INRIA

INSTITUT NATIONAL DE RECHERCHE EN INFORMATIQUE ET EN AUTOMATIQUE

# *Project-Team TRIO*

# *Temps Réel et InterOpérabilité (Real Time and InterOperability)*

*Nancy - Grand Est*

Theme : Embedded and Real Time Systems

# Table of contents


**1. Team** ..... **1**
**2. Overall Objectives** ..... **2**
2.1. Highlights of the year 2
2.2. Objectives of the team 2
**3. Scientific Foundations** ..... **2**
**4. Application Domains** ..... **3**
**5. Software** ..... **4**
5.1. Diatélic 4
5.2. MPIGate: Multi-Protocols Interface and Gateway for telehomecare and environment monitoring and control 4
5.3. SPECO: Software Platform to Evaluate the impact of Compilation Optimizations 5
5.4. ANR MORE platform 5
5.5. ANR Open-PEOPLE platform 5
5.6. VITRAIL 6
**6. New Results** ..... **7**
6.1. Real time services and protocols 7
6.1.1. Network-MAC cross-layer framework for differentiated QoS in wireless sensor networks 7
6.1.2. QoS in UWB-based sensor networks 7
6.1.3. Wireless Networked control systems (WNCS) 7
6.1.4. Wireless networks for ambient assisted living systems 8
6.1.5. QoS routing protocols 8
6.1.6. Wireless sensor network testbed 8
6.2. Evaluation and optimal scaling of real time systems 9
6.2.1. Code analyses and advanced visualization of software in real-time 9
6.2.2. Low-power memory placement 9
6.2.3. Iterative multicriteria optimizations in critical, real-time systems 9
6.2.4. Open Power and Energy Optimization PLatform and Estimator 9
6.2.5. Real time deterministic multiprocessor scheduling 10
6.2.6. Probabilistic scheduling of real time systems 10
6.2.7. Sensitivity analysis for real time distributed systems 10
6.2.8. Robustness evaluation for a critical distributed system 11
6.2.9. Robust deployment of a real-time in-vehicle embedded middleware 11
6.2.10. Scheduling of tasks on automotive multicore ECUs 11
6.2.11. Aperiodic traffic in response time analyses with adjustable safety level 11
6.2.12. Networked control systems: resource overload management using selective data dropouts according to $(m, k)$-firm model 12
6.2.13. Performance evaluation and optimization 12
**7. Contracts and Grants with Industry** ..... **13**
7.1. PSA-Peugeot Citroën contracts - End-to-end time contraints in an AUTOSAR context 13
7.2. Medetic - Remote monitoring for elderly people 13
**8. Other Grants and Activities** ..... **13**
8.1. National Grants 13
8.1.1. ANR Project “Architectures du Futur” - Multicriteria Optimizations for Real time Embedded systems (MORE) 13
8.1.2. ANR Open-PEOPLE - Open Power and Energy Optimization PLatform and Estimator 13
8.1.3. PRST MISN / Thème MIS: VITRAIL - Visualisation Temps Réel, Avancée et Immersive de Logiciels 14

8.1.4. PREDIT Project - Systèmes Critiques pour l'Automobile : Robustesse des Logiciels Embarqués Temps-réel (SCARLET) 14
8.1.5. "Pôle de Compétitivité Alsace Franche-Comté" and FCE - CRISTAL Project 15
8.1.6. ARA SSIA SAFE_NECS 15
8.1.7. GIS 3SGS: CONECS - Co-design Of NEtworked Control Systems 15
8.1.8. PRST MISN / Thème SSS: COWNECS - Co-design Of Wireless NEtworked Control Systems 15
8.2. European Projects 16
**9. Dissemination** . . . . . **16**
9.1. Visits 16
9.2. Action for the research community 16
9.3. Colloquium, seminars, invitations 17
9.4. Teaching activities 18
**10. Bibliography** . . . . . **19**

*TRIO is common project to INRIA, CNRS, INPL, Henri Poincaré University and Nancy 2 University through LORIA laboratory (UMR 7503).*

# 1. Team

**Research Scientist**

Liliana Cucu-Grosjean [ Research Scientist, INRIA ]
Nicolas Navet [ Research Scientist, INRIA ]
Olivier Zendra [ Research Scientist, INRIA ]

**Faculty Member**

Françoise Simonot-Lion [ Team Leader, Professor, INPL, École Nationale Supérieure des Mines de Nancy, HdR ]
Ye-Qiong Song [ Professor INPL, École Nationale Supérieure d'Electricité et de Mécanique, HdR ]
Jean-Pierre Thomesse [ Professor, INPL, École Nationale Supérieure d'Électricité et de Mécanique, HdR ]

**External Collaborator**

René Schott [ Professor, UHP Nancy I, IECN ]
François Simonot [ Assistant Professor, UHP Nancy I, IECN ]
Lhassane Idoumghar [ Assistant Professor, Université de Haute Alsace, LMIA ]

**Technical Staff**

Lionel Havet [ CRISTAL Project ]
Adrien Guénard [ CRISTAL Project ]
Sophie Alexandre [ OPEN-PEOPLE Project ]
Jonathan Ponroy [ MORE Project ]
Kevin Roussel [ OPEN-PEOPLE Project ]
Damien Bodenes [ VITRAIL Project ]

**PhD Student**

Najet Boughanmi [ Co-supervised with CRAN-Nancy, MNRT grant until September 2009, Teaching Assistant since September 2009, INPL ]
Pierre Caserta [ MNRT grant since October 2008 ]
Flavia Felicioni [ Co-Supervised with Rosario University - Argentina, since September 2005 ]
Maha Idrissi Aouad [ financed by contracts since October 2007 ]
Ning Jia [ financed by contracts until January 2009 ]
Dawood Khan [ CORDI grant since September 2008 ]
Yanjun Li [ co-supervised with Zhejiang university - China since February 2007 ]
Aurélien Monot [ CIFRE grant with PSA company since October 2008 ]
Bilel Nefzi [ MESR grant since September 2007 ]
Shahram Nourizadeh [ CIFRE grant with Medetic company since September 2007 ]
Jamila Ben Sliman [ co-supervised with SUPCOM Tunis - Tunisia, since October 2007 ]

**Post-Doctoral Fellow**

Hugo Cruz Sanchez [ Nancy Université ]

**Administrative Assistant**

Laurence Benini
Françoise Laurent [ INPL ]

# 2. Overall Objectives

## 2.1. Highlights of the year

- Françoise Simonot-Lion was guest editor of two special sections of the journal IEEE transactions on Industrial Informatics [14], [9].
- Liliana Cucu participated to the preparation of a STREP project within the call FP7-ICT-2009 - Embedded Systems. The project entitled PRObabilistic Analyzable Real TIme Systems (PROARTIS) had been accepted with the best rating (14.5 over 15) among all proposed projects. PROARTIS is a joint project between TRIO team, Centro Nacional de Supercomputation Barcelona, Rapita Systems York, Universita degli Studi di Padova, and Airbus France SAS. Its start time is February 2010.

## 2.2. Objectives of the team

The goal of the TRIO team is to provide a set of techniques and methods that can be applied to design, validate and scale real time distributed applications. In order to tackle this problem as a whole, our work is structured along two complementary points of view:

- specification of real time on line mechanisms (protocols, schedulers, middleware) offering services to the application with a quality of service that ensures the satisfaction of real time constraints; this includes fault detection, fault recovery and fault tolerance,
- modeling, analysis and evaluation of real time distributed systems for the verification of temporal properties and the optimisation of distributed deployment.

Furthermore, we will continue to study the modeling process of real time distributed applications that allows the description of both functional and non-functional aspects of these applications and therefore a formal use of these models for quantitative evaluation and optimal scaling.

The problems to solve are mainly due to three particularities of targeted applications:

- They are discrete event systems with temporal characteristics (temporal performances of hardware support, temporal properties); this increases the complexity of their modeling and of their analysis. Hence a part of our research objectives is to master this complexity while stating a compromise between the accuracy of a model and its ability to be analyzed.
- A second aspect is the environment of these systems that can be the cause of perturbations. We need to take into account the impact of an uncertain environment (for example, the impact of electromagnetic perturbations on a hardware support) on the required properties. Therefore we have to develop stochastic approaches.
- Finally, the main characteristic of our works is based on the fact that we consider the performances of hardware supports. Consequently, the time that we manipulate is a physical (continuous) time and the studied systems are event driven timed systems.

These above mentioned main directions contribute to cover the full spectrum from formal modeling and evaluation of real time distributed systems up to their use in industrial problems, in particular, in the field of in-car electronic embedded systems or real time Quality of Service. Furthermore, some of our results yield to software tools and fruitful collaborations with the automotive industry.

# 3. Scientific Foundations

## 3.1. Scientific Foundations

In order to check for the timed behavior and the reliability of distributed systems, the TRIO team developped several techniques based on deterministic approaches ; in particular, we apply and extend analytical evaluation of worst case response time and when necessary, e.g. for open communication systems as internet based applications, we use techniques based on network calculus.

When the environment might lead to hazards (e.g. electromagnetic interferences causing transmission errors and bit-flips in memory), or when some characteristics of the system are not perfectly known or foreseeable beforehand, we model and analyze the uncertainties using stochastic models, for instance, models of the frame transmission patterns or models of the transmission errors. In the context of real time computing, we are in general much more interested by worst-case results over a given time window than by average and asymptotic results, and dedicated analyses in that area have been developed in our team over the last 10 years. An illustration, is our recent contribution to the extension of "consecutive-k-out-of-n:F" analyses, applied to the reliability evaluation of X-by-Wire systems As far as the design of discrete event systems is concerned, we mainly use scheduling techniques for real time systems.
In the design of discrete event systems with hard real time constraints, the scheduling of the system's activities is of crucial importance. This means that we have to devise scheduling policies that ensure the respect of time constraints on line and / or optimize the behavior of the system according to some other application-dependent performance criteria. A new approach to solve these problems was partially developed in our team: the trajectory approach with priority functions. This approach has been used many times to make formal proofs of schedulability results in quite general cases. Another line of research investigated in our team is the use of techniques originating from network calculus, with the aim of minimizing the set of assumptions about the system's behaviour.

Many current systems can adapt dynamically to the environment. This is why we focus on "weakly hard" real time constraints such as $(m, k)$-firm constraints and study their applicability in two main application fields. The first one is concerned by application under weakly hard constraints, as real time multimedia application that are deployed for example on internet; in this case, the main problem is to adapt the $(m, k)$-pattern to the current requirements in terms of real time Quality of Service. The second domain where these techniques are investigated is the co-design of networked control systems. It has to be noted that in this domain several approaches are developed by the community; some of them focus on the automatic control problem and try to solve it by delayed systems while other ones are concerned only by the scheduling techniques to implement in order to guarantee the timing properties required by the closed loops. In this context, we propose to specify how to scale both control law parameters and scheduling strategies for tasks and messages and, for this purpose, we integrate control theory (linear systems, multi-variables), optimisation and schedulability analysis in order to develop off-line and on-line techniques

# 4. Application Domains

## 4.1. Application Domains

Four main application domains can be underlined.

- **In-vehicle embedded systems.** A lot of work developed in TRIO is oriented towards transportation systems (cars, autonomous vehicles, etc.). They mainly cover two points. The first one is the specification of what must be modeled in such a system and how to reach a good accuracy of a model; this leads to investigate topics like Architecture Description Languages and automatic generation of models [44]. The second point concerns the verification of dependability properties and temporal properties required by these applications and, consequently, the development of new fault tolerant on-line mechanisms to include in an application or the automatic generation of a standard middleware.
- **Compilation, memory management and low-power issues for real time embedded systems.** It is mandatory, in a context of environment preservation, to design embedded systems that respect performances and reliability constraints while minimizing the energy consumption. Hence, TRIO is involved, on the one hand, in the definition of adhoc memory management at compilation time and on the other hand, in joint study of memory management strategies and tasks scheduling for real time critical systems.

- **Code analyses and software visualization for embedded systems.** Despite important advances, it is still impossible to develop and optimize automatically all the programs with all their variety, especially when deployment constraints are considered. Software design and implementation thus remain highly ad-hoc, poorly automated activities, with a human being in the loop. TRIO is thus involved in the design of better tools for software engineering focusing on helping the human developer understand and develop the system, thanks to powerful automated program analyses and advanced visualizations techniques.
- **Quality of services (QoS) of protocols and telecommunications.** In many application domains, the evaluation and, when required, the improvement of the quality of services provided by the used communication protocols is a way to ensure the respect of real time and dependability properties. In this context, we model and analyze some protocols for internet and Cyber Physical Systems (CPS) and aim to define the optimal configuration of their characteristics (protocols for the QoS guarantee for multimedia applications or ambient assisted living applications). Although WSN (Wireless Sensors Network) technology is economically a very interesting solution for building CPS, unfortunately its current QoS is not sufficient for supporting such applications. Adaptive QoS seems to be an interesting approach to this problem. This could be achieved in two coordinated directions: one is to develop the on-line adaptive QoS management in network to cope with the time varying performance requirement of an application; another is to make applications to adapt to the network working condition changes if they go beyond the network QoS control range. We follow a pragmatic approach by assuming the use of the COTS components (e.g. IEEE802.15.4/Zigbee) at the lower levels. The adaptive QoS are mainly studied at the routing level with cross-layer optimization and by defining and developing a QoS middleware allowing the necessary on-line interaction between the network and the application.

# 5. Software

## 5.1. Diatélic

**Participant:** Jean-Pierre Thomesse.

After having developed (in 2002) the well-suited structure for the deployment of the “Diatélic” service in Lorraine, more than 200 patients have been installed and get benefits from the remote monitoring service for peritoneal dialysis therapy. This deployment has been very rich in experience for extending an innovative system at a wide scale. In terms of medical results, the same tendencies are observed as during the experiment (1999-2002); i.e. best control of weight, of blood pressure, less consumption of drugs and important decreasing of the hospitalization duration (50 %), leading to an economy for health insurance of about 15 000 euros per year and per patient.

## 5.2. MPIGate: Multi-Protocols Interface and Gateway for telehomecare and environment monitoring and control

**Participants:** Shahram Nourizadeh, Hugo Cruz Sanchez, Ye-Qiong Song.

For developing AAL (Ambient Assisted Living) or more generally the environment monitoring and control systems, heterogeneous wireless and wired networks will be used. To solve at the first time the interoperability problems, and then to ensure the application required QoS, we developed a software prototype called MPIGate. MPIGate includes two important components: a user interface for telehomecare and home automation, and a gateway for ensuring the interworking of the different networks. In its current version, the gateway ensures the communication between IP (Ethernet and Wifi), home automation networks (IHC and In One), Bluetooth and Zigbee. The interface already offers different services for a typical telehomecare system (services via internet, home automation tasks, health monitoring). Heterogeneous sensors can be used to build the actimery of the person living at home. This software prototype will be further extended to integrate a QoS middleware. Other operator oriented interface will also be added.

## 5.3. SPECO: Software Platform to Evaluate the impact of Compilation Optimizations

**Participants:** Maha Idrissi Aouad, Olivier Zendra.

This prototype platform aimed at automatically running a large number of benchmarks and thus get precise concrete results over the actual impact of any compilation optimization we design in our research. The first set of benchmarks, to experiment with the prototype platform, had been chosen among the most relevant according to the bibliography, and mostly comprise multimedia and embedded systems related programs. The platform worked as follows. It extracted static metrics to provide information about the structure and static complexity of the benchmarks. It compiled all the benchmarks, and ran them to extract dynamic metrics helping characterize the behavior of programs at run-time. Those dynamic metrics comprised time, for raw performance and space (memory) information to better understand the memory behavior of the programs. More recently, some work was realized to integrate the energy usage metric to SPECO. This metric is indeed an important part for our current research work, for example in the ANR MORE project, where SPECO used to be intended to be used to characterize programs and obtain some of the metrics needed in MORE for its iterative compilation framework. However, since the development of SPECO was not progressing as forecast, SPECO was put on hold this year to leave place to another, more thoroughly thought of and more mature development that could benefit from this experience (see ANR MORE platform).

## 5.4. ANR MORE platform

**Participants:** Jonathan Ponroy, Olivier Zendra.

With three partners (LIP6 in Paris, IRIT in Toulouse, and INRIA-LORIA), the ANR MORE (Multicriteria Optimization for Real-time Embedded systems) project aims at developing trade-off strategies that transform the code of a critical embedded application so that it meets the system constraints in terms of worst-case execution time, code size and energy consumption. In this project, we at INRIA Nancy Grand Est focus on memory optimizations for energy under real-time constraints. With our partners, we are developing in this project an iterative optimization process that will help in driving the selection of the transformations to apply according to measures carried on the system (through a simulator provided by the IRIT partner).

In the past years, we were laying the foundations for this platform. Thanks to the recruitment of Jonathan Ponroy this year, we have been able to make very significant progress in this area and worked on building the software bases for the experimental platform. More precisely, we have been developing measure tools for the energy part and for memory characterization (initially loosely based on SPECO and other developments, but not anymore) and have been working on their integration with and into the libraries ands simulator (Otawa) provided by our IRIT partner, and with the code compression extension provided by our LIP6 partner. We completed the memory cache behavior of Otawa, taking into account new elements, such as its write policy. Scratchpad memory and a part of DRAM memory were also added to Otawa to more accurately simulate energy consumption.

We are now able to simulate architectures with several memory banks, various memory placement strategies for data, and obtain the relevant energy consumption. To test and visualize theses results, we automated the simulation task, stressing various architectural environments and memory placements. We also automated the generation of graphs to visualize this large mass of data directly in OpenOffice. This helps us for the exploitation of the experimental results for the scientific work itself.

Finally, once these bases were solidly established, we started working on the iterative, multicriteria process part per se, with a strong interaction with LIP6. The architectural work for this part of the platform is still ongoing, since for example we want to be able to easily change the exploration algorithm.

## 5.5. ANR Open-PEOPLE platform

**Participants:** Sophie Alexandre, Kévin Roussel, Olivier Zendra.

The aim of Open-PEOPLE is to provide a platform for estimating and optimizing the power and energy consumption of systems (see the section about ANR Open-PEOPLE in this report for more details).

The Open-PEOPLE project formally started in April 2009. Two systems administrator and software developers have been hired: Sophie Alexandre and Kévin Roussel.

Since the beginning of the project, we have made significant progress in setting up the infrastructure for the software part of the platform, for which INRIA Nancy Grand Est is responsible.

Indeed, the ANR Open-PEOPLE project aims, amongst other objectives, at developing a software platform, using the Java programming language. These developments will follow the recommendations of the "agile software development" methodology. More specifically, a continuous integration system is installed in order to ensure the quality of the produced source code. This continuous integration system is based on the use of Subversion (SVN) as revision control tool and source code repository, and Hudson as continuous integration service (automated builds and tests).

As we defined during the Open-PEOPLE project's start specific requirements for our continuous integration system, in order to ensure a stronger quality by refusing commits that put the trunk into jeopardy, we developed plug-ins and scripts for the two aforementioned tools (SVN and Hudson) to tailor their features and operation to our needs.

The extension we developed thus adds the following features:

- definition of "protected branch(es)" into the source repository
- continuous control of the stability of the protected branch(es) by automated testing and code coverage checking
- automatic "rewind" of the protected branch(es) to the latest known stable state, should a faulty commit be performed
- lock mechanism to prevent commits from occurring while still testing a previous commit

We call this specific extension set for SVN and Hudson OPCIM (Open-PEOPLE Continuous Integration Mechanism). An APP release of OPCIM is ongoing.

A web site has also been set up to integrate the results provided by these tools and offer a privileged space for the project partners interactions.

## 5.6. VITRAIL

**Participants:** Damien Bodenes, Pierre Caserta, Olivier Zendra.

The aim of the VITRAIL operation is to provide tools for the advanced and immersive visualization of programs (see the section about the VITRAIL project, funded by the PRST MISN in this report for more details). It partners with the Université de Montréal and Pareo team of INRIA Nancy Grand Est.

This year, in VITRAIL, we first developed software to instrument and trace Java programs at the bytecode level. We then developed an analysis tool able to exploit these traces to compute relevant software metrics. Finally, we have just finished the development of a back-end tool relying on the traces and computed metrics to generate input for the VERSO visualization tool of the Université de Montréal, in order to really start experimenting on visualizations.

Furthermore, we have recently hired Damien Bodenes as software developer, and have begun working on a prototype able to render a 3D world, symbolizing software, onto various visualization hardware. The first step of this work consists in validating the software technology chosen. We have identified the main functions of our application which are metric extraction, 3D modeling of a chosen metaphor, 3D rendering. So far, we have focused on the last two functions. We evaluated and tested different 3D API (OpenGL/Directx combined with SDL) and concluded that using them directly was not an efficient path. We thus turned to 3D engines which already implement a lot of the rendering functions we need. After evaluating Ogre3D and Irrlicht, we chose the latter and are currently developing a prototype in C++ based on it.

Our next goal is to improve the current prototype and to interface it with a double screen. Using interaction peripherals (like wiimote, 3D navigation mouse,...) will also be evaluated.

An APP release of the VITRAIL software is ongoing.

# 6. New Results

## 6.1. Real time services and protocols

In this area, we developed, on the one hand, policies for managing the quality of service of operating support (mainly, networks and protocols) in order to meet the properties required by real time applications (hard real time, weakly hard real time) and, on the other hand, strategies for scheduling activities and memory management.

### *6.1.1. Network-MAC cross-layer framework for differentiated QoS in wireless sensor networks*

**Participants:** Hugo Cruz Sanchez, Bilel Nefzi, Ye-Qiong Song.

Self-adaptive QoS mechanism is preferable in large-scale wireless sensor networks because of frequent network condition changes and the difficulty to statically configure the network parameters. A network-MAC cross-layer framework has been developed for facilitating packet scheduling, congestion control and energy consumption minimization. The work is based on a very simple idea of "collecting-and-transmitting burst" scheme, called CoSenS (Collecting and Sending burst Scheme). The underlying MAC protocol is the widely adopted and deployed unslotted CSMA/CA of IEEE802.15.4. An algorithm is designed making the network self-adapts to the dynamic traffic changes. CoSenS provides a simple but efficient improvement of the MAC layer of IEEE 802.15.4 in terms of reliability, delay and throughput. The network layer uses static routing or hierarchical tree routing of ZigBee standard [47]. A scheduling algorithm GVF (Greatest Velocity First) is also developed above CoSenS. CoSenS itself has been extended to a scheme called SCSP (Send Collect and Sleep Protocol) which supports active/inactive periods of nodes, allowing thus to save energy. SCSP uses a modified version of the Zigbee hierarchical tree routing protocol [34].

### *6.1.2. QoS in UWB-based sensor networks*

**Participants:** Jamila Ben Sliman, Mounir Frikha [INIT, SupCom, Tunisia], Anis Koubâa [ISEP-IPP-Politechnic Institute of Porto, Portugal], Ye-Qiong Song.

IEEE802.15.4a provides higher data rates with smaller energy consumption thanks to the UWB (Ultra Wide Band) technology. However there exist few solutions on how to optimally exploit the great potential of this new standard. Similar to the industrial wireless network initiatives (e.g. WirelessHART, ISA SP100, IEEE802.15.4e), we are developing optimal configuration schemes based on TDMA. The aim is to find dynamic TDMA cycle configuration that optimally assigns both time-slots and frequency channels. Typical applications could be large-scale mesh networks. Hospital WSN introduced in [20] is an example where the system is organized in three tiers (Body Sensor Network, Personal Area Network and UWB/Wifi Mesh cellular network) using UWB and Wifi technologies. To ensure an efficient channel allocation, we proposed in [19] a control and data channel allocation which decomposes the frequency allocation problem into two sub-problems: static control channel allocation to ensure a permanent control channel frequency per PAN, which avoids the control channel congestion problem, and dynamic data channel allocation based on PANs duty cycle's information and spatial frequency reuse to avoid the underutilization of spectrum resource. Moreover, we proposed in [18] a prioritized multi-channel multi-time slot MAC protocol which, according to the network configuration and the available spectrum resource, tries to efficiently assign time slots per channel in response to received resource requests taking into account priority levels and some other QoS requirements.

### *6.1.3. Wireless Networked control systems (WNCS)*

**Participants:** Najet Boughanmi, Hugo Cruz Sanchez, Eric Rondeau [CRAN UMR 7039, Nancy], Ye-Qiong Song.

With recent technology progress, it is becoming attractive to use wireless solutions for industrial process monitoring and control. Our approach for developing wireless networked control systems (WNCS) is based on the application and network co-design principle [17]. The idea is to on-line adjust the network parameters according to the needs of the control loops (typically represented by the tracking error). For achieving thus on a WSN (Wireless Sensor Network) which is based on CSMA/CA MAC protocol, several enhancements must be done. In [23] several possible solutions are investigated including probabilistic priority by adjusting the minimum waiting time, deterministic priority using black burst mechanism in IEEE 802.15.4/ZigBee and the beacon-enabled mode using the Guaranteed Time Slot (GTS) mechanism. [22] presents online adaptation of the IEEE 802.15.4 parameters for WNCS. Following the tracking error of a control loop, the macMinBE parameter of the IEEE 802.15.4 MAC protocol (non beacon-enabled mode) is adjusted to provide necessary priority to the nodes of the control loop. As part of GIS 3SGS Conecs and CPER Cownecs projects, in [40] our solutions of WNCS have been extended to include multi-hops and applied to the control of an industrial process (a high speed sliding crane).

### 6.1.4. Wireless networks for ambient assisted living systems

**Participants:** Claude Deroussent [MEDeTIC], Shahram Nourizadeh, Ye-Qiong Song, Jean-Pierre Thomesse.

Wireless sensor networks have a great potential for contributing to build the ambient assisted living environment to elderly people at home (PhD work of S. Nourizadeh under LORIA-MEDETIC contract). However several problems have to be addressed for the integration of WSN into the existing home automation networks. The first problem we have addressed is the optimal data routing in the WSN which is under multiple constraints (energy, mobility, node reliability, link reliability). In [39] and [38] a new routing protocol based on dynamic clustering and fuzzy logic is proposed. Simulations showed its good performance. The second problem is the high false alarm rate of the system, partially because of the frequent sensor node failures. Always based on the fuzzy logic approach, a node failure detection algorithm has been proposed [37]. This algorithm exploits the node failure history to assign a confidence level to the nodes, preventing thus the use of too frequently failing nodes. For testing our solutions, a platform has been built including both home automation and health monitoring parts ([36], [35] and [43]).

### 6.1.5. QoS routing protocols

**Participants:** Fares Ameur, Chung Shue Chen [University of Hong-Kong], Yanjun Li [Zhejiang University], René Schott, Ye-Qiong Song, Zhi Wang [Zhejiang University].

For supporting time-constrained or more generally performance-requiring applications, a two-hop neighborhood information-based routing protocol is proposed [11]. Similar to SPEED protocol, the packet deadline is mapped to a velocity. The routing decision is based on two-hop velocity integrated with energy balancing mechanism. Initiative drop control is embedded to enhance energy efficiency. Simulations show that the new protocol has led to lower packet deadline miss ratio and higher energy efficiency than two existing popular schemes. The result indicates a promising direction in supporting real-time QoS for wireless sensor networks. Connectivity is a fundamental issue in multi-hop wireless sensor networks. However, node sleeping periods, unreliable and asymmetric links have a great impact on the global quality of connectivity and the routing protocol performance. The classic result established by F. Xue and P.R. Kumar on the number of neighbors needed (lower bound) for connectivity is no longer hold. By simulations we studied the 1-connectivity probability in different network conditions including asymmetric links and varying duty cycles. Further work is under going to find the required minimal neighbors in function of duty cycles.

### 6.1.6. Wireless sensor network testbed

**Participants:** Ahlam Bencheikh, Hugo Cruz Sanchez, Shahram Nourizadeh, Ye-Qiong Song.

Simulation models make necessarily assumptions. Some real world network and application behaviors are hard to be totally captured. To experiment our solutions, in addition to simulations, we developed a WSN platform. This platform includes not only nodes under TinyOS but also the state-of-the-art nodes of ZigbeePRO and 6loWPAN. It allowed us to test the robustness of our previously developed routing protocols, while other proposals such as N-MAC protocol are under integration.

## 6.2. Evaluation and optimal scaling of real time systems

### *6.2.1. Code analyses and advanced visualization of software in real-time*

**Participants:** Pierre Caserta, Olivier Zendra.

This work has significantly progressed. A thorough state of the art has been realized and resulted in the submission of a paper to the TVCG journal.

The implementation of instrumentation, tracing and analyses (see VITRAIL software in this report) has been done, to provide us with the necessary basis for our experiments. This design work is the topic of another paper which we have begun writing.

Now, we have entered the experimentation phase that will allow us to implement, test and validate our new ideas.

### *6.2.2. Low-power memory placement*

**Participants:** Maha Idrissi Aouad, René Schott, Olivier Zendra.

Based on last years work, a bibliographic paper about low-power memory placement strategies is about to be finished and submitted.

Since software developments were taking more time than expected, work in this domain has been refocused on more theoretical aspects. These consist in modeling energy consumption of various parts of the architecture, especially caches, and trying to find better placements strategies in memory.

### *6.2.3. Iterative multicriteria optimizations in critical, real-time systems*

**Participants:** Jonathan Ponroy, Olivier Zendra.

Work in this domains is performed in the context of the ANR MORE (Multicriteria Optimization for Real-time Embedded systems) project, which involves three partners (LIP6 in Paris, IRIT in Toulouse, and us). This project aims at finding cooperative strategies to jointly improve several criteria (namely energy, code size and WCET computability) in real-time, critical systems, in iterative setting. We at INRIA Nancy Grand Est are responsible for the energy criterion.

As explained in the software related part of this report, after taking important delays in the software developments that should have been done for the project, we started on better bases and made significant progress in implementation. A join paper is beginning to be written by the project partners about the platform we have developed this year.

This experimental platform, finally provided us with the experimental setup we had directly needed and enabled us to progress on the scientific front. Currently, we have evaluated the impact of single criterion transformations. We are finishing the evaluation of bi-criteria interactions, which will allow us to tackle the next part of the project, which is the semi-automated exploration of multicriteria compromises.

### *6.2.4. Open Power and Energy Optimization PLatform and Estimator*

**Participants:** Sophie Alexandre, Kévin Roussel, Olivier Zendra.

Work in this domain is performed in the context of the ANR Open-PEOPLE (Open Power and Energy Optimization PLatform and Estimator) project, financed since the end of 2008. For more details about the project, see the corresponding section under the Grants chapter of this report. INRIA Nancy Grand Est is responsible for the software part of the platform.

Work in this project has begun in April 2009 (kick-off meeting). We have so far finished setting up the very important infrastructure for the software part of the Open-PEOPLE platform. We are finishing expressing the requirements for the platform, in order to start the actual developments and the actual integration of tools provided by the different partners. The research work itself is also is about to begin. INRIA Nancy Grand Est is involved in peak power control issues, and memory management for low-power issues. Note that we have difficulties finding good candidates for the PhD we propose.

### 6.2.5. Real time deterministic multiprocessor scheduling

**Participants:** Liliana Cucu-Grosjean, Olivier Buffet [INRIA Nancy-Grand Est].

We deal in this topic with deterministic scheduling of tasks on different processors; the schedule must be done such that the deadlines are satisfied. For the classical model of tasks, we give in [26] a solution based on a constraint satisfaction problem (CSP) that we prove equivalent to the multiprocessor problem. We propose two different CSP formulations. The first one is a basic encoding allowing to use state of the art CSP solvers. The second one is a more complex encoding designed to obtain solutions faster. With these encodings, we then study the resolution of the scheduling problem using systematic search algorithms based on backtracking.

### 6.2.6. Probabilistic scheduling of real time systems

**Participants:** Liliana Cucu-Grosjean, Dorin Maxim.

We deal here with probabilistic scheduling of real time systems with variable execution times. Since some parameters of a system can be unknown until the time instant when the activity is released or the environment can change forcing the application to adapt, we need to consider an approach able to address this type of scheduling and we investigate the use of probabilistic approaches to solve this problem. We are interested in two different problems:

- the study of priority assignment in the uniprocessor case [33]. More precisely we deal with fixed-priority scheduling of synchronous periodic task systems with variable execution times. The tasks have variable execution times given by independent discrete random variables (that we consider known) and we study the existence of an optimal priority assignment algorithm for such tasks. We provide a first result indicating that Rate Monotonic is not optimal and we prove that optimal priority assignment algorithms do exist. Moreover a first intuitive algorithm, that orders the tasks according to their probability of meeting the deadlines, is proved not optimal.
- the study of schedulability analysis in the multiprocessor case [48]. More precisely in the case of preemptive fixed-priority scheduling of periodic task systems with variable execution times we provide (naive, but efficient) improvements to existing uniprocessor analyses. These improvements are based on a discussion on the validation of probabilistic schedulability analyses. For the case of several identical processors, we give a new probabilistic schedulability analysis for global fixed-priority scheduling.

### 6.2.7. Sensitivity analysis for real time distributed systems

**Keywords:** *distributed systems*, *schedulability analysis*.

**Participants:** Liliana Cucu-Grosjean, Reinder Bril [Eindhoven University of Technology], Joël Goossens [Université Libre de Bruxelles].

Existing end-to-end response time analysis in distributed real-time systems, where the finalization of one task on a processor activates another task on another processor, is pessimistic. By "pessimistic" we mean that not all systems deemed to be unschedulable by the analysis are in fact unschedulable. This pessimism has two causes: (i) the existing analysis is based on best-case response times rather than best-case finalization times and (ii) those best-case response times are based on analysis for (worst-case) deadlines at most equal to periods minus (absolute) activation jitter. We present in [25] analytical means to determine best-case finalization times of independent real-time tasks with deadlines larger than periods minus activation jitter under uniprocessor fixed-priority preemptive scheduling (FPPS) and arbitrary phasing, allowing an improvement of the existing analysis. Moreover, we deal in [24] with exact best-case response times of periodic released, independent real-time tasks with arbitrary deadlines that are scheduled by means of fixed-priority pre-emptive scheduling (FPPS). Apart from having a value on its own whenever timing constraints include lower bounds on response times of a system to events, the novel analysis allows for an improvement of existing end-to- end response time analysis in distributed systems, i.e. where the finalization of one task on a processor activates another task on another processor.

### *6.2.8. Robustness evaluation for a critical distributed system*

**Participants:** Adrien Guénard, Lionel Havet, Françoise Simonot-Lion.

In order to improve mobility in cities, new initiatives of Intelligent Transportation Systems are emerging based on free-access electric vehicles. Making the vehicles everywhere at anytime available requires a dispatching of these vehicles over a city, this could be accomplished at a large scale with platoons of vehicles. We developped a methodology to assess the performances of such urban platoon of vehicles using different platooning algorithms, taking into account a real operational architecture which means communication delays, task jitters, data sampling and infinite resources. As a result some timing properties requirements are provided for the choice of each vehicle operational architecture for the deployment of the platooning function. Secondly an analysis is made on platooning operational architecture in order to evaluate the robustness of the platoon of vehicle under transient faults leading to information losses for the control of the vehicles [30].

### *6.2.9. Robust deployment of a real-time in-vehicle embedded middleware*

**Participants:** Liliana Cucu-Grosjean, Dorin Maxim, Nicolas Navet, Françoise Simonot-Lion.

This study is part of the PREDIT-SCARLET project. This year we study how to evaluate the robustness of a solution given by each frame-packing algorithm developped during past years face to several transient faults (delayed signals, delayed frames, etc.) For this purpose, we have done sensitivity analyses based on probabilistic approaches [49]. Under non-preemptive hypothesis, we have considered the analysis of periodic messages with activation jitters that are scheduled on a Controller Area Network (CAN) bus. We propose two probabilistic analyses, each of them provides probability distributions of message response times where the activation jitter of messages is given by independent random variables. The first analysis gives the probability of having the worst-case response time and the second analysis the distribution of the average response time.

### *6.2.10. Scheduling of tasks on automotive multicore ECUs*

**Participants:** Aurelien Monot, Nicolas Navet, Françoise Simonot-Lion.

As the demand for computing power is quickly increasing in the automotive domain, car manufacturers and tier-one suppliers are gradually introducing multicore ECUs (Electronic Control Units) in their electronic architectures. In [46], we address the general problem of scheduling numerous elementary software components (called runnables in AUTOSAR terminology) on a limited set of identical cores. In the context of an automotive design, we assume the use of the static task partitioning scheme which provides simplicity and better predictability for the ECU designers with respect to a global scheduling approach. We show how the global scheduling problem can be addressed as two sub-problems: partitioning the set of runnables and building the schedule on each core. Then, we prove that each of the sub-problems cannot be solved optimally due to their algorithmic complexity. We then present low complexity heuristics and derive lower bounds on their efficiency (i.e., competitive ratio). Finally, we assess the performance of our approach on realistic case-studies.

### *6.2.11. Aperiodic traffic in response time analyses with adjustable safety level*

**Participants:** Dawood Khan, Nicolas Navet, Françoise Simonot-Lion.

In distributed real-time systems it is crucial to ensure the temporal validity of the data exchanged among the nodes. Classically, the frame Worst Case Response Time (WCRT) analyses, and the software tools which implement them, do not take into account the aperiodic traffic. One of the main reasons for this is that the aperiodic traffic is generally very difficult to characterize (i.e., the arrival patterns of the aperiodic frames). The consequence is that one tends to underestimate the WCRT, which may have an impact on the overall safety of the system. In [32], we propose a probabilistic approach to model the aperiodic traffic and integrate it into response time analysis. The approach we develop allows the system designer to choose the safety level of the analysis based on the system's dependability requirements. Compared to existing deterministic approaches the approach leads to more realistic WCRT evaluation and thus to a better dimensioning of the hardware platform.

### 6.2.12. Networked control systems: resource overload management using selective data dropouts according to $(m, k)$-firm model

**Participants:** Flavia Felicioni [Rosario University, Argentina], Ning Jia, François Simonot, Françoise Simonot-Lion, Ye-Qiong Song.

The stability and performance of a networked control system are strongly influenced by the network delay and packet drops. We consider that late arrived sampling data are dropped, so that we only focus on the analysis of the impact of packet drop sequences on the control loop stability and performance. For any dropping sequence specified by (m,k)-firm model, and considering a simple mono-variable linear system with a proportional controller and zero control action in case of sampling data drop, we derived the stability conditions based on the upper bound of the plant state variance. It has been shown that the stability only depends on the values of m and k but not the pattern of the dropping sequence. In case of network overload, this gives much freedom to actively dropping some packets while still keeping the system stable. An analytic method to determine the optimal control gain for any given packet drop pattern is also derived, providing thus a guideline for optimal control and network resource scheduling co-design ([29]).

### 6.2.13. Performance evaluation and optimization

**Participants:** Francis Comets [LPMA, University Paris 7], Liliana Cucu-Grosjean, François Delarue [LPMA, University Paris 7], Lhassane Idoumghar, René Schott.

We analysed the deadlock phenomena occuring in (real-time) distributed systems sharing common resources [10]. In our model transition probabilities of resource allocation and deallocation are time and space dependent. The process is driven by an ergodic Markov chain and is reflected on the boundary of the d-dimensional cube. In the large resource limit, we prove Freidlin-Wentzell estimates, we study the asymptotic of the deadlock time and we show that the quasi-poyential is a viscosity solution of a Hamilton-Jacobi equation with a Neumann boundary condition. We give a complete analysis of the colliding 2-stacks problem and show an example where the system has a stable attractor which is a cycle limit.

We have designed a novel hybrid evolutionary algorithm that combines Particle Swarm Optimization (PSO) and Simulated Annealing (SA) algorithms. When a local optimal solution is reached with PSO, all particles gather around it, and escaping from this local optima becomes difficult . To avoid premature convergence of PSO, we present a new hybrid evolutionary algorithm, called PSOSA, based on the idea that PSO ensures fast convergence, while SA brings the search out of local optima because of its strong local-search ability [31]. The proposed PSOSA algorithm is validated on ten standard benchmark functions and two engineering design problems. The numerical results show that our approach outperforms algorithms proposed recently by A. Abraham, A. Ishigame, S. Nakano, P.M. Thanjaraj and K. Yasuda.

The multiprocessor scheduling problem consists in finding a schedule for a general task graph to be executed on a multiprocessor system so that the schedule length can be minimized. The multiprocessor scheduling problem is known to be NP-hard, and to obtain optimal and suboptimal solutions, several heuristic based algorithms have been developed . We propose two original Tabu Search type algorithms for solving this problem [41]. Our heuristic algorithms are validated on 13 randomly generated instances. The numerical results show that our algorithms produce solutions closer to optimality and/or of better quality than the methods presented by Chauvière, Geniet and Schott.

The frequency assignment problem involves the assignment of discrete frequencies to the transmitters of a radio network, such as a radio broadcasting network. Frequency separation is necessary to avoid interference by other transmitters to the signal received from the wanted transmitter at the reception region. Here, it is of major importance to minimize the interference while at the same time using the spectrum efficiently. We developped two original distributed algorithms implemented on clusters of PCs used to solve the frequency assignment problem in the field of radio broadcasting. The first one is based on the island distributed implementation of our hybrid genetic algorithm. The second one uses a distributed cooperative Tabu Search. Experimental results show that our algorithms, applied to several instances given by TDF-C2R, lead to important time performance improvements [13].

# 7. Contracts and Grants with Industry

## 7.1. PSA-Peugeot Citroën contracts - End-to-end time contraints in an AUTOSAR context

**Participants:** Aurélien Monot, Nicolas Navet, Françoise Simonot-Lion.

The objective of this project (October 2008-September 2011) between TRIO and PSA Peugeot-Citroën is to provide a framework for the validation and the building of deployment of in-vehicle applications compliant with AUTOSAR standard. This study targets both accuracy of models, specification of analysis and optimal deployment methods and recovery mechanisms. This contract is related to the PhD Aurélien Monot (CIFRE grant).

## 7.2. Medetic - Remote monitoring for elderly people

**Participants:** Sharham Nourizadeh, Ye-Qiong Song, Jean-Pierre Thomesse.

The topic of this contract is the development of a system for remote monitoring of the health and activities of old people at home. A new CIFRE grant has been obtained in October 2007 for a collaborative research project with MEDETIC in the form of the PhD thesis of Sharam Nourizadeh. The research goal is twofolds. The first one aims to develop QoS mechanisms in wireless sensor networks for supporting the application constraints in terms of communication reliability and response time. The second one consists in developing a modelling technique allowing the proper description and configuration of the whole system (based probably on the component approach and web service technology). Real world test bed installed by Medetic will allow the validation of our solution.

# 8. Other Grants and Activities

## 8.1. National Grants

### *8.1.1. ANR Project "Architectures du Futur" - Multicriteria Optimizations for Real time Embedded systems (MORE)*

**Participants:** Jonathan Ponroy, Olivier Zendra.

The MORE project begun in 2007. Gathering three Partners (LIP6 in Paris, IRIT in Toulouse, and INRIA-LORIA), it aims at developing trade-off strategies that transform the code of a critical embedded application so that it meets the system constraints in terms of worst-case execution time, code size and energy consumption. In a first stage, it will consist in analyzing the effects of a set of transformations (modifications of the control flow, code and data placement and compression, etc.) on the three criteria to identify their interactions. Then, an iterative optimization process will be set up, that will help in driving the selection of the transformations to apply according to measures carried on the system (through a simulator). An algorithm for searching trade-offs between the three criteria will decide among the collection of possible solutions produced by the iterative process. The third stage will consist in learning from the obtained results to propose new code transformations, with their hardware support, that would make it possible to reach more efficiently better trade-offs. The MORE project includes an experimental part that will necessitate to develop a software framework integrating measure tools, code transformation routines and a driver to implement the iterative optimization process and the trade-off search. in this project, INRIA-LORIA focuses on memory optimizations for energy under real time constraints.

### *8.1.2. ANR Open-PEOPLE - Open Power and Energy Optimization PLatform and Estimator*

**Participants:** Sophie Alexandre, Kévin Roussel, Olivier Zendra.

Open-PEOPLE initially gathers 5 partners from academia and 2 from industry. This project aims at providing a federative and open platform for the estimation and optimization of power and energy consumption in computer systems. The platform users will be able to evaluate application consumption on a hardware architecture chosen among a set of provided typical, parametric architectures. In the considered system, the components will be picked from a library of hardware and software components, be they parametric or not. It will be possible to perform the estimation at various stages of the specification refinement, thanks to a methodology based on multi-level, interoperable and exchangeable consumption models allowing an easy exploration of the design space. Thus, estimations results may be used to check the energy behaviour of a system developed with simulation platforms. Feedback about the application functional properties will allow further refining of the estimation results in Open-PEOPLE. A standardisation of consumption models will be proposed in order to allow interoperability and have easier exchanges with other platforms. The Open-PEOPLE library of consumption models will be extendible: new component models will be added as the user applicative requirements evolve and as implementation techniques progress. To do so, the software estimation platform that will be accessible via an Internet portal shall be linked to a hardware platform made of an automated measurement testbench, which will be controllable from the software platform. A standalone version will also be provided to meet the confidentiality requirements of industry. A library of applications benchmarks will be proposed to characterize new components and new architectures. In addition to the research work required to build methods for multi-level estimation in heterogeneous complex systems, research work shall be carried on in order to offer new methods and techniques making it possible to optimize consumption thanks to the results provided by Open-PEOPLE. Open-PEOPLE is hence geared towards academia to support research work pertaining to consumption estimation and optimization methods, as well as towards industry to estimate or optimize the consumption of future products.

### *8.1.3. PRST MISN / Thème MIS: VITRAIL - Visualisation Temps Réel, Avancée et Immersive de Logiciels*

**Participants:** Damien Bodenes, Pierre Caserta, Olivier Zendra.

The VITRAIL operation begun in 2009.

VITRAIL stems from the fact that software design and development still are very hand-made activities. Development tools almost uniquely consist of editors. Even advanced environments which allow a more graphical developments such as those based on UML, with "arrows and boxes", are limited by our 2D computer screens. VITRAIL's ultimate objective is to improve significantly the current practices in the design and development of programs. VITRAIL aims, by the creation of advanced, immersive software engineering techniques based on visualization, at allowing a better and faster understanding of software by their developers and maintainers. This will result in better quality, safety and optimality.

To do so, taking the opposite of current development techniques which are mainly based on text, VITRAIL intends to explode the limits that are pushed upon us when we visualize programs and their runs. We start from a very simple observation: the human field of vision only allows a precise view of a few degrees, but offer a (coarser) perception of about 180 degrees. Current computer screens only occupy about 45 degrees of the visual field are thus too limiting. We want to explode this limit, with a display that would fill the whole visual field of the developer, and even by putting directly the developer inside the program or its execution. We also want to provide the developer with a large amount of information, but with a simple, intuitive and easy to integrate way, thanks to metaphors. We believe this will enable a dramatically different approach of programs and a better understanding of their structure and behavior. Indeed the amount of information present in a program is huge and currently poorly presented. Making the understanding of this mass of information easy and quick is thus a very promising path. In addition we intend, on a longer term, in allowing the manipulation of programs in a much more natural way, by relying on body and gestures way beyond the mere fingers. all this in real time.

### *8.1.4. PREDIT Project - Systèmes Critiques pour l'Automobile : Robustesse des Logiciels Embarqués Temps-réel (SCARLET)*

**Participants:** Liliana Cucu, Dorin Maxim, Nicolas Navet, Françoise Simonot-Lion.

This project proposed by the competitivity pole System@tic / Num@tec Automotive will be financed by ANR / PREDIT Program. It started in January 2007. The purpose of this project is to define methods and services that ensure the reliability of software COTS when integrating them in a critical embedded system. In SCARLET, TRIO is involved in tasks that aim to specify a methodology for the correct and optimal deployement of a real time system. A good input of this research were the works done by Ricardo Santos Marques during his PhD. In 2009, we mainly focused on sensivity analyses of a network configuration and on optimal deployment of the AUTOSAR communication stack on an ECU.

### *8.1.5. "Pôle de Compétitivité Alsace Franche-Comté" and FCE - CRISTAL Project*

**Participants:** Adrien Guénard, Lionel Havet, Françoise Simonot-Lion.

The context of the CRISTAL project is a new transportation system for cities. The project gathers town planning consultants and scientifics. The role of the latter ones is to study an adaptive system of platooning, i.e. a system operating electrical vehicles under precise automatic control at close spacings to form a platoon. In particular, for TRIO, the challenge is to specify an optimal deployment of embedded functions that ensures by construction the safety properties required by the European regulation [30]. The LORIA research teams involved in this project are DEDALE, MAIA and TRIO. The partners are Lohr Industry, VU-log, Transitec.

### *8.1.6. ARA SSIA SAFE_NECS*

**Participants:** Flavia Felicioni, Ning Jia, François Simonot, Françoise Simonot-Lion, Ye-Qiong Song.

Since December 2005, TRIO participates to the ARA SSIA Safe_NECS national project under ANR grant n° ANR-05-SSIA-015. The context of this project is the design of embedded systems whose function is the fault tolerant control of continuous process and whose implementation is done onto a distributed platform (Networked Control Systems). In particular, the project aims to develop a "co-design" approach that integrates in a coordinated way several kinds of parameters: the characteristics modelling the Quality of Control (QoC) as given by automatic control specialists, the dependability properties required on a system and the parameters of real time scheduling (tasks and messages). This year, we proposed several techniques for the co-design of control laws and scheduling strategies of tasks that implement them for a centralized architecture [8], [29].

### *8.1.7. GIS 3SGS: CONECS - Co-design Of NEtworked Control Systems*

**Participants:** Laurent Ciarletta, Françoise Simonot-Lion, Ye-Qiong Song.

CONECS aims at developing a methodology of integrated codesign of dependable networked control systems. This approach should consider in a coordinated way the quality of control (QoC), the properties of dependability, and the task and message scheduling policies on the support system (processors and networks). It is a common project between LORIA and CRAN supported by GIS 3SGS (with Dominique Sauter of CRAN as the project coordinator). TRIO team has developed adaptive QoS control algorithms and on-line mechanisms in networks [40]

### *8.1.8. PRST MISN / Thème SSS: COWNECS - Co-design Of Wireless NEtworked Control Systems*

**Participants:** Najet Boughanmi, Liliana Cucu-Grosjean, Françoise Simonot-Lion, Ye-Qiong Song.

COWNECS is a common project between LORIA (with Y.Q. Song as project coordinator), CRAN and LICM funded by Lorraine region as part of CPER SSS and SafeTech frameworks. Its aim is similar to that of CONECS but with a strong emphasize on the wireless network QoS adaptation for supporting dependable control applications. It is also complementary with CONECS by providing a platform to show the interest of our co-design approach. This platform is a high speed travelling crane with supervision, control and diagnostic through standard wireless networks (WiFi and Zigbee). For ensuring the quality of control and the dependability of such applications, we developed efficient on-line QoS mechanisms at MAC layer ([40], [22]).

## 8.2. European Projects

### *8.2.1. NOE High Performance Embedded Architecture an Compilation (HiPEAC)*

**Participant:** Olivier Zendra.

The TRIO team is involved in the HiPEAC (High Performance Embedded Archiotecture and Compilation) European Network of Excellence (NoE). Olivier Zendra was initiator and leader in this context of a cluster of European Researchers “Architecture-aware compiler solutions for energy issues in embedded systems” from mid-2007 to mid-2009.

# 9. Dissemination

## 9.1. Visits

In 2009 TRIO has invited, for short term visit, Ben Rodriguez, Joël Goosens, Vandy Berten, Nelis Vincent, Nadia Kabbali (Université Libre de Bruxelles), Reinder Brill (Eindhoven University), Ramon Serna, Gerhard Fohler, Raphael Guerra (Kaiserslautern Technical University), Nicole Megow (Max Planck Institute, Sarrebrück), Fatma Bouabdallah (IRISA Rennes), Dominique Bertrand (IRCCYN Nantes), Chung Shue Chen (Hong-Kong University), Daniel Simon (INRIA Grenoble), Jiming Chen (Zhejiang University), Thomas Nolte (Maelardalen University, Västerå, Sweden), Nathan Fisher (Wayne State University, Detroit), Shelby Funk (University of Georgia).

## 9.2. Action for the research community

- Nicolas Navet chairs with Thomas Nolte (MRTC Mälardalen) of the Sub-Committee on Real-Time Fault Tolerant Systems of the IEEE Industrial Electronic Society (IES) - Technical Committee on Factory Automation (TCFA).
- Jean-Pierre Thomesse is DRRT at Region Lorraine.
- Françoise Simonot-Lion is elected member of the administration board of École Nationale Supérieure des Mines de Nancy.
- Ye-Qiong Song is member the administration board of ENSEM
- Françoise Simonot-Lion is member of the Program committee of INRIA-Lorraine
- Françoise Simonot-Lion chairs with Steve Hung (Clemson University, USA) the subcommittee “Automotive Electronic and Embedded Systems” of the IEEE Industrial Electronic Society (IES) - Technical Committee on Factory Automation (TCFA).
- Ye-Qiong Song is the responsible of the "research by training" of CRI Nancy - Grand Est
- Ye-Qiong Song is the head of the doctoral department of Computer Science of Lorraine.
- Olivier Zendra is Head of the Documentation Committee, Head of the Sustainable Development Committee of INRIA Nancy Grand Est; he is member of the Health and Safety Committe of INRIA Nancy Grand Est - LORIA, member of the INRIA national workgroup on travel and elected member of the INRIA Nancy Grand Est Research Center Council; he was a member in 2009 of the INRIA Nancy Grand Est advisory group for the creation of the Camus team and a member in 2009 of the Office Allocation Commitee of LORIA.
- Liliana Cucu is member of Commission des développements technologiques (CDT), Nancy and member of Commission des Utilisateurs des Moyens Informatiques (CUMI), Nancy
- Françoise Simonot-Lion and Olivier Zendra are elected members of LORIA Laboratory Council.
- Nicolas Navet was Assessor for a FRIA Phd grant application (Fonds pour la Formation à la Recherche dans l’Industrie et dans l’Agriculture, Belgium)

- Jean-Pierre Thomesse was member of the AERES evaluation committee for ISAE, Toulouse.
- Ye-Qiong Song was reviewer for the PhD of Patrick Meumeu (University of Paris 11) and Emna Bouazizi (University of Le Havre), member of the PhD defense committees of Fei Yin (University of Paris 6), Jean-Paul Wetzel (Nancy University) and Ning Jia. He was member of the Habilitation (HdR) defense committee of Emmanuel Grolleau (University of Poitiers); Nicolas Navet was member of the Phd of Julien Forget(ISAE, Toulouse); Françoise Simonot-Lion was reviewer for the PhD of Youssef Laarouchi (INPT, Toulouse), Caroline Lu (INPT, Toulouse), Cédric Berbra (INPG, Grenoble), Nadège Pontisso (Toulouse University), Minh Duc Nguyen (Toulouse University); Nicolas Navet was Member of the Master jury of Nadia Kabbali at ULB Bruxelles (department of Computer Science)

## 9.3. Colloquium, seminars, invitations

- Liliana Cucu and Françoise Simonot-Lion were invited to give two seminars on ”Automotive critical applications distributed on TDMA-based networks: a contribution to the quantitative evaluation of their safety” and on ”Stochastic real-time scheduling: from uniprocessor to multiprocessor when the execution times are uncertain ” at Linköping University, Sweden.
- Ye-Qiong Song was invited to give a talk at IFAC FET2009 conference on "Networked Control Systems: From Independent Designs of the Network QoS and the Control to the Co-design".
- Nicolas Navet was invited to give a talk on "In-Vehicle Networking : a Survey and Look Forward", at the Workshop on Specialized Networks (in conjunction with ETFA 2009, Mallorca, Spain, September 26, 2009), on "Automotive embedded systems: some research challenges" at the Summer School on Real-Time Systems (ETR-09, Paris, September 3, 2009) and on "Performance Guarantees for Highly Loaded ECUs and Communication Networks in Embedded Automotive Systems" at the University Koblenz-Landau (Germany, January 30, 2009).
- Liliana Cucu was invited to give a talk at Laboratoire d’Informatique de l’Ecole Polytechnique (January 2009) and at University of Galati (April 2009).
- Olivier Zendra was head of the organizing committee of the LMO 2009, CAL 2009 and IDM 2009 conferences in Nancy (March 2009).
- Françoise Simonot-Lion will be general co-chair of IEEE WFCS’2010 in Nancy (May 2010).
- Nicolas Navet was Program Co-Chair of the 8th International Conference on Embedded Computing (EmbeddedCom-09), Dalian, China, September 25-27, 2009, Publicity Co-Chair of the 4th International Symposium on Embedded Multicore Systems-on-Chip (MCSoC-09), Vienna, Austria, September 22-25, 2009.
- Ye-Qiong Song was chair of the special session on wireless sensor networks at COGnitive systems with Interactive Sensors (COGIS’09); he was posters and demos session co-chair of SensorNets2009 (The First International School on Cyber-Physical and Sensor Networks).
- Nicolas Navet and Françoise Simonot-Lion are steering committee members of the RTNS conference.
- Olivier Zendra is streering committe member of the ICOOOLPS workshop.
- Françoise Simonot-Lion is Member of the Advisory Board of the “Embedded Systems Handbook” at CRC Press.
- Françoise Simonot-Lion was guest editor of the special section "automotive embedded systems" [14] and, with Gianluca Cena (Politecnico di Torino) of the special section "Communication in Automation" of the IEEE Transactions on Industrial Informatics [9]
- Nicolas Navet and Françoise Simonot-Lion are editors of the book series on "Real-time and dependable systems" at Taylor and Francis / CRC Press.

- Nicolas Navet was program committee member for the 4th International Conference on Frontier of Computer Science and Technology (FCST 2009), December 17-19, Shanghai, China, the IEEE International Conference on Service-Oriented Computing and Applications (SOCA'09), Taipei, Taiwan, December 14-15, 2009, the 4th International Conference on Embedded and Multimedia Computing (EM-Com 2009), Jeju, Korea, December 10-12, 2009, the Second International Conference on Advances in Circuits, Electronics and Micro-electronics (CENICS 2009), Sliema, Malta, October 11-16, 2009, the 14th IEEE International Conference on Emerging Technologies and Factory Automation (ETFA 2009), Mallorca, Spain, September 22-25, 2009 (Tracks on Real-Time and (Networked) Embedded Systems, on Industrial Communication Systems, on Information Technology in Automation), the 6th French Summer School on Real-Time Systems (ETR 2009), Paris, France, August 31-September 4, 2009, the IEEE Symposium on Industrial Embedded Systems (SIES 2009), Switzerland, July 8-10, 2009, the IEEE Euromicro Conference on Real-Time Systems (ECRTS 2009), Dublin, Ireland, July 1-3, 2009, the 2nd International Workshop on Cyber-Physical Systems (WCPS 2009), Montreal, Canada, June 22, 2009, the International Conference on Embedded Software and Systems 2009 (ICESS09), HangZhou, Zhejiang, China, May 25-27, 2009, the 11th Workshop on Real-time and Embedded Systems (WTR-09), Pernambuco, Brazil, May 25th, 2009, the Eighth IFAC International Conference on Fieldbuses and Networks in Industrial Embedded Systems ( FeT'2009), Ansan, Korea, May 20-22, 2009, the "Real-time, Networked, and Dependable Systems" track of Design Automation and Test in Europe (DATE 2009), Nice, France, April 20-24, 2009, the Operating Systems Track, ACM Symposium on Applied Computing (ACM SAC), Honolulu, Hawaii, March 8-12, 2009.
- Françoise Simonot-Lion was program committee member for the the 14th IEEE International Conference on Emerging Technologies and Factory Automation (ETFA 2009), Mallorca, Spain, September 22-25, 2009, the 6th French Summer School on Real-Time Systems (ETR 2009), Paris, France, August 31-September 4, 2009, the Eighth IFAC International Conference on Fieldbuses and Networks in Industrial Embedded Systems ( FeT'2009), Ansan, Korea, May 20-22, 2009, 11th International Conference on Formal Engineering Methods, ICFEM 2009 (workshop on UML& FM), Rio de Janeiro, December 9, 2009, the INCOM'2009 in Moscow June, 2009, the 17th International Conference on Real-Time and Network Systems, RTNS'2009, October 26-27, 2009, Paris, France.
- Ye-Qiong Song was program committee member for the 14th IEEE International Conference on Emerging Technologies and Factory Automation (ETFA 2009), Mallorca, Spain, September 22-25, 2009, the Eighth IFAC International Conference on Fieldbuses and Networks in Industrial Embedded Systems ( FeT'2009), Ansan, Korea, May 20-22, 2009, the CSE2009 conference, the RTN2009 workshop, the ComNet2009 conference, the IWCMC 2009 conference.
- Olivier Zendra is program committee member of CAL 2010 (Pau, France); he was program committee member of LMO 2009 (Nancy, France), IDM 2009 (Nancy, France), CAL 2009 (Nancy, France), ICOOOLPS 2009 (Genes, Italy).
- The permanent members of TRIO team are reviewers for several international Conferences and Workshops and, in particular for the following journals: IEEE Transactions on Industrial Informatics (Nicolas Navet, Françoise Simonot-Lion, Liliana Cucu, Ye-Qiong Song), Eurasip Journal (Françoise Simonot-Lion), IEEE Computer Communications (Ye-Qiong Song), Science of Computer Programming journal (SCP), Integration, the VLSI Journal, Journal of Discrete Event Systems (Nicolas Navet).

## 9.4. Teaching activities

The permanent members of TRIO are teaching in INPL and Université Henri Poincaré-Nancy 1 (engineer schools and masters).

# 10. Bibliography

## Major publications by the team in recent years

[1] B. GAUJAL, N. NAVET, C. WALSH. *Shortest Path Algorithms for Real-Time Scheduling of FIFO tasks with Minimal Energy Use*, in "ACM Transactions on Embedded Computing Systems", Dec 2004.

[2] A. KOUBÂA, Y.-Q. SONG. *Graceful Degradation of Loss Tolerant QoS using (m,k)-Firm Constraints in Guaranteed Rate Networks*, in "Journal of Computer Communications", 2005.

[3] N. NAVET, F. SIMONOT-LION. *Fault Tolerant Services For Safe In-Car Embedded Systems*, in "The Embedded Systems Handbook", R. ZURAWSKI (editor), CRC Press, Dec 2005.

[4] N. NAVET, Y.-Q. SONG, F. SIMONOT. *Worst-Case Deadline Failure Probability in Real-Time Applications Distributed over CAN (Controller Area Network)*, in "Journal of Systems Architecture - The EUROMICRO Journal", vol. 46, n$^{o}$ 7, Apr 2000, p. 607-617.

[5] N. NAVET, Y. SONG, F. SIMONOT-LION, C. WILWERT. *Trends in Automotive Communication Systems*, in "Proceedings of the IEEE", vol. 93, n$^{o}$ 6, Jun 2005, p. 1204-1223.

[6] J.-P. THOMESSE. *The WorldFIP Fieldbus*, in "Industrial Information Technology Handbook", R. ZURAWSKI (editor), Industrial Electronics Series, CRC Press, Dec 2004.

[7] C. WILWERT, N. NAVET, Y.-Q. SONG, F. SIMONOT-LION. *Design of Automotive X-by-Wire System*, in "The Industrial Communication Technology Handbook", R. ZURAWSKI (editor), CRC Press, Dec 2005.

## Year Publications

### Doctoral Dissertations and Habilitation Theses

[8] N. JIA. *Conception conjointe optimisée de lois de contrôle et d'ordonnancement*, Institut National Polytechnique de Lorraine - INPL, 01 2009, http://tel.archives-ouvertes.fr/tel-00369354/en/, Ph. D. Thesis.

### Articles in International Peer-Reviewed Journal

[9] G. CENA, F. SIMONOT-LION. *Guest Editorial Special Section on Communication in Automation*, in "IEEE Transactions on Industrial Informatics", vol. 5, n$^{o}$ 2, 2009, p. 70-74, http://hal.inria.fr/inria-00433066/en/IT.

[10] F. COMETS, F. DELARUE, R. SCHOTT. *Large Deviations Analysis for Distributed Algorithms in an Ergodic Markovian Environment*, in "Applied Mathematics and Optimization", vol. 60, n$^{o}$ 3, 12 2009, p. 341–396, dx.doi.org/10.1007/s00245-009-9079-8http://hal.archives-ouvertes.fr/hal-00198408/en/.

[11] Y. LI, C. S. CHEN, Y.-Q. SONG, Z. WANG, Y. SUN. *Enhancing Real-Time Delivery in Wireless Sensor Networks With Two-Hop Information*, in "IEEE Transactions on Industrial Informatics", vol. 5, n$^{o}$ 2, 2009, p. 113-122, http://hal.inria.fr/inria-00431252/en/CN.

[12] J. LI, Y.-Q. SONG. *DLB: a novel real-time QoS control mechanism for multimedia transmission*, in "International Journal of High Performance Computing and Networking", vol. 6, n$^{o}$ 1, 2009, p. 4-14, http://hal.inria.fr/inria-00432719/en/CN.

[13] R. SCHOTT, L. IDOUMGHAR. *Two distributed algorithms for the frequency assignment problem in the field of radio broadcasting.*, in "IEEE Transactions on Broadcasting", vol. 55, n$^{o}$ 2, 2009, p. 223-229, http://hal.archives-ouvertes.fr/hal-00431552/en/.

[14] F. SIMONOT-LION. *Guest Editorial - Special Section on In-vehicle Embedded Systems*, in "IEEE Transactions on Industrial Informatics", vol. 5, n$^{o}$ 4, 2009, p. 372-374, http://hal.inria.fr/inria-00433072/en/.

### Invited Conferences

[15] N. NAVET. *Automotive embedded systems: some research challenges*, in "Ecole d'Eté Temps Réel 2009, France Paris", 2009, http://hal.inria.fr/inria-00437359/en/.

[16] N. NAVET. *In-Vehicle Networking : a Survey and Look Forward*, in "Workshop on Specialized Networks at IEEE ETFA 2009, Espagne Palma de Mallorca", 2009, http://hal.inria.fr/inria-00437357/en/.

[17] Y.-Q. SONG. *Networked Control Systems: From Independent Designs of the Network QoS and the Control to the Co-desig*, in "8th IFAC international conference on Fieldbuses and networks in industrial and embedded systems (FeT 2009), Corée, République de Ansan", G. JUANOLE, S. HO HONG (editors), IFAC, IFAC, 2009, http://hal.inria.fr/inria-00432710/en/.

### International Peer-Reviewed Conference/Proceedings

[18] J. BEN SLIMAN, Y.-Q. SONG, A. KOUBÂA. *A Prioritized Multi-Channel Multi-Time slot MAC Protocol For Large-Scale Wireless Sensor Networks*, in "ComNet'09: The First International Conference on Communications, and Networking, Tunisie Hammamet", 2009, 8, http://hal.inria.fr/inria-00435517/en/PT.

[19] J. BEN SLIMAN, Y.-Q. SONG, A. KOUBÂA. *Control and data channels allocation for Large-Scale UWB-based WSNs*, in "ComNet'09: The First International Conference on Communications, and Networking, Tunisie Hammamet", 2009, 64, http://hal.inria.fr/inria-00435514/en/PT.

[20] J. BEN SLIMAN, Y.-Q. SONG, A. KOUBÂA, M. FRIKHA. *A Three-Tiered Architecture for Large-Scale Wireless Hospital Sensor Networks*, in "Workshop MobiHealthInf 2009 in conjunction with BIOSTEC 2009, Portugal Porto", 2009, 64, http://hal.inria.fr/inria-00435508/en/TNPT.

[21] M.-O. BERGER, J. PONROY, B. WROBEL-DAUTCOURT. *Realistic Face Animation for Audiovisual Speech Applications: A Densification Approach Driven by Sparse Stereo Meshes*, in "Computer Vision/Computer Graphics CollaborationTechniques 4th International Conference, MIRAGE 2009, France Rocquencourt", A. GAGALOWICZ (editor), vol. 5496, Springer Berlin / Heidelberg, INRIA Rocquencourt, 2009, p. 297-307, http://hal.inria.fr/inria-00429338/en/.

[22] N. BOUGHANMI, Y.-Q. SONG, E. RONDEAU. *Online adaptation of the IEEE 802.15.4 parameters for wireless networked control systems*, in "8th IFAC International Conference on Fieldbuses and networks in industrial and embedded systems, FET'2009, Corée, République de Ansan", 2009, CDROM, http://hal.inria.fr/inria-00430957/en/.

[23] N. BOUGHANMI, Y.-Q. SONG, E. RONDEAU. *Wireless networked control system using ZigBee/IEEE 802.15.4*, in "13th IFAC Symposium on Information Control Problems in Manufacturing, INCOM'2009, Russie Moscou", 2009, CDROM, http://hal.inria.fr/inria-00430974/en/.

[24] R. BRIL, L. CUCU-GROSJEAN, J. GOOSSENS. *Exact best-case response time analysis of real-time tasks under fixed-priority pre-emptive scheduling for arbitrary deadlines*, in "the 21st Euromicro Conference on Real-Time Systems - ECRTS'09, WIP session, Irlande Dublin", 2009, http://hal.inria.fr/inria-00432968/en/ BENL.

[25] R. BRIL, L. CUCU-GROSJEAN, J. GOOSSENS. *Response time analysis in distributed real-time systems*, in "4th Multidisciplinary International Scheduling Conference: Theory & Applications - MISTA 2009, Irlande Dublin", 2009, http://hal.inria.fr/inria-00432963/en/BENL.

[26] L. CUCU, O. BUFFET. *Global Multiprocessor Real-Time Scheduling as a Constraint Satisfaction Problem*, in "ICPP'09 Workshop on Real-time systems on multicore platforms: Theory and Practice (XRTS'09), Autriche Vienne", G. FOHLER, S. BARUAH (editors), 2009, http://hal.inria.fr/inria-00429506/en/.

[27] L. CUCU-GROSJEAN, Y. SOREL. *An exact schedulability test for real-time dependant periodic task systems with latency constraints*, in "Models and Algorithms for Planning and Scheduling Problems - MAPSP'09, Pays-Bas Abbey Rolduc", 2009, http://hal.inria.fr/inria-00432976/en/.

[28] J. DUCLOY, A. HERMANN, P. MUSSOT, V. WARTH, J.-P. THOMESSE. *WICRI : construire des réseaux de la recherche et de l'innovation dans l'UPM*, in "Espace Numérique Ouvert Pour la Méditerranée, Maroc Agadir", 2009, http://hal.inria.fr/inria-00439214/en/.

[29] F. FELICIONI, F. SIMONOT, F. SIMONOT-LION, Y.-Q. SONG. *Optimal Control with Packet Drops in Networked Control Systems*, in "8th IFAC International Conference on Fieldbuses & Networks in Industrial & Embedded Systems (FET'2009), Corée, République de Hanyang", G. JUANOLE, S. HO HONG (editors), 2009, p. 64-71, http://hal.inria.fr/inria-00431406/en/.

[30] L. HAVET, F. SIMONOT-LION. *Timing properties requirements and robustness analysis of a platoon of vehicles*, in "8th IFAC International Conference on Fieldbuses and networks in industrial and embedded systems - FeT2009, Corée, République de Ansan", 2009, http://hal.inria.fr/inria-00431345/en/.

[31] L. IDOUMGHAR, M. MELKEMI, R. SCHOTT. *A novel hybrid evolutionary algorithm for multi-modal function optimization and engineering applications*, in "13th IASTED International Conference on Artificial Intelligence and Soft Computing - ASC 2009, Espagne Palma de Mallorca", vol. 683, Acta Press, 2009, p. 87-93, http://hal.archives-ouvertes.fr/hal-00431693/en/.

[32] D. KHAN, N. NAVET, B. BAVOUX, J. MIGGE. *Aperiodic traffic in response time analyses with adjustable safety level*, in "14th IEEE International Conference on Emerging Techonologies and Factory Automation - ETFA 2009, Espagne Palma de Mallorca", 2009, http://hal.inria.fr/inria-00437221/en/.

[33] D. MAXIM, L. CUCU-GROSJEAN. *Towards optimal priority assignment for probabilistic real-time systems with variable execution times*, in "3rd Junior Researcher Workshop on Real-Time Computing - JRWRTC 2009, France Paris", 2009, http://hal.inria.fr/inria-00433897/en/.

[34] B. NEFZI, Y.-Q. SONG, H. CRUZ SANCHEZ. *SCSP : an Energy Efficient Network-MAC Cross-layer design for wireless Sensor Networks*, in "The Ninth IEEE International Workshop on Wireless Local Networks - WLN'09, Suisse Zurich", 2009, http://hal.inria.fr/inria-00431125/en/.

[35] S. NOURIZADEH, C. DEROUSSENT, Y.-Q. SONG, J.-P. THOMESSE. *A Distributed Elderly healthcare System*, in "MobiHealth 2009, Portugal Porto", 2009, http://hal.inria.fr/inria-00431202/en/.

[36] S. NOURIZADEH, C. DEROUSSENT, Y.-Q. SONG, J.-P. THOMESSE. *Medical and Home automation Sensor Networks for Senior Citizens Telehomecare*, in "First International Workshop on Medical Applications Networking, IEEE International Conference on Communications - IEEE ICC MAN'2009, Allemagne Dresden", IEEE, 2009, p. 1-5, http://hal.inria.fr/inria-00431096/en/.

[37] S. NOURIZADEH, Y.-Q. SONG, J.-P. THOMESSE. *A Distributed Fuzzy-based Failure Management for Wireless Sensor Networks*, in "The Second International Conference on Communication Theory, Reliability, and Quality of Service - CTRQ 2009, France Colmar", 2009, http://hal.inria.fr/inria-00431035/en/.

[38] S. NOURIZADEH, Y.-Q. SONG, J.-P. THOMESSE. *A Failure Adapted, Load-balanced Distributed Routing for Wireless Ad-hoc Sensor Networks*, in "7th IEEE/IFIP International Conference on Embedded and Ubiquitous Computing - IEEE EUC-2009, Canada Vancouver", IEEE, 2009, p. 593-596, http://hal.inria.fr/inria-00431036/en/.

[39] S. NOURIZADEH, Y.-Q. SONG, J.-P. THOMESSE. *An Adaptive Hierarchical Routing Protocol for Wireless Ad-hoc Sensor Networks*, in "Third International Conference on Next Generation Mobile Applications, Services and Technologies - NGMAST'09, Royaume-Uni Cardiff, Wales", IEEE, 2009, p. 452 - 460, http://hal.inria.fr/inria-00431018/en/.

### National Peer-Reviewed Conference/Proceedings

[40] N. BOUGHANMI, H. CRUZ-SANCHEZ, Y.-Q. SONG, I. AL-SALAMI, J. YAMÉ. *Case study of wireless networked control system : CONECS and COWNECS platform*, in "2ème Workshop Surveillance, Sûreté et Sécurité des Grands Systèmes - 3SGS'09, France Nancy", 2009, CDROM, http://hal.inria.fr/inria-00431024/en/.

### Workshops without Proceedings

[41] L. CUCU-GROSJEAN, L. IDOUMGHAR, R. SCHOTT. *Tabu Search Type Algorithms for the Multiprocessor Scheduling Problem*, in "Tenth IASTED International Conference on Artificial Intelligence and Applications (AIA 2010) Proceedings of the Tenth IASTED International Conference on Artificial Intelligence and Applications (AIA 2010), Innsbrück Autriche", 2010, http://hal.inria.fr/inria-00435272/en/.

[42] N. NAVET, H. PERRAULT. *Mécanismes de protection dans AUTOSAR OS*, in "RTS Embedded System 2009, France Paris", 2009, http://hal.inria.fr/inria-00439102/en/.

[43] S. NOURIZADEH, Y.-Q. SONG, J.-P. THOMESSE, X. SEPULCHRE. *Un système de télémédecine pour les seniors*, in "1er congrès de la Société Française des Technologies pour l'Autonomie et de Gérontechnologie - SFTAG09, France Troyes", 2009, http://hal.inria.fr/inria-00431053/en/.

### Scientific Books (or Scientific Book chapters)

[44] S. FAUCOU, F. SIMONOT-LION, Y. TRINQUET. *Architecture Description Languages for the Automotive Domain*, in "Behavioral Modeling for Embedded Systems and Technologies: Applications for Design and Implementation", L. GOMES, J. M. FERNANDES (editors), IGI Global, 2009, p. 353-376, http://hal.inria.fr/inria-00431438/en/.

[45] N. NAVET, F. SIMONOT-LION. *Trends in Automotive Communication Systems*, in "Embedded Systems Handbook: Networked Embedded Systems - 2nd ed.", R. ZURAWSKI (editor), Taylor and Francis / CRC Press, 2009, p. 13.1-13.24, http://hal.inria.fr/inria-00439105/en/.

## Research Reports

[46] A. MONOT, N. NAVET, F. SIMONOT-LION, B. BAVOUX. *Partioned scheduling of tasks on automotive multicore ECUs*, 2009, http://hal.inria.fr/inria-00443080/en/, Research Report.

[47] B. NEFZI, Y.-Q. SONG. *CoSenS reference guide*, 2009, http://hal.archives-ouvertes.fr/inria-00443594/en/, Research Report.

## Other Publications

[48] L. CUCU-GROSJEAN. *Probabilistic real-time schedulability: from uniprocessor to multiprocessor when the execution times are uncertain*, 2009, http://hal.inria.fr/inria-00433845/en/.

[49] L. CUCU-GROSJEAN, F. SIMONOT-LION. *Probabilistic feasibility analysis of messages with variable jitter on CAN*, 2009, http://hal.inria.fr/inria-00433848/en/.

[50] N. NAVET. *Performance guarantees with highly loaded ECUs and communication networks in embedded automotive systems*, 2009, http://hal.inria.fr/inria-00437372/en/.