report

2010

Table of contents

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

1. Team

Research Scientists

Cédric Lauradoux [Research Associate (CR) Inria]
Hervé Rivano [Invited Research Associate (CR) CNRS]

Faculty Members

Jean-Marie Gorce [Team leader, Professor, INSA-Lyon, HdR]
Isabelle Augé-Blum [Associate Professor, INSA-Lyon]
Marco Fiore [Associate Professor, INSA-Lyon]
Claire Goursaud [Associate Professor, INSA-Lyon]
Florin Hutu [Associate Professor, INSA-Lyon]
Nikolaï Lebedev [Associate Professor, CPE Lyon]
Jia-Liang Lu [Temporary Associate Professor, INSA-Lyon/Shanghaï Jiao Tong University]
Marine Minier [Associate Professor, INSA-Lyon]
Tanguy Risset [Professor, INSA-Lyon, HdR]
Bernard Tourancheau [Professor, Université Lyon 1, HdR]
Fabrice Valois [Professor, INSA-Lyon, HdR]
Jacques Verdier [Associate Professor, INSA-Lyon]
Guillaume Villemaud [Associate Professor, INSA-Lyon]
Wassim Znaidi [Temporary Associate Professor, INSA-Lyon]

Technical Staff

Stéphane d'Alu [Research Engineer, INSA-Lyon, 50%]
Paul Flipo [Research assistant, INRIA]
Ludovic L'Hours [Research assistant, INSA-Lyon]

PhD Students

Ibrahim Amadou [MENRT grant, since 11/2008, 3rd year]
Anya Apavatjrut [Thailand grant, since 11/2007, 4th year]
Riadh Ben Abdallah [Inria/CEA grant, defended 10/2010]
Ahmed Benfarah [Orange labs grant, since 11/2009, 2nd year]
Leila Ben Saad [MENRT grant, since 10/2008, 3rd year]
Ioan Burciu [Orange labs grant, defended 10/2010]
Cédric Chauvenet [CIFRE Watteco/Citi grant, since 02/2010, 1st year]
Cengis Hasan [INRIA grant, since 01/2010, 1st year]
Ochirkhand Erdene-Ochir [Orange labs grant, since 10/2009, 2nd year]
Paul Ferrand [MENRT, since 10/2009, 2nd year]
Virgile Garcia [INRIA/Alcatel-Lucent grant, since 12/2008, 3rd year]
Quentin Lampin [Orange labs grant, since 01/10/2009, 2nd year]
Cédric Levy-Bencheton [MENRT grant, since 09/2007, 3rd year]
Meiling Luo [MENRT grant, since 01/2010, 1st year]
Laurent Maviel [CIFRE grant with SIRADEL, since , 11/2009, 2nd year]
Benoit Miscopein [Orange labs grant, defended 05/2010]
Alexandre Mouradian [ANR ARESA II grant, since 10/2010, 1st year]
Anis Ouni [ANR ECOSCells project grant, since , 10/2009, 2nd year]
Bilel Romdhani [Orange labs grant, since 10/2008, 3rd year]
Sandesh Uppoor [INRIA/Alcatel-Lucent grant, since 10/2010, 1st year]
Fei Yang [CSN grant, since 10/2007, 3rd year]

Post-Doctoral Fellows

Katia Jaffres-Runser [Marie Curie action, INSA-Lyon / Stevens Institute of Technology, NJ, USA]

Dmitry Umansky [iPlan grant]

Administrative Assistant

Gaelle Tworkowski [ITA INRIA (part time)]

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. Software

4.1. 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.

4.2. 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.

4.3. 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.

5. New Results

5.1. Reconfigurable Radio

In [38], we propose a virtual machine based programming model which can express different physical layer protocols independently of the target platform. To this model we defined an associated language compilable into a high level byte-code to be executed by the radio virtual machine (which itself is executed by either a classic native processor or dedicated hardware) for configuration and control of radio platforms. The radio virtual machine was first tested functionally on a software platform (PC) Then it has been experimented on a realistic platform with real-time constraints consideration : the CEA-Leti MAGALI chip. To validate the concept, several transmit and receive services of existing physical layer standards have been implemented. The additional costs of the virtual machine and the programming model were studied. A quantitative experimental evaluation of this additional costs have been realized and optimization techniques have been proposed.

5.2. Radio Link

A new model used to compute the outdoor to indoor signal strength emitted from an outdoor base station is presented in [4]. This model is based on the combination of 2 existing models: IRLA (Intelligent Ray Launching), a 3D Ray Optical model especially optimized for outdoor predictions, and MR-FDPF (Multiresolution Frequency Domain ParFlow), a 2D Finite Difference model initially implemented for indoor propagation. The combination of these models implies the conversion of the ray launching paths on the border of the buildings, into virtual source flows that will be used as input for the indoor model. The performance of the new combined model is evaluated via measurements at 2 frequencies (WiMAX and WiFi). This solution appears to be efficient for radio network planning, in term of both accuracy and computational cost.

In [5], we address the architecture of a multi-antenna receiver and we aim at reducing the complexity of the analog front-end. To this end, an innovative architecture is introduced based on code multiplexing. 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 the bit error rate does not increase so much with the multiplexing in both Gaussian and fading environments and with strong RF defaults conditions. The complexity evaluation shows that the proposed architecture significantly reduces the chip area and the power consumption of the front-end.

Diversity is a powerful means to increase the transmission performance of wireless communications. For the case of fountain codes relaying, it has been shown previously that introducing diversity is also beneficial since it counteracts transmission losses on the channel. Instead of simply hop-by-hop forwarding information, each sensor node diversifies the information flow using XOR combinations of stored packets. This approach has been shown to be efficient for random linear fountain codes. However, random linear codes exhibit high decoding complexity. In [46], we propose diversity increased relaying strategies for the more realistic and lower complexity Luby Transform code in a linear network. Results are provided herein for a linear network assuming uniform imperfect channel states.

In [34], we focus on the use of network coding in a wireless sensor network where data is already encoded at the source node with fountain codes, in particular LT or Raptor codes. These codes have a specific degree distribution to follow in order to obtain an efficient decoding process. However, adding a layer of network coding on such packets triggers a distorsion of the degree distribution. Consequently, the packet overhead needed for the decoding process can grow significantly. In this paper, we analytically study how the degree distribution of the encoded packets evolves when they are XORed together. We prove that the degree distribution can be preserved if the degrees of the packets to XOR them are chosen according to a certain probability, that we define theoretically. Our results hold for any type of fountain codes, even if this paper presents results only for LT and Raptor codes.

Finding performance bounds for wireless ad hoc networks consist to optimize the network policies with respect to several criteria [29]. The considered criteria are capacity, robustness, delay and energy. Therefore, we have developed a stochastic network model which is combined to a multiobjective optimization problem formulation. This model is valid for any network topology. In this network model, a node of the network is characterized by a stochastic matrix whose elements give the probability to broadcast a packet coming from any of its neighbors. It is different from standard routing approaches where the node's routing decisions are formalized by the decision to transmit a packet to a specific neighbor. The model we propose better fits the actual property of wireless transmission which are inherently done in a broadcast mode (i.e. a packet sent can be heard by all the nodes in the transmission range). The broadcast decisions of the nodes set the interference distribution in the network. Hence, with the proposed model, it is possible to accurately model the interference power for the links of the network for a constantly transmitting source node. Based on this stochastic network model, it is possible to derive various performance metrics. For instance, in our first approach [29], criteria such as robustness, delay and energy consumption were proposed to obtain performance bounds in a wireless sensor network. In this work, we assume a unique continuous transmission flow between a source and a destination node.

5.3. Autonomous wireless networking

In [11], we consider an intelligent transportation system where a given number of infrastructured nodes (called Dissemination Points, DPs) have to be deployed for disseminating information to vehicles in an urban area. We formulate our problem as a Maximum Coverage Problem (MCP) and we seek to maximize the number of vehicles that get in contact with the DPs over the considered area. The MCP is known to be NP-hard in its standard formulation, therefore we tackle it through heuristic algorithms, which present different levels of complexity and require different knowledge on the system. Next, we address the problem of guaranteeing that a large number of vehicles travel under the coverage of one or more DPs for a sufficient amount of time. We therefore give a different formulation of the problem, which however is still NP-hard and requires a heuristic approach to be solved. By evaluating the proposed solutions in a realistic urban environment, we observe that simple heuristics provide near-optimal results even in large-scale scenarios. However, we remark that a near-optimal coverage of mobile users can be achieved only when the characteristics of vehicular mobility are known.

It has been proven that the use of mobile nodes as data mules in wireless sensor networks can improve the information collection process, increase the sensors lifetime, and reduce the probability that sensors experience buffer overflow. To that end, data mules are typically required to follow precise trajectories. However, controlling the movement of mobile nodes is not always possible. In [20], we introduce the concept of virtual data mule (VDM), which, by leveraging opportunistic cooperation between mobile nodes, abstracts the data collection function from specific physical mules. We apply the VDM concept to the case of data retrieval from road-side sensors through vehicular nodes. We propose two VDM algorithms targeting such a scenario and, by means of simulation in realistic mobility settings, we show that VDMs can fulfill data collection requirements that are simply unfeasible when traditional data mules are employed.

WSNs are data centric networks to which data aggregation is a central mechanism. Nodes in such networks are known to be of low complexity and highly constrained in energy. This requires novel distributed algorithms to data aggregation, where accuracy, complexity and energy need to be optimized in the aggregation of the raw data as well as the communication process of the aggregated data. To this end, we propose in [32] a distributed data aggregation scheme based on an adaptive Auto-Regression Moving Average (ARMA) model estimation using a moving window technique and running over suitable communications protocols. In our approach, we balance the complexity of the algorithm and the accuracy of the model so as to facilitate the implementation. Subsequent analysis shows that an aggregation efficiency up to 60% can be achieved with a very fine accuracy of 0.03 degree. And simulation results confirm that this distributed algorithm provides significant energy savings (over 80%) for mass data collection applications.

Self-organization appears as a new paradigm for providing efficient, self-adaptive, scalable, fault-tolerant and robust communication protocols in dynamic and distributed wireless multi-hop networks such as WSNs. Thus, it allows high level applications or protocols to operate efficiently above an underlying logical topology without neither waste of resources nor centralized point of control. A variety of distributed algorithms for forming virtual network topologies are being considered as basic mechanisms to achieve these goals. This paper presents performance evaluation and analysis work of two kinds of self-organization algorithms for data gathering applications under realistic radio assumptions for WSN using network simulation tool. In [14], we investigate the characteristics of self-organization algorithms such as connected dominating set and link pruning strategies during the WSN life. We study the latency, the dissipated energy during the chaotic network deployment, the robustness and the cardinality of virtual topologies. Then, we study the throughput and the communication overhead of these self-organization algorithms while data gathering application are proposed with one or several sinks.

In [12], we presents and evaluates a cross-layered communication architecture which allows for robust, reliable and efficient data collection in an embedded wireless multi-hop network. The proposed solution, based on a novel embodiment of gradient routing, proposes to piggyback control data along with data packets. We show how this simple scheme is robust against topological changes which are quickly absorbed by the network, and that it is largely unaffected by the density or size of the network. Experimental results confirm these observations and show how the nodes and sinks can be added/removed without disturbing network operation while staying energy efficient. The simple solution proposed in this paper offers a true deploy-and-forget user experience.

In [13], a novel forwarding scheme based on a distributed wakeup scheduling algorithm is proposed which can guarantee bounded delay on the messages that are delivered, and can have higher delivery ratios for ultra-low duty-cycle WSNs under unreliable links. The proposed forwarding protocol has two phases, initialisation and run-time. In the initialisation phase, every node can get their hop count and expected delivery ratio to the sink node. In the run-time phase, every node can locally calculate the wakeup slots using the proposed wakeup scheduling algorithm which schedules the wakeup time of each node according to the hop count and expected delivery ratio to the sink node that are got in the initialisation phase. We model the forwarding scheme and analyse its properties. Analytical results show that the proposed wakeup scheduling algorithm can have an optimal delivery ratio. We also simulate the forwarding protocol using WSNet. Simulation results are in line with the mathematical model and show that the proposed forwarding protocol has good performances in terms of delivery ratio, end-to-end delay and energy efficiency.

The capacity of a multi-hop wireless network is the traffic payload that it can transport. This is a prominent quality of service issue, particularly in the highly constrained settings of 802.11 wireless mesh network. Complementary definitions of the capacity exists. A network-wise capacity is defined as the sum of the upload traffic, and a flow-wise capacity highlights the unfairness among traffic flows. In the settings of omnidirectional antennas and local broadcast medium, these capacities present an insensitivity to several parameters (routing protocols, number and location of gateways bridging the network to the Internet, and the physical network topology) while it is directly related to the congestion around the gateway [36]. On the other hand, when directional and tightly focused antennas are used, e.g. for fixed broadband wireless backhauling networks, interference mitigation is no longer an optimization issue and the focus is on power efficiency. Under this scenario, a power-efficient configuration can be characterized by a modulation constellation size and a transmission power level and a network wide joint optimization of data routing and radio configuration is defined to minimize the total energy consumption while handling all the traffic requirements simultaneously. An exact mathematical formulation of the problem relies on a minimum cost multicommodity flow with step increasing cost functions, which is very hard to optimize. A piecewise linear approximation of the energy cost to capacity binding, obtained by linear interpolation of power-efficient points, provides a good approximation of the energy consumption on the links [3].

Technology evolution have made possible to connect all kind of devices to IP network. This becomes an evident objective for sensors networks research. The IETF 6LoWPAN RFC proposal was developed in that sense to use the benefit of IPV6 over wirelessly connected sensors. The IEEE 802.15.4 MAC layer stack being popular in the domain of wireless sensors within constrained resources, a few 6LoWPAN adaptations already exist. In [23], we investigate the possibility of using IPv6 for sensor networks connected through powerline communication (PLC) non-wireless mediums and demonstrate possible interoperability. This document propose the first adaptation of the IEEE 802.15.4 commons standard on PLC medium. Following this standard interface, we demonstrate the possibility to carry out data on PLC with great reliability, and low power energy requirement using our WPCTMphysical layer (called Watt Pulse Communication (WPC)). This allows to benefit from the development of WSN research for PLC communication networks. Moreover, such a IEEE 802.15.4/6LoWPAN communication stack provides a generic communication standard for heterogeneous sensors networks. Thus, we finally demonstrate interoperability with tests between powerline and wireless sensor networks running IEEE 802.15.4/6LoWPAN stacks.

5.4. Security

The recent advances in information theory and networking have significantly modified the way to disseminate data in WSNs: aggregation, network coding or rateless codes. These new paradigms of dissemination create new threats for security such as pollution attacks. These attacks exploit the difficulty to protect data integrity in those contexts. In [18], we considered the particular case of xor network coding. We compare the different strategies based on message authentication codes algorithms (MACs) to thwart these attacks. We emphasize the advantages of universal hash functions (UHFs) in terms of flexibility and efficiency. These schemes reduce the energy consumption by 42% and 68% (according to the used protocol) for the relaying nodes over those based on classical cryptographic primitives without any loss in security. The key feature of the UHFs considered here is their homomorphic linear property. These homomorphic MACs offer more possibilities for the relying nodes than the classical cryptographic ones: the detection time of a pollution attack can be adjusted to preserve the nodes energy. Moreover, they can be computed with the low resources of a sensor.

In [26], we focus on the resiliency of WSN routing protocols against selective forwarding attacks by compromised nodes. To provide for security in such a context cryptographic solutions must be completed by algorithmic solutions considering "beyond cryptography" approaches. Enhancing the routing protocol resiliency to attacks is one approach that merits further investigation. First, we have described some protocol behaviors enhancing resiliency in this particular context. These behaviors are mainly based on traffic redundancy and probabilistic selection for the next hop candidates which permit to exploit and benefit from the inherent structural redundancy of densely deployed WSNs. Several variants of the well known Gradient Based Routing (GBR) protocol were tested and simulation results show that using the proposed strategies resiliency can be improved. The results also shed some light on the resiliency-energy consumption trade-off.

Many distance bounding protocols appropriate for the RFID technology have been proposed recently. Unfortunately, they are commonly designed without any formal approach, which leads to inaccurate analyzes and unfair comparisons. Motivated by this need, we introduce in [6] a unified framework that aims to improve analysis and design of distance bounding protocols. Our framework includes a thorough terminology about the frauds, adversary, and prover, thus disambiguating many misleading terms. It also explores the adversary capabilities and strategies, and addresses the impact of the prover ability to tamper with his device. It thus introduces some new concepts in the distance bounding domain as the black-box and white-box models, and the relation between the frauds with respect to these models. The relevancy and impact of the framework is finally demonstrated on a study case: Munilla-Peinado distance bounding protocol.

In [19], the threat of relay attacks is considered for the UWB technology. Distance bounding protocols have been designed to thwart these attacks. In this work, we study the way to adapt distance bounding protocols to time-hopping ultra wide band (TH-UWB) radios. Two protocols are proposed which are based on the milestones of the TH-UWB radio: the time-hopping sequence and the mapping code. The security and the different merits of those protocols are analyzed.

6. Contracts and Grants with Industry

6.1. 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.

7. Other Grants and Activities

7.1. National Actions

7.1.1. 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, Télécom Bretagne and INRIA.

7.1.2. 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.

7.1.3. 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.

7.1.4. 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.

7.1.5. 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.

7.2. Actions Funded by the EC

7.2.1. 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.

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

Participants: Jean-Marie Gorce, Katia Jaffres-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.

8. Dissemination

8.1. Leadership within the scientific community

8.1.1. 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: member of the “Expert for recruiting committees of 61^{e} section” in INSA Lyon, 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 (MCF); expert reviewer of the “recruiting committees of 27e section” in INSA Lyon (Professor); member of the "Expert for recruiting committees of 27e section" in University of Grenoble I; member of the "Expert for recruiting committees of 27e section" in Paris 13.

8.1.2. Editorial Boards

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

8.1.3. Conferences and workshops organization

Marco Fiore: REVE/ResCom (November, Lyon, France).

Fabrice Valois: Co-Chair of the “journées d’automne” ResCom, (November, Lyon France), General chair of the 1-day conference about Challenges for Digital Society for e-Human during Shanghai Expo’10 (May, Shanghai, China).

8.1.4. Participation in program committees

Marco Fiore: IEEE WiVeC’10, IWCMC’10 and WDN’10.
Jean-Marie Gorce: EuMW 2010, IEEE VTC spring 2010 and PLANET 2010.
Cédric Lauradoux: CARDIS 2010, EICAR 2010.

Marine Minier: CIS 2010, MEDES 2010 and TOOLS 2010.
Tanguy Risset: ASAP 2010, IEEE SIES 2010 and SAMOS 2010.
Hervé Rivano: Algotel 2010.
Bernard Tourancheau: NTMS/WSN 2010, IFIP 2010.
Fabrice Valois: Globecom'10, WiMob'10, ACM Mobility'10, ADHOCNETS'10, SensorComm'10, IWCMC'10, WiCON'10 and JDIR'10.
Guillaume Villemaud: VTC spring 2010, VTC Fall 2010 and ICC 2010.

8.2. Theses, Internships

8.2.1. Theses

8.2.1.1. Theses defended in 2010

Benoit Miscopein: "*Systèmes UWB Impulsionnelles non cohérents*", PhD thesis from INSA LYON, Orange labs grant, 04/05/2010.

Ioan Burciu: "Architecture de récepteurs radio pour le traitement bibande simultanée", PhD thesis from INSA LYON, Orange labs grant, 04/05/2010.

Wassim Znaidi: "*Quelques propositions de solutions pour la sécurité des réseaux de capteurs sans fil*", PhD thesis from INSA Lyon, Rhône-Alpes grant, 15/10/2006.

Riadh Ben Abdallah: "Machine Virtuelle pour la Radio Logicielle", PhD thesis from INSA LYON, Inria/CEA grant, 20/10/2010.

8.2.1.2. 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.

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

Cédric Chauvenet: "*IPv6/6LoWPAN network architecture design over low power*", CIFRE Watteco/CITI grant, since 02/2010.

Cengis Hasan: "Optimization of resource allocation for small cells networks", Orange labs grant, since 01/2010.

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.

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.

Meiling Luo: "*Fast and accurate radio propagation models for radio network planning*", MENRT grant, since 01/2010.

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

Mouradian Alexandre: "*Proposition et validation de protocoles de communication temps-réel pour les réseaux de capteurs sans fil*", ANR ARESA2 grant, since 10/2010.

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.

Uppoor Sandesh: "*Understanding and exploiting mobility in wireless networks*", INRIA/Alcatel-Lucent grant, since 10/2010.

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

8.2.2. Participation in thesis Committees

Jean-Marie Gorce: thesis of Cédric Abgrall (September, Paris, Telecom Paris Tech)[reviewer], thesis of Ayman Khalil (September, Rennes, INSA Rennes)[reviewer], thesis of Mathieu Lacage (November, Nice, Université de Nice)[examinator], thesis of Benoit Miscopein (May, Grenoble, INSA Lyon)[supervisor], thesis of Alberto Suarez (May, Nice, Université de Nice)[reviewer], thesis of Ali Usman (November, Paris, Telecom Paris Tech)[reviewer], thesis of Haitao Wan (December, Nantes, Polytech Nantes)[reviewer].

Marine Minier: thesis of Wassim Znaidi (October, Lyon, INSA LYON)[director], thesis of Benjamin Pousse (December, Limoges, Université de Limoges)[director].

Tanguy Risset: thesis of Riadh Ben Abdallah (October, Lyon, INSA LYON)[director], thesis of Khaled Rahmouni (December, Grenoble, INP)[president], thesis of Alexandre Chagoya Garzon (December, Grenoble, INP)[president], thesis of Muhammad Pasha (December, Rennes, Université de Rennes)[president], thesis of Joel Porquet (December, Paris, Université de Paris 6)[reviewer].

Hervé Rivano: thesis of Florent Hernandez (November, Montpellier, LIRMM)[examinator], thesis of Julien Champ (December, Montpellier, LIRMM)[examinator].

Bernard Tourrancheau: thesis of Eugène Pamba Capo-Chichi (March, Besançon, LIRMM)[reviewer], thesis of Aurélien Jacquot (March, Clermont-Ferrand, Université Blaise Pascal - Clermont II)[reviewer], thesis of Alexandre Chagoya-Garzon (December, Grenoble, Université de Grenoble)[reviewer].

Fabrice Valois: thesis of Nadjib Ait Saadi (March, Paris, Université de Paris 6)[examinator], thesis of Yacine Benallouche (November, Versailles, Université de Versailles)[reviewer], thesis of Sondes Khemiri (October, Paris, Université de Paris 6)[reviewer], thesis of Napoleao Nepomecenu (December, Nice, Université de nice)[reviewer], thesis of Sadaf Tanvir (March, Grenoble, Université de Grenoble)[reviewer].

Guillaume Villemaud: thesis of Ioan Burcu (May, Grenoble, INSA Lyon)[director].

8.2.3. Internships

Amal Yangui Moalla: QoS-aware scheduling in dense cellular networks (Nikolai Lebedev)

Cherifa Boucetta: Securing virtual coordinates systems in sensor networks (Marine Minier)

Guillaume Kremer: Protocole temps-réel pour la remontée d'alarme dans un réseau de capteurs sans fils (Isabelle Auge-Blum)

Henda Ben Cheik: Interfaces pour Wiplan, simulateur de propagation des ondes radios en intérieur (Paul Flipo et Jean-Marie Gorce)

Hoang Thanh Nguyen: Interfaçage d'IP matériel dans SOCLIB (Tanguy Risset)

Javier Cuadrado Lopez: Mac/Phy optimization in a multiservice BAN network (Claire Goursaud)

Lucie Nodin: Relaying strategies for fountain codes in wireless sensors networks. (Claire Goursaud)

Marc Lafort: Sondage de canal dans la bande WiMax (Guillaume Villemaud)

Mehdi Diouri: Sécurisation d'un mécanisme d'élection de cluster heads et lutte contre les attaques Sybille (Marine Minier)

Nicaise Ishimwe: Allocation des ressources dans les systèmes OFDMA-MIMO avec une connaissance partielle du canal basée sur la boucle de retour (Nikolai Lebedev)

Nicolas Adrian Acosta: Plateform implementation fo MIMO communication (Guillaume Villemaud)

Sebastien Mazy: Developp a base library for sensor networks (Tanguy Risset)

8.3. 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, Florin Hutu 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 Electronics, Lyon.

Bernard Tourrencheau is involved in the teaching activity at University of Lyon in different masters. 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. Bernard Tourrencheau

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 2400 hours per year.

8.4. Participation in conferences and workshops

8.4.1. Participation in conferences/workshops/schools

Ibrahim Amadou: JDIR 2010 (March, Sophia Antipolis, France), PEWASUN 2010 (October, Bodrum, Turquie), REVE/ResCom (November, Lyon, France), ResCom (November, Lyon, France).

Anya Apavatjrut: Algotel 2010 (May, Belle-Dune, France), APCC 2010 (November, Auckland, New Zealand).

Ahmed Benfarah: SEMBA 2010 (October, Autrans, France), Physical security day (GDR ISIS) (September, Paris, France) ,Globecom 2010 (December, Miami, USA).

Leila Ben Saad: NTMS (February 2010, Paris, France), JDIR 2010 (March, Sophia Antipolis, France).

Cédric Chauvenet: Recap 2009 (November 2009, Grenoble, France), Infocom 2010 (March, San Diego, USA), AICCSA'10 (Mai, Hammamet, Tunisia), IETF 77 (March, Anaheim, USA), IETF 78 (July, Maastricht, Netherlands), Smartgridcomm '10 (Octobre, Gaithersburg, US), SEMBA 2010 (October, Autrans, France), ResCom (November, Lyon, France).

Paul Ferrand: SEMBA 2010 (October, Autrans, France), COST2100 (Novembre, Bologne, Italie).

Marco Fiore: REVE/ResCom (November, Lyon, France), ResCom (November, Lyon, France).

Katia Jaffres-Runser: Algotel 2010 (May, Belle-Dune, France), IEEE WiOpt 2010 (May, Avignon, France), ACM MobiHoc/MobiCom 2010 (September, Chicago, USA), IEEE PIMRC 2010 (September, Istanbul, Turkey), ACM N2 Women Workshop (September, Chicago, USA).

Quentin Lampin: ResCom (November, Lyon, France).

Cédric Lauradoux: Algotel 2010 (May, Belle-Dune, France), Physical security workshop (GDR ISIS) (September, Paris, France).

Meiling Luo: International workshop on Femtocells (June, Luton, UK).

Marine Minier: Eurocrypt 2010 (May, Nice-Monaco, France), Cryptarchi (June, Gif sur Yvette, France).

Alexandre Mouradian: Afsec (November, Paris, France), NC2 (November, Lyon, France), REVE/ResCom (November, Lyon, France), ResCom (November, Lyon, France).

Anis Ouni: SEMBA 2010 (October, Autrans, France), JDIR 2010 (March, Sophia Antipolis, France), Algotel 2010 (May, Belle-Dune, France).

Hervé Rivano: Algotel 2010 (May, Belle-Dune, France), REVE/ResCom (November, Lyon, France), ResCom (November, Lyon, France).

Bilel Romdhani: JDIR 2010 (March, Sophia Antipolis, France), WIMOB 2010 (October, Niagara Falls, Canada, REVE/ResCom (November, Lyon, France), ResCom (November, Lyon, France).

Fabrice Valois: Algotel 2010 (May, Belle-Dune, France), SensorComm (July, Venice, Italy), REVE/ResCom (November, Lyon, France), ResCom (November, Lyon, France).

Wassim Znaidi: Algotel 2010 (May, Belle-Dune, France), NSS 2010 (September, Melbourne, Australia).

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Publications of the year

Articles in International Peer-Reviewed Journal

[1] I. BURCIU, G. VILLEMAUD, J. VERDIER, M. GAUTIER. *Low Power Front-End Architecture dedicated to the Multistandard Simultaneous Reception*, in "International journal of microwave and wireless technologies", August 2010, http://hal.inria.fr/inria-00527991/en.

[2] C. COMANICIU, N. B. MANDAYAM, V. H. POOR, J.-M. GORCE. *An Auctioning Mechanism for Green Radio*, in "Journal of Communications and Networks", 2010, vol. 12, n^{o} 2, p. 114-121, http://hal.inria.fr/inria-00499400/en.

[3] D. COUDERT, N. NEPOMUCENO, H. RIVANO. *Power-Efficient Radio Configuration in Fixed Broadband Wireless Networks*, in "Computer Communications", 2010, vol. 33, n^{o} 8, p. 898-906 [*DOI :* 10.1016/J.COMCOM.2010.01.006], http://hal.inria.fr/inria-00466477/en.

[4] G. DE LA ROCHE, P. FLIPO, G. VILLEMAUD, Z. LAI, J. ZHANG, J.-M. GORCE. *Implementation and Validation of a New Combined Model for Outdoor to Indoor Radio Coverage Predictions*, in "Eurasip Journal on Wireless Communications and Networking", 2010, http://hal.inria.fr/inria-00511655/en.

[5] M. GAUTIER, G. VILLEMAUD, I. BURCIU. *The Multi-antenna Code Multiplexing Front-end : Theory and Performance*, in "International journal of microwave and wireless technologies", August 2010, http://hal.inria.fr/inria-00528007/en.

[6] A. GILDAS, M. A. BINGÉL, S. KARDAS, C. LAURADOUX, B. MARTIN. *A Framework for Analyzing RFID Distance Bounding Protocols*, in "Journal of Computer Security - Special Issue on RFID System Security", 2010, page : to appear, http://hal.inria.fr/hal-00527408/en.

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[10] H. RIVANO, F. THEOLEYRE, F. VALOIS. *A Framework for the Capacity Evaluation of Multihop Wireless Networks*, in "Ad Hoc and Sensor Wireless networks (AHSWN)", January 2010, vol. 9, n^o^ 3-4, p. 139-162, http://hal.inria.fr/hal-00371161/en.

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[12] T. WATTEYNE, D. BARTHEL, M. DOHLER, I. AUGÉ-BLUM. *Sense&Sensitivity: A Large-Scale Experimental Study of Reactive Gradient Routing*, in "Measurement Science and Technology, Special Issue on Wireless Sensor Networks", October 2010, http://hal.inria.fr/hal-00526216/en.

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[14] I. AMADOU, F. VALOIS. *Performance Evaluation of Distributed Self-Organization Protocols in Wireless Sensor Networks*, in "7th ACM International Symposium on Performance Evaluation of Wireless Ad Hoc, Sensor, and Ubiquitous Networks (PE-WASUN)", Turquie Bodrum, October 2010, http://hal.inria.fr/inria-00540850/en.

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on Modeling and Optimization in Mobile, Ad Hoc, and Wireless Networks (WiOpt) 2010", France Avignon, IEEE, 2010, 1, Routing, http://hal.inria.fr/inria-00485780/en.

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