ANNUAL REPORT 2011
Mälardalen Real-Time Research Centre
Content

Mälardalen Real-Time Research Centre, MRTC

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Mälardalen Real-Time Research Centre, MRTC, conducts research with the mission to provide research excellence that enables industry to take advantage of the opportunity provided by software in products and production systems.

**World-leading competence in**
- Embedded Software Development
- Real-Time Systems Modelling and Analysis

**We offer**
- Extensive experience of international projects
- Proven track record in industrial cooperation and commercialization of research
- A professional research organization with 16 professors, 30 PhDs, and 50 PhD students

Mälardalen Real-Time Research Centre (MRTC) is one of two Embedded systems research directions at the School of Innovation, Design and Engineering at Mälardalen University, MDH. MRTC is the leading research profile at MDH, and a national leader in Embedded Systems related research. Internationally, MRTC has extensive co-operation worldwide, and is known for its research in Real-Time Systems and Software Engineering, as well as its strong industrial links. Industrial partners include major companies, such as ABB, Bombardier, Ericsson, Scania and Volvo, as well as many smaller ones, including several spin-off companies.

MRTC provides a stimulating international research environment, characterized by its cooperative atmosphere, openness, and team spirit – a great environment for a researcher to grow in; with a mix of established and young researchers, including including 12 full professors, 4 adjunct professors, 30 additional senior researchers, and 50 PhD students; several of which are employed or funded by industry. Research at MRTC has a dominating focus on Embedded Software, with a particular emphasis on component-based software development. MRTC’s mission is to provide research excellence that enables industry to take advantage of the opportunity provided by software in products and production systems. The research is organized in 10 mutually supportive and cooperating research groups with research on various aspects of embedded systems software engineering, real-time systems, data communication, and circuit design.
**MRTC’s vision**
- To provide state-of-the-art competence for industry
- To advance basic and applied research in relevant areas
- Education for engineers and researchers

**The MRTC research is organized in following divisions and research groups:**

**Divisions**
- Computer Science and Networks
- Embedded Systems
- Software Engineering

**Research groups**
- **Business-Oriented Engineering of Software and Systems group**
  Professor Jakob Axelsson
- **Complex Real-Time Embedded Systems group**
  Associate professor Thomas Nolte
- **Dependable Software Engineering group**
  Professor Sasikumar Punnekkat
- **Formal modeling and analysis of embedded systems group**
  Professor Paul Pettersson
- **Industrial Software Engineering group**
  Professor Ivica Crnkovic
- **Model-Based Engineering of Embedded Systems group**
  Professor Mikael Sjödin
- **Programming Language group**
  Professor Björn Lisper
- **Real-Time Systems Design group**
  Professor Hans Hansson
- **Safety-Critical Engineering group**
  Professor Kristina Lundqvist
- **Wireless Communication group**
  Professor Mats Björkman
Divisions at MRTC

Division of Computer Science and Networks

The mission of the Division of Computer Science and Networks is to provide education in all relevant aspects of Computer Science, and research in Computer Science both in itself and applied to areas such as Software Engineering, Computer and Real-time systems, and Electronic System Design. The goal is to strengthen and secure the Computer Science part of the education, and to provide scientifically well founded methods and theories for the application areas.

Leader:
Rikard Lindell
+46-21-151759
rikard.lindell@mdh.se

Division of Embedded Systems

The mission of the Embedded System Division (ES) is to provide engineers with scientific methods and tools for designing safety critical real-time systems. The goal is to advance state-of-art and practice for developing such systems into a mature engineering discipline, i.e., in analogue with the scientifically well founded methods and tools for mechanical construction. ES develops methods for constructing safety critical real-time systems, ultimately capable of guaranteeing their multitude of requirements to be fulfilled.

ES is very research intensive and it has an internationally proved record of excellence in conducting high-quality research and has a very productive graduate training program. All research is performed in projects with specific goals with respect to achievements, publications, collaborations, and prototype tools. A project typically has elements of both basic and applied research. Equally important is the undergraduate education, where ES is responsible for computer engineering related courses, with a particular focus on computer based real-time systems. ES are responsible for the international Master Program in Intelligent Embedded Systems.

Leader:
Dag Nyström
+46-21-107042
dag.nystrom@mdh.se

Division of Software Engineering

The mission of the Division of Software Engineering (SE) is to provide education in all relevant aspects of Software Engineering, and research in Systems and software engineering for industrial and embedded systems. To establish world class education and research in this utterly complex area extensive collaboration with industry is required.

The research at SE is directed to increase the knowledge of software engineering and in particular of industrial software engineering, real-time and embedded systems component-based software engineering, dependable systems, from both theoretical and practical points of view. The research results of SE is supposed to be used both at the university and in the industry. At the university, the accumulated knowledge is used for further education in order to prepare the students for new aspects in system development. The industry will benefit with direct implementation of methods and knowledge built up in the research activities and well educated students.

Research Areas:
- Component-Based Software Engineering
- Software engineering for real-time embedded systems
- Software Configuration Management
- Product-line architectures for real-time systems
- Software Processes
- Dependable embedded systems
- Test and Verification
- Legacy systems modelling

Leader:
Radu Dobrin
+46-21-107356
radu.dobrin@mdh.se

Leader:
Rikard Lindell
+46-21-151759
rikard.lindell@mdh.se

Leader:
Dag Nyström
+46-21-107042
dag.nystrom@mdh.se
Research groups at MRTC

**Business-Oriented Engineering of Software and Systems group**

Focusing on problems related to the management of industrial product development, in particular software and systems engineering of embedded products.

Primary area: System and Software Evolution.

Members: Jakob Axelsson, Christer Norström, Ivica Crnkovic, Magnus Larsson, Peter Wallin, Stig Larsson, Anders Wall, Håkan Gustavsson, Joakim Fröberg, Hongyu Pei-Breivold, Stefan Cedergren, Frank Lüders, Daniel Sundmark, Kristian Sandström, Sara Dersten, Apala Ray

**Complex Real-Time Embedded Systems group**

Focusing on compositional execution and analysis of real-time systems, multiprocessor scheduling and synchronization, predictable execution of real-time systems and similar topics related to predictability of real-time systems.

We conduct research in the following areas:

- Compositional execution and analysis of real-time systems
- Multiprocessor scheduling and synchronization
- Predictable execution of real-time systems
- Source code analysis for industrial embedded software
- Simulation-based analysis of complex embedded systems
- Stochastic and statistical analysis of real-time systems

**Dependable Software Engineering group**

Focusing on methods and processes for engineering dependable software systems, in particular in a combination of efficient development processes, and focusing on real-time, safety and reliability of the products.

Members: Radu Dobrin, Sasikumar Punnekkat, Heinz Schmidt, Hüseyin Aysan, Kristina Lundqvist, Adnan Causevic, Senthil Kumar Chandran, Anju S Pillai, Jiale Zhou, Barbara Gallina, Abhilash Thekkilakattil, Iain Bate, Henrik Jonsson

**Formal modeling and analysis of embedded systems group**

Focusing on formal modelling, analysis, and verification techniques for real-time embedded systems. In particular, formal syntax and semantics of component based and service oriented models with extra-functional properties such as time or resources.

Members: Paul Pettersson, Cristina Seceleanu, Jagadish Suryadevara, Stefan Björnander, Aida Causevic, Leo Hatvani, Raluca Marinescu, Sigrid Eldh, Paul Pettersson, Daniel Sundmark, Kivanc Doganay, Eduard Paul Enoiu

**Leader:**
Professor Jakob Axelsson,
jakob.axelsson@mdh.se

**Leader:**
Professor Thomas Nolte,
Thomas.nolte@mdh.se,
+46 21 103178

**Leader:**
Professor Sasikumar Punnekkat,
sasikumar.punnekkat@mdh.se,
+46 21 107324

**Leader:**
Professor Paul Pettersson,
paul.pettersson@mdh.se,
+46 21 151741
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Industrial Software Engineering group

Focusing on engineering of complex software-intensive embedded systems, covering the entire lifecycle and including technologies, methods and processes. Particular emphasis on component-based software engineering and component-models for embedded systems.
Members: Federico Ciccozzi, Ivica Crnkovic, Séverine Sentilles, Aneta Vulgarakis, Daniel Flemström, Magnus Larsson, Frank Lüders, Jan Carlson, Luka Lednicki, Juraj Feljan, Antonio Cicchetti, Anton Jansen, Josip Maras, Tiberiu Seceleanu, Gaetana Sapienza

Leader: Professor Ivica Crnkovic, ivica.crnkovic@mdh.se, +46 21 103183

Real-Time Systems Design group

Focusing on design methods, architectures, and communication for real-time system, with current emphasis on functional safety, adaptive real-time systems, and software testing.
Members: Hans Hansson, Kaj Hänninen, Hang Yin, Guillermo Rodriguez-Navas

Leader: Professor Hans Hansson, hans.hansson@mdh.se, +46 21 103163

Model-Based Engineering of Embedded Systems group

Focusing on development of methods and tools for model-based engineering of embedded systems. Specializing in modelling and analysis of non-functional properties of component-based systems, and resource-efficient and predictable run-time infrastructures.
Members: Jukka Mäki-Turja, Damir Isovic, Federico Ciccozzi, Markus Bohlin, Dag Nyström, Rafia Inam, Mikael Sjödin, Andreas Hjerström, Antonio Cicchetti, Saad Mubeen, Mehrdad Saadatmand, Shihong Huang

Leader: Professor Mikael Sjödin, mikael.sjodin@mdh.se, +46 70 288 2829

Safety-Critical Engineering group

Focusing on bridging the theoretical foundations of dependability and industrial software development practices, with an emphasis on the technology and process aspects of complex dependable systems.
Members: Andreas Johnsen, Kristina Lundqvist, Jiale Zhou, Göran Bertheau

Leader: Professor Kristina Lundqvist, kristina.lundqvist@mdh.se, +46 21 101428

Programming Language group

Focusing on static program analysis for embedded systems, specializing in Worst-Case Execution Time analysis.
Members: Jan Gustafsson, Björn Lisper, Andreas Gustavsson, Stefan Bygde

Leader: Professor Björn Lisper, bjorn.lisper@mdh.se, +46 21 151709

Wireless Communication group

Focus on research in wireless sensor networks; communication energy optimization, Safe and secure wireless industrial automation, Reliable wireless communication in harsh environments and Content distribution network optimization.
Members: Johan Åkerberg, Henrik Abrahamsson, Mats Björkman, Andreas Johnsson, Mikael Ekström, Marcus Bergblomma, Martin Ekström, Elisabeth Uhlemann, Shahid Raza, Mudassar Aslam, Sveltana Girs, Kan Yu, Apala Ray

Leader: Professor Mats Björkman, mats.bjorkman@mdh.se, +46 21 107037
Theses at MRTTC 2011

Doctoral Theses

Identifying and Managing Key Challenges in Architecting Software-Intensive Systems
Peter Wallin

Lean Thinking Applied to System Architecting
Håkan Gustavsson

On Safe and Secure Communication in Process Automation
Johan Åkerberg

On Test Design
Sigrid Eldh

Performance in Product Development - The Case of Complex Products
Stefan Cedergren

Software Architecture Evolution through Evolvability Analysis
Hongyu Pei Breivold

Licentiate Theses

Design and Analysis Support for Abstract Models of Component-based Embedded Systems
Jagadish Suryadevara

Securing Communication in IP-Connected Industrial Wireless Sensor Networks
Shahid Raza

Formal Approaches to Service-oriented Design: From Behavioral Modeling to Service Analysis
Aida Čaušević

Software Testing in Agile Development: Technological and Organisational Challenges
Adnan Čaušević
A new industrial research school has started at Mälardalen University. ITS-EASY is a joint project between the University and nine Swedish industrial companies, and is co-financed by KKS, the Swedish Knowledge Foundation. ITS-EASY is a unique research school. The focus is on embedded systems, an area of great importance to Swedish industry, above all in the areas of automation, telecommunications and the vehicle industry. During the forthcoming six years the 16 admitted doctoral students will have the opportunity of combining their normal work with research at Mälardalen University. The fact that the doctoral students will begin their research at the same time is original and it is hoped that the combination will be mutually beneficial.

– Being a doctoral student is rather a lonesome occupation. For industrial doctoral students it can furthermore be quite difficult to get into the academic world, and at the same running the risk of being swallowed up by their regular jobs, says Helena Malmqvist, in charge of ABB Sweden’s external research collaborations and Chair of the Board of ITS-EASY.

That risk is diminishing now, by the participants in the industrial research school forming a “class”. In the initial stages they have quite a few joint seminars and courses, and since the doctoral students do research in closely-related fields the idea is that they will be able to get mutual benefit and support.

Cooperation is important

Three of the industrial research school’s participants come from ABB. During the forthcoming six years they will continue to work, and at the same time spending at least half their working time on their research.

– The industrial research school has an interesting setup and for our staff it’s a great opportunity, says Peter Löfgren. He is in charge of both of the industrial doctoral students working at ABB AB, Corporate Research, where they are among the forty or so persons who are working in the field of embedded systems.

– These are important issues for ABB and for our clients. It’s an area of technology which is moving quickly and there’s a big need for research, for example in producing standards suitable for industry, says Peter Löfgren. To do this we need to cooperate, as is the case with Mälardalen University.

– We can’t have competence in all areas and it wouldn’t be cost-effective for us to do everything ourselves, says Peter Löfgren.

– The fact that the University is just round the corner from us is a bonus, but more important is that MDH are good at what they do. They are in world class in certain research areas and have succeeded extremely well in industrial communication and wireless communication. Moreover they are very good at cooperating with industry, says Helena Malmqvist.

The fact that research cooperation between industry and academia is important is shown in an investigation which Mälardalen University and the Knowledge Founda
tion have recently commissioned. In this, 50 of Sweden’s largest export companies expressed their views on the research being carried out today.

The investigation demonstrates a great need of company-oriented and needs-driven research. Nine out of ten companies answered that cooperation between companies and HEIs (higher education institutions) ought to increase. This sort of cooperation can provide great opportunities for growth and strengthen the companies’ competitiveness as well as academic development.

– Working in teams is efficient and occasions like these contribute different things to industry and academia. Academia represents the eagerness to learn and we supply influences from the market. And it is precisely at the intersection of these that it is at its best, says Peter Löfgren.

**Advantages of doing a PhD**

The start of the industrial research school ITS-EASY was preceded by meticulous work to engage both suitable industries and the right doctoral students. The participants were selected because they have the ability, the will and the drive required to pursue doctoral studies. Moreover they have a number of advantages to take with them from working life. Efficiency, keeping deadlines and achieving set goals are what they have learnt in industry.

– For our staff this is a good opportunity to avoid making the choice between work and research. For an individual it’s a big step stopping work to start researching, and for ABB it’s disappointing to lose such an employee. This is a win-win situation for both the employee and the company, says Helena Malmqvist. Both she and Peter Löfgren underline the importance of going as far in their research as to a doctoral degree.

– There are a lot of advantages of doing a PhD, not only because you become an expert in your field, but you also develop an approach that is necessary to be able to go a long way. Researchers don’t give up so easily; someone who has become the best and has not left a stone unturned once can do it again.

– Furthermore, and not least important, it is the networks that the doctoral students build up, both in the academic world and in industry.

The industrial research school ITS-EASY is still newly-started. On ABB’s part the hope is that they will have three new PhDs in six years’ time, and who during this period will to strengthen the company’s trademark at conferences and by publishing articles. And of course they hope that the research will lead to some important technological advances for ABB.

**FACTS**

**ABB Corporate Research**

ABB, one of the world’s leading companies in power and automation technology, supports seven corporate research centres around the world, including a centre in Västerås, Sweden. The centres employ about 800 people and develop technology for future products and services for ABB core businesses. The Västerås research centre collaborates with a number of universities around the world and with most universities in Sweden.

**ITS-EASY**

ITS-EASY is an industrial research school in Embedded Software and Systems, affiliated with the School of Innovation, Design and Engineering at Mälardalen University, as an integrated part of the MDH strategic research area Embedded Systems. ITS-EASY started in October 2011, has admitted 16 doctoral students and will run over the next six years. The research school is funded by KKS (the Knowledge Foundation) and the participating companies: ABB, Bombardier, CrossControl, Etteplan, Ericsson, Imagination Studios, SAAB, SICS, Volvo Construction Equipment and Xdin. The ITS-EASY PhD students are affiliated both with MDH and one of the participating industries. ITS-EASY students will become experts in a selected research area, and will have experience of industrial development, ready to continue their careers as industrial specialists, innovators, or academic researchers.
Research projects at MRTC

**ABV - Enabling Architecture Based Verification and Validation of Mission-Critical Systems**

**Leader:** Kristina Lundqvist  
**Research group:** Safety-Critical Engineering  
**Start:** 2007  
**End:** 2012  
**Funding:** FP7 Marie Curie Reintegration grant  
**Overview:** The overarching research goal of this project is to develop an integrated framework to support more effective verification and validation of mission-critical systems. Within this overarching goal, we define four measurable objectives:
1. Define the formal semantics of the AADL language
2. Develop test suite generation algorithms to support integration testing
3. Develop algorithms to enable effective regression testing
4. Engage industry to assess the feasibility and effectiveness of automated test case generation

**APARTS - Advanced Program Analysis for Real-Time Systems**

**Leader:** Björn Lisper  
**Members:** Stefan Bygde, Björn Lisper, Niklas Holsti (Tidorum LTD)  
**Research Group:** Programming Language  
**Start:** 2010-12-01  
**End:** 2014-11-30  
**Funding:** EU, Marie Curie IAPP  
**Overview:** The real-time performance of embedded software is often critical for the safety and quality of the software-controlled system. Recent research has made it possible to find safe bounds on the worst-case execution time (WCET) of a program by statically analysing the machine-code program. A crucial step is the analysis of the program’s computations on integer data. For instance, the program flow usually depends on such computations. Current WCET tools often require program flow constraints to be provided manually, which is cumbersome and error-prone. Better analyses of integer computations would reduce the need for such manual intervention. Such analyses must be both precise and correct. The mathematical models for such analyses are usually formulated in terms of mathematical integers of unbounded size, while the program actually uses data stored in a fixed number of bits. This can lead to incorrect or imprecise results. We aim to improve WCET analysis by incorporating computation models that give bit-precise results reflecting the finite size of each variable and the possibility of overflow. Most current WCET-analysis tools analyse the possible values of each variable separately, commonly producing an interval of possible values for each variable. However, the behaviour of the program, and thus its WCET, often depend strongly on the relationship between variable values. Ignoring such relationships can make the analysis fail or give over-estimated WCET bounds. We aim to develop computation models that find and use such relationships, typically expressed as affine constraints between several variables. The end goal is WCET analysis with computation models that are both relational and bit-precise. We expect that this will increase the safety, precision, and level of automation of the analysis, and lead to WCET analysis tools that are easier to apply.

**ARIES - Applied Research in Industrial and Embedded Software**

**Leader at MDH:** Sasikumar Punnekkat  
**Members:** Sasikumar Punnekkat, Daniel Sundmark, Radu Dobrin, Frank Lüders, Thomas Nolte, Moris Behnam  
**Research group:** Dependable Software Engineering Group  
**Start:** 2010-06-01  
**End:** 2015  
**Partners:** Blekinge Institute of Technology (BTH), Halmstad University (HH), Mälardalen University (MDH), Swedish Defence Research Agency (FOI), Swedish Institute of Computer Science (SICS), SP Technical Research Institute of Sweden (SP)  
**Funding:** The Knowledge Foundation (KKS), RISE Holding AB  
**Overview:** ARIES brings together competences from three university excellence centres, three industrial research institutes and a strong and diverse set of industry partners, forming a distributed centre of excellence in the field of industrial and embedded software-intensive systems. Especially, we target high-quality software on complex platforms, where we envision composable components as a key ingredient and a joint focus of ARIES. Through our combined competencies in the areas of multi-/manycore, dependable and secure systems, and software engineering methods, we will target innovative solutions and knowledge towards a comprehensive view of how to develop industrial and embedded systems effectively through composable components.

**ARROWS - Design Techniques for Adaptive Embedded Systems**

**Leader:** Hans Hansson  
**Members:** Hans Hansson, Kristina Lundqvist, Thomas Nolte, Paul Pettersson, Cristina Seceleanu, Yin Hang  
**Research group:** Real-Time Systems Design  
**Start:** 2010  
**End:** 2012  
**Funding:** Swedish Research Council (VR)
**Overview:** The ARROWS project is dedicated to development of modeling, analysis and execution support for adaptive embedded system. Traditional embedded systems typically have to satisfy static requirements on e.g., size, energy consumption, timing, and performance. Adaptive embedded systems must additionally be capable of dynamically reconfiguring to adapt to e.g., changes in available resources, user- or application driven mode changes, and modified quality of service requirements. The adaptivity provides flexibility that extends the area of operation and potentially reduces resource consumption, but also poses challenges in many aspects of systems development. The goals of the ARROWS project are to develop rigorous design techniques, platform mechanisms, and design methods for adaptive embedded systems. The following are the main research directions of the project:

- **formal models, verification techniques, and tools for adaptive behaviors and reconfiguration based the theory of priced timed automata, task automata, and the UPPAAL tool**
- **design-time and run-time techniques for balancing conflicting requirements using stochastic models, simulation, model-checking, and run-time monitoring**
- **predictable dynamic resource management, extending the hierarchical scheduling framework with mechanisms for run-time reconfiguration and a calculus for abstract resources**
- **methods for traceability between different system, platform, and software specifications using timed abstract state machines to define transitioning between system representations**

**ArtistDesign**

**Leader:** Björn Lisper  
**Members:** Björn Lisper, Andreas Ermedahl, Jan Gustafsson, Stefan Bygde, Andreas Gustavsson  
**Research group:** Programming Language  
**Start:** 2008-01-01  
**End:** 2011-12-31  
Universidade de Aveiro, Lund University, University of Bologna, Verimag Laboratory, INRIA / IRISA, University of York, Scuola Superiore Sant’Anna CEA, Linköping University, Technische Universität Braunschweig, Technische Universität Kaiserslautern, Universidad de Cantabria, Ecole Polytechnique Fédérale de Lausanne, KTH, Uppsala University, University of Salzburg, Aalborg University, University of Passau, RWTH Aachen, Mälardalen University, Technical University of Denmark, IMEC, Technische Universität Dortmund, Technische Universität Wien, PARADES, ETH Zurich, Instituto Politécnico do Porto - ISEP-IPP, Universität des Saarlandes  
**Funding:** EU FP7 Network of Excellence  
**Overview:** ArtistDesign is a driving force for federating the European research community in Embedded Systems Design. It brings together 31 of the best research teams as core partners, 15 Industrial and SME affiliated Industrial partners, 25 affiliated Academic partners, and 5 affiliated International Collaboration partners who participate actively in the technical meetings and events. The central objective for the ArtistDesign European Network of Excellence on Embedded Systems Design is to build on existing structures and links forged in the FP6 Artist2 NoE, to become a virtual Center of Excellence in Embedded Systems Design. This is mainly achieved through tight integration between the central players of the European research community. These teams have already established a long-term vision for embedded systems in Europe, which advances the emergence of Embedded Systems as a mature discipline. The research effort aims to integrate topics, teams, and competencies, through an ambitious and coherent research programme of research activities which are grouped into 4 Thematic Clusters: “Modelling and Validation”, “Software Synthesis, Code Generation, and Timing Analysis”, “Operating Systems and Networks”, “Platforms and MPSoC”. “Transversal Integration” covering both industrial applications and design issues aims for integration between clusters. The NoE has a very dynamic International Collaboration programme, interacting at top levels with the best research centers and industrial partners in the USA: (NSF, NASA, SRI, Boeing, Honeywell, Windriver, Carnegie Mellon, Vanderbilt, Berkeley, UPenn, UNC Chapel Hill, UIUC, etc) and in Asia (Tsinghua University, Chinese Academy of Sciences, Seoul National University, East China Normal University, etc). ArtistDesign also has a very strong tradition of Summer Schools, Graduate Courses, and major workshops. ArtistDesign builds on existing international visibility and recognition, to play a leading role in structuring the area. The Scientific Coordinator for the ArtistDesign European Network of Excellence is Joseph Sifakis (VERIMAG Laboratory).

**ASIS - Architecture-based verification of software-intensive systems**

**Leader:** Kristina Lundqvist  
**Members:** Andreas Johnsen, Kristina Lundqvist  
**Research group:** Safety-Critical Engineering  
**Start:** 2009  
**End:** 2011  
**Funding:** Swedish Research Council (VR)  
**Overview:** In order to reach the goal of automating test case generation from architecture specifications, a number of tasks needs to be performed. We have started by focusing on the following tasks. 1) Support of model transformation without loss of meaning, 2) Developing a technique for automated testing, 3) Through execution and model checking of the specification be able to carry out dynamic analysis and verify that the architectural specification correctly passes data and control.
**ASSIST - Analysis and Synthesis of Industrial Software Systems**

**Leader:** Jan Carlson  
**Research Group:** Industrial Software Engineering  
**Start:** 2012-02-01  
**End:** 2012-10-31  
**Funding:** ABB Software Research Grant Program  
**Overview:** The ASSIST project aims to bridge the gap between recent academic research achievements and concrete industrial needs and state of practice. Concretely, we will investigate how novel timing analysis and code synthesis techniques developed in the context of an academic component model for embedded systems can be extended and adapted in order to be applicable to IEC61499, focusing on model-level timing analysis, back propagation of analysis results to model elements, and flexible synthesis of independent units.

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**ATAC - Advanced Test Automation for Complex Software-Intensive System**

**Leader:** Paul Pettersson  
**Research Group:** Formal Modelling and Analysis of Embedded Systems  
**Members:** Paul Pettersson, Daniel Sundmark, Sigrid Eldh, Markus Bohlin, Eduard Paul Enoiu, Kivanc Doganay  
**Start:** 2011-09-30  
**End:** 2014-09-29  
**Partners:** Bombardier, CrossControl, Ericsson, MDH, SICs, and partners from other European countries, i.e., Finland, Belgium, and Lithuania.  
**Funding:** VINNOVA/ITEA2  
**Overview:** ATAC is a project which aims at developing, enhancing, and deploying high performance methods and tools for quality assurance of large and distributed software-intensive systems.

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**CHESS**

**Leader:** Mikael Sjödin  
**Members:** Christer Norström, Mikael Sjödin, Antonio Cicchetti, Daniel Flemström, Sasikumar Punnekkat, Federico Ciccozzi, Mehrdad Saadatmand, Barbara Gallina  
**Research group:** Model-Based Engineering of Embedded Systems  
**Start:** 2009-01-01  
**End:** 2011-12-31  
**Partners:** Ericsson AB, Xdin  
**Funding:** VINNOVA/ARTEMIS  
**Overview:** CHESS seeks industrial-quality research solutions to problems of property-preserving component assembly in real-time and dependable embedded systems, and supports the description, verification, and preservation of non-functional properties of software components at the abstract level of component design as well as at the execution level. CHESS develops model-driven solutions, integrates them in component-based execution frameworks, assesses their applicability from the perspective of multiple domains (such as space, railways, telecommunications and automotive), and verifies their performance through the elaboration of industrial use cases.

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**COMING**

**Leader:** Antonio Cicchetti  
**Members:** Hans Hansson, Antonio Cicchetti  
**Research Group:** Industrial Software Engineering  
**Start:** 2010-05-01  
**End:** 2012-04-30  
**Funding:** Marie Curie Intra-European Fellowships for Career Development (IEF), 2009, Individual Fellowship  
**Overview:** The research proposed in the COMING project aims at exploiting the interplay between Model-Driven Engineering (MDE) and Component-Based Development (CBD) for an improved embedded systems development process. In particular, it focuses on the precise formalization of CBD concepts in a MDE setting as the definition of corresponding Domain-Specific Languages; moreover, the subsequent exploitation of MDE design/analysis methodologies will disclose the possibility to cope with current challenges in CBD, like domain independence, incremental and distributed development involving language interoperability, system maintenance, and validation.

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**CONTESSE - Contract-Based Components for Embedded Software**

**Leader:** Ivica Crnkovic  
**Members:** Ivica Crnkovic, Jan Carlson, Radu Dobrin, Björn Lisper, Paul Pettersson, Sasikumar Punnekkat, Heinz Schmidt, Abhilash Thekkilakattil, Juraj Feljan  
**Research Group:** Industrial Software Engineering  
**Start:** 2011-01-01  
**End:** 2014-12-31  
**Funding:** Swedish Research Council (VR)  
**Overview:** Embedded systems make the vast majority of computer systems today. The complexity of software in these systems is growing exponentially. Sound approaches to manage complexity is to use component-based and model-based approach. The aim of the project is to advance state of the art in component- and model-based software development for embedded systems by improving prerequisites for efficient reuse of components. This will be done by introduction of component contracts that define the conditions required by components and provided output. In the existing approaches component contracts specify functional pre- and postconditions of components. Contesse will manage contracts that also include non-functional properties. This will be done through providing formal specification of components contracts, mechanisms for instantiation and verification of the contracts in different contexts, then developing a reasoning framework for contract compositions, provid-
ing input to the contract specification from components code analysis, and system level analysis based on con-
tracts that ensure system characteristics required. The
work will be based on the previous results of the project
members: formal analysis and verification, priced timed
automata and modelling embedded resources, component
models developed, execution time and other resources
estimation based on static analysis, compositions of non-
functional properties, and building run-time mechanisms
to ensure the system quality.

**DICES - Distributed Component-based Embedded Software Systems**

**Leader:** Ivica Crnkovic  
**Members:** Ivica Crnkovic, Jan Carlson, Ana Petricic, Luka Lednicki, Juraj Feljan. External: Mario Zagar (University of Zagreb)  
**Research Group:** Industrial Software Engineering  
**Start:** 2008-03-01  
**End:** 2011-02-28  
**Partners:** Mälardalen University, University of Zagreb Faculty of Electrical Engineering and Computing University of Split, Faculty of Electrical Engineering Ericsson Nikola Tesla, Croatia  
**Funding:** The Knowledge Foundation (KKS), PROGRESS, Mälardalen University, Ericsson Nikola Tesla, Croatia  
**Overview:** DICES has a goal to advance development of distributed embedded software systems with emphasis on software reusability and predictability of software quality. The aim of the project is increasing the software development efficiency and quality by applying service-oriented and component-based approaches. The project will advance theories and methodologies for prediction of certain system properties, develop tools that will help in reusability of software components, and assure performance efficiency of the systems. The overall presence of distributed embedded systems in the modern society is a fact. Examples of such systems are telecommunication systems, grid systems, control and information systems of vehicular systems (cars, trains), different monitoring environmental systems. Embedded systems development is one of the strategic research areas of EU-FP7 programmes. It is also of significant importance in Croatia, since many leading companies in Croatia either produce such systems (e.g. Koncar, Ericsson Nikola Tesla) or use such systems (e.g. Pliva). DICES will address efficient reusability of software components and prediction of the important properties for embedded systems: resource utilisation, and performance, by applying the service-oriented software engineering and component-based software engineering methods and technologies. The project will apply existing and develop new theories for predictability of certain quality attributes providing: a) improved and more efficient software development b) optimal solutions of software architecture and components configurations for distributed systems. The theories will be validated on a case – “iForestFire - Intelligent Forest Fire System” developed at FESB Split. This will enable a thorough validation of the approach and provide input for further development of this system and possible commercialisation of the improved product. Further, abilities of commercialisation, and possibilities of Open Source publicity will be investigated.

**Embedded Systems Verification using Timed Automata Technology**

**Leader:** Paul Pettersson  
**Members:** Leo Hatvani, Cristina Seceleanu, Paul Pettersson  
**Research group:** Formal modeling and analysis of embedded systems  
**Start:** 2009-01-01  
**End:** 2011-12-31  
**Funding:** Swedish Research Council (VR)  
**Overview:** The main motivation of this project is the need for design techniques to support the development of software in embedded systems. In such systems, the software is embedded into a hardware product, and must operate correctly with respect to timing constraints, while using limited resources, such as CPU, energy, memory, bus bandwidth, etc. Hence, an important concern during the design of such systems is to predict that the limited resources of the target platform will not be exceeded. Automated mathematical techniques that would guarantee all of the previously mentioned behaviours, starting from early design stages, are still missing. This project will focus on research in this problem area, with the goal to develop formal description techniques for embedded systems based on automata theoretic approaches, supporting the early development life-cycle phases with prediction analysis techniques for abstract design descriptions. The following will be the main research directions of the project: an automata theoretic approach based on combining the models of priced timed automata and task automata to develop a formal modeling framework for function, timing, and resources in embedded system applications -algorithmic techniques for verification of functional, timing, and resource consumption of embedded systems, and -a tool for automatic verification of the proposed model, based on the existing tools Times and Uppaal.

**ECSS - Efficient Certification of functional Safety for Software systems**

**Leader:** Ivica Crnkovic  
**Members:** Ivica Crnkovic, Mikael Åkerholm, Rikard Land. External: Christian Strzyz (CrossControl)  
**Research group:** Industrial Software Engineering  
**Start:** 2009-05-01  
**End:** 2011-05-01  
**Partners:** CrossControl  
**Funding:** The Knowledge Foundation (KKS)
Overview: The goal is to develop an efficient approach for development of software that is certifiable with respect to functional safety. To efficiently develop such software systems is today, without doubt, one of the greatest challenges for Swedish machine and automotive industry. Manufacturers are today under great pressure to certify their systems due to legislation, for example, the Machinery Directive, EU Directive 2006/42/EC, which comes into legal force from December 29, 2009. Certifying software systems with respect to functional safety requires qualitative evidence of compatibility to a comprehensive development process, that extensive safety analysis have ben conducted, and that the safety related functions in the software have been tested in a convincing way - and these functions are often hard to test at all. In practice this implies that each line of source code becomes much more expensive to develop. We are looking for an efficient development process that is compatible with the requirements of safety standards in combination with model-based and component-based strategies.

Automated mathematical techniques that would guarantee all of the previously mentioned behaviours, starting from early design stages, are still missing. This project will focus on research in this problem area, with the goal to develop formal description techniques for embedded systems based on automata theoretic approaches, supporting the early development life-cycle phases with prediction analysis techniques for abstract design descriptions. The following will be the main research directions of the project:

• an automata theoretic approach based on combining the models of priced timed automata and task automata to develop a formal modeling framework for function, timing, and resources in embedded system applications
• algorithmic techniques for verification of functional, timing, and resource consumption of embedded systems, and
• a tool for automatic verification of the proposed model, based on the existing tools Times and Uppaal.

EURECA
Leader: Sasikumar Punnekkat
Members: Sasikumar Punnekkat, Radu Dobrin
Research group: Dependable Software Engineering
Start: 2008-07-15
End: 2011-04-15
Partners: Sofia University, Bulgaria, University of L'Aquila, Italy, University of Limerick, Ireland, University of Paderborn, Germany, University of Turku, Finland, University of York, UK, Uppsala University, Sweden, VU University Amsterdam, Netherlands, Amrita University, India, Indian Institute of Information Technology and Management- Kerala, India, Indian Institute of Technology-Kanpur, India, Institute of Engineering, Tribhuvan University, Nepal, Lahore University of Management Sciences, Pakistan, University of Colombo, Sri Lanka, XLRI Jamshedpur, India and KTH. Sweden (Associate Partner)
Funding: EU, EMECW
Overview: The EURECA project aims to establish a Eurasian academic mobility Network, for achieving excellence in research and education in a global context, by identifying key themes for cooperation, leveraging on the complementary competencies and providing synergies essential for the progress and mutual benefit of the targeted Asian countries as well as the European Union. The consortium comprises of 16 prominent educational institutions (9 from Europe and 7 from Asia) and is coordinated by Mälardalen University, Sweden. The exchange of personnel, knowledge and competences in multiple study domains of science and technology by our consortium is expected to have a positive and long ranging impact on the socio-economic development of Asia in a sustainable manner. On the other hand, EU will gain knowledge about the socio-technological setup prevailing at the developing Asian countries and will be able to engage in long-standing business relations with the Asian economies.
The consortium partners have special competencies/requirements in the study areas such as Software Engineering, Computer Science, Electrical Engineering, Business studies and Management Sciences, and pay special attention to the mobility needs in these identified thematic fields. Our primary goal is to find top talents from Asia and help them to achieve highest level of excellence in research and education. Additionally, we aim to provide the necessary impetus to the educational systems prevailing at various Asian partner institutions to comprehend and adapt the European educational models and values to the extent feasible.

With a funding of of nearly 5 million Euros, EURECA project already facilitated about 200 students/researchers faculty from Asia/EU to conduct a part of their study at one of the partner institutions.

EUROWEB - European Research and Education Collaboration with Western Balkans

**Leader:** Sasikumar Punnekkat  
**Members:** Radu Dobrin, Damir Isovic  
**Research Group:** Dependability  
**Start:** 2011-09-01  
**End:** 2014-09-01  
**Partners:** Mälardalen University, Sofia University St. Kliment Ohridski, Universita degli Studi dell’Aquila, Vrije Universiteit Amsterdam, The Netherlands, Universität Paderborn, Germany, University of Westminster, United Kingdom, POLITEHNICA University Bucharest, Romania, Åbo Akademi University, Finland, Universitat de les Illes Balears, Spain, University of Sarajevo, Bosnia and Herzegovina, University of Mostar, Bosnia and Herzegovina, University of Banja Luka, Bosnia and Herzegovina, Ss Cyril and Methodius University, Skopje, Former Yugoslav Republic of Macedonia, University of Niš, Serbia, University of Belgrade, University Mediterranean Podgorica, Montenegro, University of Elbasan “Aleksander Xhuvani”, Albania

**Funding:** EU- Erasmus Mundus Action 2  
**Overview:** The EUROWEB project, funded by the European commission, aims to establish a European-western Balkan academic mobility Network, for achieving excellence in research and education in a global context, by identifying key themes for cooperation, leveraging on the complementary competencies and providing synergies essential for the progress and mutual benefit of the targeted western Balkan countries as well as the European Union. The consortium comprises of 17 prominent educational institutions (10 from Europe and 7 from Western Balkans) and is coordinated by Mälardalen University, Sweden.

FIND - Flexibility in Industrial Systems

**Leader:** Ivica Crnkovic  
**Members:** Johan Fredriksson, Ivica Crnkovic  
**Research group:** Industrial Software Engineering  
**Start:** 2009-06-01  
**End:** 2011-06-01

**Partners:** XdIn  
**Funding:** The Knowledge Foundation (KKS)  
**Overview:** The project aims to create conditions and a framework for developing a research center, by developing the prerequisites for a graduate school at ENEA in collaboration with the MRTC. The technical part of the research aims to increase the predictability of time behaviour in large industrial embedded real-time systems. It is important that technology transfer takes place so that the techniques and methods will become easily accessible. An important part of this is to develop rules, frameworks and tools. The projects activities include case studies to understand the methods that can be used in the development of industrial software.

GAUSS - Guaranteed automation communication under severe interference

**Leader:** Mats Björkman  
**Members:** Mats Björkman, Maria Lindén, Svetlana Girs, Kan Yu, Marcus Bergblomma, Martin Ekström, Mikael Ekström, Johan Akerberg, Mikael Gidlund  
**Research group:** Wireless communication  
**Start:** 2009-01-01  
**End:** 2012-12-31  
**Partners:** VG Power, DELTA  
**Funding:** The Knowledge Foundation (KKS)  
**Overview:** The project investigates how safety in wireless communication can be guaranteed in spite of electromagnetic interference.

Hi5 - A Holistic and Improved Infrastructure for Increased Industrial Impact of research

**Leader:** Ivica Crnkovic  
**Members:** Ivica Crnkovic, Kristina Lundqvist, Sasikumar Punnekkat, Paul Pettersson, Hans Hansson, Christer Norström, Malin Rosqvist, Stig Larsson  
**Research group:** Industrial Software Engineering  
**Start:** 2008-01-01  
**End:** 2011-12-31  
**Partners:** ABB, CC Systems, Ericsson, Prevas, Volvo CE  
**Funding:** VINNOVA, the Swedish Governmental Agency for Innovation Systems, ABB, CC Systems, Ericsson, Prevas, Volvo CE  
**Overview:** Hi5 is a project at Mälardalen Real-Time Research Centre (MRTCs) that has a goal to increase the cooperation and synergy of the activities between the research and industry. The three instruments are used to achieve that goal: (i) Increased cooperation on Master education (in particular Software Engineering master program), (ii) increased mobility between academia and industry for PhD students (both industrial and academic PhD students) and (iii) increase mobility and increase cooperation on Postdoc/ expert and specialist level.
**HISCORE - Hierarchical Scheduling of Complex Real-Time Embedded Systems**

**Leader:** Thomas Nolte  
**Members:** Thomas Nolte, Mikael Åsberg, Moris Behnam, Farhang Nemati, Insik Shin  
**Research Group:** Complex Real-Time Embedded Systems  
**Start:** 2008-01-01  
**End:** 2011-12-31  
**Funding:** Swedish Research Council (VR)  
**Overview:** Most of today’s complex embedded systems must satisfy extra-functional requirements for proper operation, i.e., in addition to correct function, there are important requirements on, e.g., timeliness, reliability and energy consumption. It is desirable to be able to construct a system from multiple subsystems, since subsystems are often provided by different suppliers, and since partitioning provides a basis for complexity reduction. However, subsystems often share logical resources, e.g., memory areas, hence making it hard to independently develop and validate subsystems. Moreover, integration of these semi-independent subsystems may be difficult due to intricate dependencies. For independent subsystems, hierarchical scheduling has shown to be useful in preserving the extra-functional property of timeliness. In this project we will develop and generalize hierarchical scheduling frameworks allowing for semi-independent subsystems, thus making hierarchical scheduling frameworks suitable for deployment in complex (real) architectures, such as those encountered in the automation, telecom, and vehicular domains. More specifically we will develop abstract representations of hierarchically scheduled semi-independent subsystems on uni-processor, distributed and multiprocessor architectures. For each of these, we will develop appropriate synchronization protocols and associated real-time analysis.

**IDEAS - Innovation and Design for Euro-Asian Scholars**

**Leader:** Damir Isovic  
**Members:** Damir Isovic, Radu Dobrin, Sasikumar Punnekat, Annika Björklund  
**Research group:** Model-Based Engineering of Embedded Systems  
**Start:** 2011-09-01  
**End:** 2014-09-01  
**Partners:** Mälardalen University Sweden, Darmstadt University Of Applied Sciences Germany, Eindhoven University Of Technology The Netherlands, Indian Institute Of Technology Bombay, Maharashtra, Lahore University Of Management Sciences Pakistan, Royal University Of Buthan Bhutan, Tribhuvan University Nepal, Universidad Politecnica De Madrid Spain, Universidad Politecnica De Valencia Spain, University Court Of The University Of Abertay United Kingdom, University Of Tartu Estonia, Universiti Teknologi Malaysia Malaysia.  
**Funding:** Erasmus Mundus Action 2  
**Overview:** The overall objective of IDEAS project is to create a partnership in research and education that will strengthen the ties between Europe and Asia, with a special focus on innovation and product realization in a global context. The project will provide students with an excellence in scientific and technological domains, based on both theoretical foundations and practical experience with an international perspective, and prepare them to participate in building and managing complex and large systems and infrastructures. The project will establish a mobility network between Europe and Asia, to exchange excellence in research and education in several relevant disciplines, such as innovation, design, engineering and environmental science. It will expand the experience of European partners in student and staff exchange to the partner institution in Asia, and thus disseminate good practices with regard to organization and mobility. Furthermore, IDEAS will facilitate the mobility of students and academic staff through a scholarships scheme, curriculum development of the individuals, the transfer of know-how, and the exchange of best practices. Although the funding of this specific Lot is only for mobility from Asia to EU, we will strive to implement the mobility in both directions. The emphasis will be placed on capacity building aspects, in particular the ability of the partner institutions to handle international mobility and large international cooperation projects. Finally, the project will also provide the long-lasting value to the individuals involved, who will benefit from a study/research period abroad. As the consortium offers a wide range of thematic fields, any individual mobility demand will find the right educational or research environment at the host university. This will contribute to develop a pool from well qualified, open-minded and internationally experienced young women/men as future leaders.

**ITS-EASY Post Graduate School for Embedded Software and Systems**

**Leader:** Ivica Crnkovic  
**Members:** Members: Ivica Crnkovic, Kristina Lundqvist, Malin Rosqvist, Gunnar Widforss, Radu Dobrin, Apala Ray, Daniel Hallmans, Gaetana Sapienza, Mathias Ekman, Stefan Björnander, Henrik Jonsson, Kristian Wiklund, Marcus Jägemark, Daniel Kade, Göran Bertheau, Kivanc Doganay, David Rylander, Fredrik Ekstrand, Stephan Baumgart, Tomas Olsson, Mehrdad Saadatmand, Lars Asplund, Jakob Axelsson, Mats Björkman, Antonio Ciccetti, Peter Funk, Hans Hansson, Damir Isovic, Stig Larsson, Björn Lisper, Thomas Nolte, Paul Pettersson  
**Research Group:** Industrial Software Engineering  
**Start:** 2011-04-01  
**End:** 2018-03-31  
**Partners:** ABB, Bombardier, CrossControl, Ericsson, Etteplan, Imagination Studios, SAAB, SICS, Volvo CE, Xdin  
**Funding:** The Knowledge Foundation (KK) and industrial partners  
**Overview:** ITS-EASY is an industrial research school in Embedded Software and Systems, affiliated with the School of Innovation, Design and Engineering (IDT) at Mälardalen University (MDH), as an integrated part of the MDH strategic research area Embedded Systems (ES). ITS-EASY envisions to be a unique industrial research school par excellence in the Embedded Systems domain
in Sweden. ITS-EASY is focused on topics of paramount importance for dominating parts of Swedish industry: Embedded Systems including Software-Intensive Systems, Dependable (reliable and safe) Systems, and Sensor Systems. The main industrial domains considered are automation, telecommunication and vehicles.

**Intelligent Embedded Systems**

**Leader:** Damir Isovic  
**Members:** Mats Björkman, Damir Isovic, Lars Asplund, Peter Funk, Maria Lindén, Anders Martinsen  
**Research Group:** Model-Based Engineering of Embedded Systems  
**Start:** 2009-01-01  
**End:** 2011-08-31  
**Partners:** CrossControl, Prevas AB, Hök instrument AB, RealTest AB, Motion Control AB, Elektronikpartner AB  
**Funding:** The Knowledge Foundation (KKS)  
**Overview:** Embedded systems is Mälardalen University’s most research-intensive area. This master program relies on a strong research base in the field, provided by Mälardalen Real-Time Research Centre (MRTC) and Intelligent Sensor Systems (ISS) centre, both hosted at our school. MKTC is a nationally leading research center for embedded systems, mainly focused on embedded software. The goal is to provide research excellence that will enable the industry to seize the opportunities offered by programmable products and production. ISS is a unit which conducts research in the fields of artificial intelligence, biomedical engineering, robotics and wireless communications. The focus is on mobile, intelligent sensor systems that will lead to improved safety and efficiency in business and healthcare. All teachers in this master program are researchers at MKTC and ISS, with deep ties to the industry. Research results are continuously being transferred in education. Most of the advanced level courses offered to master students in their second year cover state-of-the art research technique in intelligent embedded systems, and they are taken jointly with the PhD students of the department. Master program in Intelligent Embedded Systems has eight industrial partners and additional five associated companies, all of them involved in the education through industrial projects for students, mentorship and guest lectures. Our industrial partners assure the quality and industrial relevance of the program. All course units contain both theory and practice. The main pedagogical idea that we apply is Problem-Based Learning (PBL), which means that large part of the program is performed in project form. The projects are supplied by our industrial partners, and are solved in collaboration with them.

**MBAT - Combined Model-based Analysis and Testing**

**Leader:** Cristina Seceleanu, Paul Pettersson  
**Members:** Paul Pettersson, Cristina Seceleanu, Mehrdad Saadatmand, Raluca Marinescu  
**Research Group:** Software Engineering Group  
**Overview:** MBAT will provide Europe with a new leading-edge Reference Technology Platform for effective and cost-reducing validation and verification, focusing primarily on transportation domain, but also to be used in further domains. Developed by European industrial key players (large companies and SMEs) in this domain and supported by leading research partners, this MBAT RTP will be of high value for the European industry, providing very effective means to assure utmost quality embedded systems at reduced costs. With this, MBAT will also strongly support the EU vision of zero traffic fatalities by 2020. As this project is clearly industrial-driven it will be assured that the MBAT RTP will provide solutions for real-life development challenges existing in the European industry as this is also the goal of ARTEMIS projects.
**MESSI - Methods for innovation development in software intensive systems**

**Leader:** Hans Hansson  
**Members:** Hans Hansson, Stefan Cedergren  
**Research Group:** Business-Oriented Engineering of Software and Systems group  
**Start:** 2010-06-01  
**End:** 2012-06-01  
**Partners:** Volvo Construction Equipment AB  
**Funding:** The Knowledge Foundation (KKS) and Volvo CE  
**Overview:** The main objective of the strategic recruitment within the project is to support efforts to identify requirements and develop a process for the electronics and software development, based on the needs Volvo CE will face in 2020. Examples of such challenges is the need for increased functionality that must be supported by electronic systems, where, for example, more advanced control functions are included, which contributes to the product as a whole becomes more advanced.

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**OPEN-SME Open-Source Software Reuse Service for SMEs**

**Leader:** Ivica Crnkovic  
**Members:** Ivica Crnkovic, Sasikumar Punnekkat, Adnan Causevic  
**Research Group:** Industrial Software Engineering  
**Start:** 2010-06-01  
**End:** 2012-06-01  
**Partners:** Greek Association of Computer Engineers Thessaloniki University unu-merit rdt. Performers: Teletel, Västerås Science Park, Solinet gnonom informatics, Infmaciono drustbo srbije  
**Funding:** EU FP7  
**Overview:** The OPEN-SME project aims to develop a set of methodologies, associated tools and business models centred on SME Associations, which will enable software SMEs to effectively introduce Open Source Software Reuse practices in their production processes. In this scope, software reuse is regarded as the sharing of software modules across different development teams, organisations, and diverse application domains.

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**PRESS - Predictable Embedded Software Systems**

**Leader:** Thomas Nolte  
**Members:** Thomas Nolte, Sara Afshar, Mohammad Ashjaei  
**Research Group:** Complex Real-Time Embedded Systems  
**Start:** 2011-01-01  
**End:** 2015-12-31  
**Funding:** The Swedish Foundation for Strategic Research (SSF)  
**Overview:** For most of today’s embedded software systems, correct operation requires not only correct function, they must additionally satisfy extra-functional properties, in particular related to resource usage and timing. The goal of this project is to develop new resource reservation techniques for distributed embedded software systems; techniques allowing for design-time and run-time management of these extra-functional properties. We will develop a resource aware framework providing predictable timing and resource usage of embedded software. Our overall goal is to develop hierarchical scheduling techniques into a cost efficient approach applicable for a wide range of applications, including automotive, automation, aerospace and consumer electronics. The challenge is to guarantee extra-functional properties stretching from one node to another node over the network.

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**PROGRESS**

**Leader:** Hans Hansson  
**Members:** Andreas Ermedahl, Andreas Hjertström, Aneta Vulgarakis, Björn Lisper, Christer Norström, Cristina Seceleanu, Dag Nyström, Damir Isovic, Farhang Nematí, Hans Hansson, Hüseyin Aysan, Ivica Crnkovic, Jagadish Suryadevara, Jan Carlsson, Johan Fredriksson, Johan Kraft, Jukka Mäki-Turja, Kristina Lundqvist, Marcelo Santos, Mikael Sjödin, Moris Behnam, Paul Pettersson, Radu Dobrin, Raffa Inam, Rikard Land, Sasikumar Punnekkat, Séverine Sentilles, Stefan Björnander, Stefan Bygde, Thomas Nolte, Yue Lu, Gunnar Widforss  
**Start:** 2006  
**End:** 2011  
**Funding:** Swedish Foundation for Strategic Research (SSF)  
**Overview:** PROGRESS is a Swedish national strategic research centre at Mälardalen University in Västerås. PROGRESS is dedicated to find methods for cost-efficient handling of the increasing complexity of embedded software used in computer-based products. Our focus is on the domains of automation, ground vehicles and telecom; domains of great strategic importance for Swedish economy, and for which the majority of innovation and added value stem from software. Alas, these are also domains where the cost of software is rampaging, and where the necessary quality of software is becoming increasingly difficult to achieve. Adopting a software-component approach to engineering and re-engineering of embedded software systems, PROGRESS provides theories, methods, and tools that increase quality and reduce life-cycle costs. PROGRESS is focusing its research on development, adaptation and extension of Component Based Development (CBD) into a mature engineering discipline for cost-efficient development of embedded software. Based on a common vision and concept, the PROGRESS research is organized into a set of interrelated disciplinary research directions, interlinked via cross-cutting and integrating tool environment and demonstrator projects. The cross-cutting projects are important vehicles for integration of disciplinary research results and provide means for evaluation and verification of the developed technology.
PROGRESS’ vision is to be a worldwide-recognized centre in software engineering of embedded real-time systems with extensive contacts/exchange with other leading universities and to be the preferred partner for the industry. Research includes theories, methods, and tools for

- predictable embedded software development from software components and legacy code,
- interfacing components with the underlying platform and synthesising platforms from application requirements, and
- adopting and applying real-time modelling and analysis techniques across all stages of the component-based design and development chain.

**PROGRESS sub projects:**

- **PG-CBD-CVer – Component Verification.** Leader: Paul Pettersson
- **PG-CBD-IDE – Integration Development Environment.** Leader: Ivica Crnkovic
- **PG-CBD-Proc – Identification and specification of CB process.** Leader: Ivica Crnkovic, Rikard Land
- **PG-CBD-StatA – Static Timing Analysis of Component-Based Systems.** Leader: Björn Lisper
- **PG-CBD-Trans – Transformation of processes.** Leader: Ivica Crnkovic, Rikard Land
- **PG-Demo-Evolution – Progress Component Models.** Leader: Mikael Åkerholm
- **PG-Demo-Leg – Legacy demonstrator.** Leader: PG-Demo-SAVE – The SAVE demonstrator. Leader: Thomas Nolte, Dag Nyström
- **PG-Dep-ET – Enabling Technologies for Evaluating/Ensuring Dependability.** Leader: Sasikumar Punnekkat
- **PG-Dep-FRAMES – Faults and Reliability Aware Methodologies for Efficient Scheduling.** Leader: Radu Dobrin
- **PG-Dep-PEARLS – Parameterized Evaluation of Attributes of Reliable Systems.** Leader: Sasikumar Punnekkat
- **PG-Dep-REMAP - Reliability Modeling and Analysis for Predictability Assurance.** Leader:
- **PG-Leg-Asis – Legacy Model Analysis.** Leader: Christer Norström
- **PG-Leg-Comp – Composition of legacy systems.** Leader: Christer Norström
- **PG-Leg-Extract – Model Extraction for Legacy Systems.** Leader: Christer Norström
- **PG-Pla-INC – Information Centric development of component-based embedded real-time systems.** Leader: Dag Nyström
- **PG-Pla-OSC – Optimization, Synthesis and Configuration.** Leader: Mikael Sjödin
- **PG-Pla-SSI – SubSystem Integration.** Leader: Thomas Nolte

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**RAP - Robotics, Automation and Process Control**

**Leader:** Mats Björkman  
**Members:** Mats Björkman, Johan Åkerberg  
**Research group:** Wireless communication  
**Start:** 2008-07-01  
**End:** 2011-12-31  
**Partners:** ABB, Örebro University, and others  
**Funding:** The Knowledge Foundation (KKS)  
**Overview:** RAP is an industrial PhD school, led by Örebro university. MDHs project within RAP deals with safety and security in wireless automation networks.

**SafeCer - Safety Certification of Software-Intensive Systems with Reusable Components**

**Leader:** Hans Hansson  
**Members:** Hans Hansson, Sasikumar Punnekkat, Gunnar Widforss, Jan Carlson, Barbara Gallina, Iain Bate, Björn Lisper, Philippa Conmy, Stefan Björnander, Stephan Baumgart, Guillermo Rodriguez-Navas  
**Research group:** Real-Time Systems Design  
**Start:** 2011  
**End:** 2013  
**Partners:** Swedish partners are Volvo Technology, CrossControl, SP (in total 23 partners in 6 countries)  
**Funding:** VINNOVA/ARTEMIS  
**Overview:** SafeCer is targeting increased efficiency and reduced time-to-market by composable safety certification of safety-relevant embedded systems. The industrial domains targeted are within automotive and construction equipment, avionics, and rail. SafeCer will also develop certification guidelines and a training example for other domains, thus considerably increasing its market impact. A primary objective is to provide support for system safety arguments based on arguments and properties of system components as well as to provide support for generation of corresponding evidence in a similar compositional way. By providing support for efficient reuse of certification and stronger links between certification and development, component reuse will be facilitated, and by providing support for reuse across domains the amount of components available for reuse will increase dramatically. The resulting efficiency and reduced time to market will, together with increased quality and reduced risk, increase competitiveness and pave the way for a cross-domain market for software components qualified for certification. SafeCer brings together leading companies and SMEs across Europe (including OEMs, technology, tool, and competence providers, as well as certification and standardisation experts), which together with selected universities and research institutes are capable and motivated to realize the SafeCer objectives.
**Safety-Critical Component-Based Systems**

**Leader:** Ivica Crnkovic  
**Members:** Ivica Crnkovic, Rikard Land, Mikael Åkerholm. External: Christian Strzyz (CrossControl)  
**Research group:** Industrial Software Engineering group  
**Start:** 2009-05-01  
**End:** 2011-06-01  
**Partner:** CrossControl  
**Funding:** The Knowledge Foundation (KKS)  
**Overview:** Through new standards and stricter legislation, companies developing safety-critical products have to meet stronger requirements regarding functional safety. Still, development and manufacturing of the products must be cost efficient. The project intends to study practices which enable reuse of existing software components during product development in order to improve the efficiency, while also meeting the requirements on the integrity of the system and functions, as well as the requirements on e.g. documentation and traceability. The goal is to suggest and study methods and practices, instructions, forms of documentation, and technology which supports that the work performed during one development project gives a higher confidence when system parts are reused. By this, the effort to certify a new system with the reused component can presumably be significantly lower. We believe this also means that technologies need to be adapted so that components can be executed side by side in a predictable and trustworthy manner. An important part of the project is the active contact with Swedish industry in order to understand what are the most important requirements and limitations met in practice.

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**SAVE-IT**

**Leader:** Hans Hansson  
**Members:** Hans Hansson, Andreas Ermedahl, Paul Pettersson, Gunnar Widforss  
**Start:** 2004-01-01  
**End:** 2011-10-31  
**Partners:** Linköping University, KTH Royal Institute of Technology, Uppsala University  
**Funding:** The Knowledge Foundation (KKS)  
**Overview:** SAVE-IT is an industrial graduate school with a research focus upon real-time- and safety-critical systems, and with a special focus upon component-based development of such systems. SAVE-IT organizes research studies for a number of industrial PhD students, and works for an increased cooperation and exchange between participating companies and universities. PhD students accepted to SAVE-IT are offered financial support, and are allowed to freely participate in a collection of tailor-made network activities and graduate courses. SAVE-IT is supported by the KK-foundation as part of an effort to enhance competence in Swedish industry. SAVE-IT has its organisational location at Mälardalen Real-Time research Center (MRTC) at Mälardalen University. SAVE-IT includes a network of industrial and academic partners. SAVE-IT also has some appointed staff (coordinator, administrator, etc.) and a controlling board.

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**START - Stochastic Real-Time Analysis of Embedded Software Systems**

**Leader:** Thomas Nolte  
**Members:** Thomas Nolte, Yue Lu  
**Research Group:** Complex Real-Time Embedded Systems  
**Start:** 2011-01-01  
**End:** 2014-12-31  
**Funding:** Swedish Research Council (VR)  
**Overview:** The real-time research community has over the years developed mature results in the area of real-time scheduling and timing analysis of embedded software systems. In parallel, engineers have created, developed, and evolved embedded software systems without complying with the academic real-time models required to do timing analysis. This gap between academic models and industrial practice is a key challenge in applying the (often very restrictive) academic models to real systems. The aim of this project is to develop new models that, by using statistical inference techniques, are better suited for development of real industrial systems. Given these more expressive models, we will research and develop stochastic and simulation-based analysis of embedded software systems, providing software engineers with probabilistic measures of timing requirement violations for embedded software systems, in contrast to the more traditional and coarse grained pass/fail result provided by the conventional academic worst-case real-time analysis. The developed analysis will provide an important foundation for a broader adoption of sound timing analysis techniques for complex embedded software systems with real-time requirements.

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**SWELL - Swedish V&V Excellence**

**Leader:** Daniel Sundmark  
**Members:** Daniel Sundmark, Adnan Causevic, Stefan Björnander, Andreas Johnsen  
**Research Group:** Software Testing Laboratory  
**Start:** 2008  
**End:** 2012  
**Partners:** Blekinge Institute of Technology (BTH), Lund University, Chalmers, Mälardalen University, ABB, Ericsson, Saab, Swedish Association for Software Testing, Volvo, Sogeti, Logica, Spidexa, QTema, SauerDanfoss, ST Ericsson  
**Funding:** VINNOVA (the Swedish Governmental Agency for Innovation Systems) and industrial partners  
**Overview:** SWELL is the Swedish research school in Verification and Validation. SWELL is doing research and innovation in testing and software quality methods together with Swedish software companies. The school started in 2008 and has 15 PhD students, 4 universities, and 10 companies and organisations directly supporting and participating. SWELL is supported by a grant from Vinnova and co-sponsored by the participating universities and companies.
SYNOPSIS

Leader: Hans Hansson

Members: Hans Hansson, Björn Lisper, Sasikumar Punnekkat, Kristina Lundqvist, Iain Bate, Jan Carlson, Thomas Nolte, Paul Pettersson, Barbara Gallina, Mikael Åsberg, Guillermo Rodriguez-Navas

Research Group: Real-Time Systems Design

Start: 2011-09-01
End: 2016-08-31

Funding: The Swedish Foundation for Strategic Research (SSF)

Overview: SYNOPSIS is targeting increased efficiency and reduced time-to-market by composable safety certification of safety-relevant embedded systems. The fundamental approach is built upon new disciplinary research in component contracts, parameterized verification, and behavioural interference analysis, together with system-oriented research on safety case argumentations, co-development processes and provision of evidences based on testing of system robustness. The resulting efficiency and reduced time to market will increase competitiveness and pave the way for a cross-domain market for software components qualified for certification. The industrial domains targeted are within heavy-vehicles, construction equipment, avionics, and rail, and suitable use cases from industrial partners will form the backbone of the demonstrator planned.

TESLA - Time-critical & Safe wireless Automation communication

Leader: Mats Björkman

Members: Mats Björkman, Maria Lindén, Mikael Ekström, Marcus Bergblomma, Martin Ekström, Johan Åkerberg

Research group: Wireless Communication

Start: 2010-01-01
End: 2012-12-31

Partners: ABB Corporate Research, VG Power AB, DELTA AB

Funding: VINNOVA, the Swedish Governmental Agency for Innovation Systems

Overview: The project aims at providing guarantees for safety and security in electromagnetically disturbed environment.

TIMMO-2-USE

Leader: Björn Lisper

Research group: Programming Language

Start: 2010-10-01
End: 2012-09-30


Funding: VINNOVA, the Swedish Governmental Agency for Innovation Systems

Overview: TIMMO-2-USE aims at increasing the efficiency and accuracy in handling timing-related issues in the complex development of automotive real-time embedded systems. TIMMO-2-USE stands for TIMing MØdel - TOols, algorithms, languages, methodology, and USE cases which summarizes the main objectives of the project, i.e., the development of novel tools, algorithms, languages, and a methodology validated by use cases. TIMMO-2-USE is an ITEA2 project (ITEA 2 project 09033) with 17 partners from France, Germany, and Sweden. The project started in October 2010 and has a duration of 2 years. The project is funded by the national agencies of France, Germany and Sweden. Network-based electronic systems in today’s vehicles are of big and increasing complexity. Mastering different types of timing constraints and behaviour in the AUTOSAR-based supply chain of the complex development process is of crucial importance when designing distributed real-time automotive systems. On the one hand this requires an adequate transition of timing information in the complete development process throughout the different abstraction levels. On the other hand, an efficient exchange of timing information is necessary between different tools and between different roles in the overall tool and supply chain, e.g., between OEM and Tier-1 suppliers. TIMMO-2-USE will address the specification, transition and exchange of different types of timing information throughout different steps of the development process. The general goal is to evaluate and enhance standards for different applications in the development by different technical use cases covering multiple abstraction levels and tools. For this, TIMMO-2-USE will bring the AUTOSAR standard and EASTADL2 into different applications like WCET analysis and in-the-loop scenarios. This will bring new algorithms and tools for the transition and conversion of timing information between different tools and abstraction level based on a new advanced methodology which, in turn, will be based on a combination of the TIMMO and the ATEST2 methodologies.
**TIPCES - Timing Predictions of Complex Embedded Systems**

**Leader:** Jukka Mäki-Turja  
**Research Group:** Model-Based Engineering of Embedded Systems  
**Start:** 2011-03-01  
**End:** 2016-02-28  
**Partners:** Arcticus Systems AB  
**Funding:** The Swedish Research Council (VR)  
**Overview:** Embedded systems (ES) can be found everywhere; in vehicles, robots, medical appliances, etc. Software reliability of these systems is paramount. The trend of these systems is to incorporate more and more complex functionality. Timing behavior is usually addressed during the final phases of the development process, resulting in long and costly design iterations. This research will focus on extending academic theories, specifically response-time analysis (RTA), for timing predictions of ES. RTA theory is a mature technology from a scientific viewpoint. However, the industrial impact of these theories has been limited and unsuccessful. This project will investigate, through studies on actual systems, how RTA can be extended to incorporate information of the behavior of actual systems in order to improve the accuracy of RTA. Our preliminary research has already identified some of the problems to be addressed. Furthermore, we will investigate how to encapsulate this theory into tools, so it can be incorporated into development tool chains. With such tools, timing flaws can be discovered early in the design process, reducing development costs significantly. RTA also provides formal evidence of correctness, an important aspect in certification processes. This research proposal has been identified in cooperation with several industrial partners. Thus, besides providing new scientific real-time theories, they will have a good chance of being accepted and adopted by industry.

**Worst-Case Execution Time Analysis of Parallel Systems**

**Leader:** Björn Lisper  
**Members:** Björn Lisper, Andreas Gustavsson, Andreas Ermedahl, Jan Gustafsson  
**Research group:** Programming Language  
**Start:** 2009-01-01  
**End:** 2011-12-31  
**Funding:** Swedish Research Council (VR)  
**Overview:** Worst-Case Execution Time (WCET) analysis finds safe upper bounds for the execution time of code fragments. Reliable WCET estimates are essential in the development of safety-critical hard real-time systems, where failures to meet deadlines can have catastrophic consequences. This project targets WCET analysis of parallel systems. Compared to WCET analysis of sequential processors, research in WCET analysis for parallel systems is almost non-existent. In the light of the current hardware revolution, where multicore processors rapidly are becoming standard, this is a glaring omission. In a few years also hard real-time applications will run on multicores, and then current WCET analysis methods and tools will become obsolete. The goal of the project is to find suitable models and methods for WCET analysis of parallel systems, mainly multicore and MPSoC’s. The emphasis is on basic models taking parallelism into account, mainly for flow analysis and calculation. We aim to produce seminal results of the same dignity as the original works on timing schemas and IPET for sequential programs.
Projects starting in 2012

**AUTOSAR for Multi-Core in Automotive and Automation Industries**

**Leader:** Anders Svensson  
**Members:** Björn Lisper, Thomas Nolte  
**Research Group:** Complex Real-Time Embedded Systems  
**Start:** 2012-06-01  
**End:** 2014-05-31  
**Partners:** ABB Corporate Research, Volvo Technology, ArcCore AB, MDH.  
**Funding:** VINNOVA, the Swedish Governmental Agency for Innovation Systems  
**Overview:** Multi-core technology is recognized as a key component to cost-efficiently enable new products. It opens up for the possibility for hardware consolidation thus reducing the overall hardware and electronics cost of the system, but also results in tremendous challenges. The AUTOSAR consortium has developed a world-wide standard for automotive embedded software systems, which includes support for multi-cores. The standard can now be used in non-automotive domains, such as industrial automation. The project will in an AUTOSAR context address the issues of hardware consolidation on multicore architectures, how to achieve good performance, and how to ensure timing predictability to meet hard real-time requirements. We believe that cooperation between companies in different industrial segments with common technical challenges will provide better solutions. Therefore, the project consortium has partners from both the automotive and industrial automation domains.

**Femmva - Functional- and execution-models in modern electronic vehicle architectures**

**Leader:** Mikael Sjödin  
**Members:** Mikael Sjödin, Saad Mubeen, Jukka Mäki-Turja, Peter Wallin  
**Research Group:** Model-Based Engineering of Embedded Systems  
**Start:** 2012-01-01  
**End:** 2014-12-31  
**Partners:** Arcticus Systems, Volvo Construction Equipment  
**Funding:** The Knowledge Foundation (KKS)  
**Overview:** In development of the software architecture of modern vehicles, models are becoming increasingly important as design objects. To this end, several domain-specific modeling languages have been developed within the different vehicular segments. In this project we seek to bridge the semantic gap that exits between such models that are used in the segment of construction-equipment vehicles. In particular we will attack the gap between functional models (expressed in standard languages as EAST-ADL and/or proprietary languages such as Simulink or Statemate) and execution models (expressed in standard languages like TIMMO and Autosar and/or proprietary languages like Rubus Component Model). In development of a new vehicle, as much as 80% of the innovation is realized in software. A major part of the development cost and time is spent on software development. Thus, improvements in the development technologies have direct impact on companies’ competitiveness, with respect to cost and time-to-market. While the introduction of models into the development of software architectures has increased efficiency in some parts of the engineering process, the models are also cause of novel concerns. In particular, mismatch between structural and semantic assumptions in modeling languages used in different parts of the design-process cause large problems when designs artifacts are transformed between modeling languages. In this project we will develop patterns that allow transformation between the different modeling languages used in the segment; thus enabling use of automated transformations. Development of such automated transformations and also automatic detection of design-patterns that does not allow unambiguous transformation is a second step in the project. Based on these transformations, it will be possible to assemble a seamless development-chain of existing software-engineering tools; where the appropriate transformation can be used to convert the output of one tool to the input of another tool. Furthermore, the identification of design-patterns that are impossible, or difficult, to transform with preserved semantics will serve as valuable feedback to the future standardization process for the languages studied. This project brings together world leading competence in modeling and model-transformation for predictable embedded systems (MDH), software-development tools for vehicular systems (Arcticus), and expertise in development of state-of-the-art functionality in vehicular architectures (Volvo Construction Equipment). This small team spans the necessary competence to tackle this complex problem and make tangible contribution to the academic field while also generating industrially useful results and tools.

**PPMsched - Performance Preserving Multicore Scheduling**

**Leader:** Thomas Nolte  
**Members:** Thomas Nolte, Mikael Sjödin, Rafia Inam  
**Research Group:** Complex Real-Time Embedded Systems  
**Start:** 2012-01-01  
**End:** 2014-12-31  
**Partners:** Ericsson, Xdin  
**Funding:** The Knowledge Foundation (KKS)  
**Overview:** Contemporary scheduling of real-time tasks on multicore architectures is inherently unpredictable, and activities in one part of a system (subsystem) can have negative impact on performance in unrelated parts of the system. A major source of such unpredictable negative impact is contention for shared physical memory. In essence, there are currently no mechanisms that allow a subsystem to protect itself from negative impact if other subsystems start stealing its memory bandwidth. For performance critical real-time systems, overcoming this
problem is paramount. In this project we will investigate novel methods to preserve performance of a subsystem in the face of changes in other subsystems or even during larger changes of the software architecture. We will do so by treating memory bandwidth as a shared resource to be arbitrated by the operating-system; thus guaranteeing each subsystem a certain amount of memory accesses. Our methods can not only be used to preserve performance in face of system changes, but also allow us to fine-tune performance and they allow the systems engineers to make tradeoffs between resource allocations to different parts of the system. Our techniques will give significant contributions to solving two major industrial problems in performance-critical embedded systems: (1) migration of legacy, singlecore, systems to multicore, and (2) reuse of tested and validated subsystems in new contexts. While building a conceptually simple idea, this project faces several scientific and industrial challenges. For instance a key goal in the project is to build our techniques on existing hardware platforms, i.e. we cannot rely on any special hardware to trace and arbitrate memory accesses. Our hypothesis is that performance counters, available in modern CPUs, will allow us to deduce the memory bandwidth consumed by analyzing e.g. number of stores, loads and cache-misses. To keep the overhead of a software based solution reasonable, we need to investigate methods that can find approximated values of the consumed bandwidth. Tracking and arbitrating the exact number of memory cycles used is likely to give unrealistic overhead. Hence, to allow use of our techniques in real-time applications, the approximations we use need to have bounded error that can be accounted for in real-time analysis. This project brings together world leading competence in resource-arbitration using scheduling techniques (MDH), operating systems design and development (Enea), and development of performance critical embedded systems (Ericsson). The team-members each bring critical competence to tackle the above problem; a problem which neither organization is equipped to attack in a cost efficient manner by themselves.

PREMISE - Predictable Multicore Systems

Leader: Thomas Nolte
Research Group: Complex Real-Time Embedded Systems
Start: 2012-01-01
End: 2017-12-31
Partners: ABB AB, Mälardalen University
Funding: The Knowledge Foundation (KKS), ABB AB, Mälardalen University
Overview: In this project we perform research on multicore embedded systems with a particular focus on issues related to timing and predictability in an industrial context. Industry is faced with a situation having to use new multicore technology, partly due to the fact that chip manufacturers are discontinuing production of single core processors, and partly due to customer demand. Hence, systems that have been developed for single core architectures must be moved to (migrated to) new parallel architectures, introducing parallelism that require a new way of thinking, a new way of constructing software and a new way of executing this software. In this project we expected to take an active role in this development at our industrial partner ABB AB, Corporate Research. In the coming four years we expect to have gained a solid knowledge in how embedded multicore systems are to be constructed such that they are easy to develop, maintain and evolve.

PROMPT - Professionell masterutbildning i programvaruteknik

Leaders: Hans Hansson, Malin Rosqvist
Members: Hans Hansson, Damir Isovic, Anders Martinsson, Malin Rosqvist.
Research Group: Real-Time Systems Design group
Start: 2012-03-01
End: 2013-02-28
Partners: Blekinge Institute of Technology (BTH), Chalmers, University of Gothenburg, Swedish Institute of Computer Science (SICS), Swedsoft
Funding: The Knowledge Foundation (KKS)
Overview: Software is the soul of Swedish industry is an expression of that software is a business critical resource for large parts of Swedish industry and an important source of innovation and competitiveness. Through PROMPT, we intend to establish a national education initiative with the goal of ensuring the supply of advanced software-related skills and innovation to Swedish industry. The project includes an inventory and identification of skills needs in small, medium and large companies, and a business intelligence and trend analysis. PROMPT will be an open initiative that welcomes the participation of additional companies and universities. A special focus will be on appropriate techniques for flexible learning that allows for course attendance, irrespective of time and space.

RALF3 - Software for Embedded High Performance Architectures

Leader: Ivica Crnkovic
Members: Ivica Crnkovic, Lars Asplund, Jan Carlson, Björn Lisper, Thomas Larsson, Magnus Otterskog, Juraj Feljan, Andreas Gustavsson, Gunnar Widforss, Malin Rosqvist, Luka Lednicki
Start: 2012-01-01
End: 2016-12-31
Funding: The Swedish Foundation for Strategic Research (SSF)
Overview: The overall goal of Ralf 3 is to formulate and implement an appropriate component model for computation-intensive embedded real-time systems with very high data rates, and to provide a support for distribution of software to the heterogeneous platform to achieve optimal results in performance, system response, and other important requirements for embedded systems. In parallel with this work a number of systems will be used as test benches and demonstrators. In particular we will use an underwater robot with stereo cameras to evaluate our research results, through architecting its embedded systems.
Staff at MRTC

Afshar, Sara, PhD student
Sara Afshar is a PhD student at Mälardalen University since April, 2012. She received her B.Sc. degree in Electrical Engineering from Tabriz University in 2002. She worked at different engineering companies until 2009. In the year 2012, she obtained her M.Sc in Embedded Systems at MDH together with a summer job at ABB Corporate Research as a software developer (2011), implementing the WirelessHART protocol in TrueTime toolbox for network scheduling simulation. During her M.Sc. study, she associated herself to the winning group in ROSA project. Sara’s current research interests lie in resource management on multiprocessor platforms. She is involved in the project PRESS- Predictable Embedded Software Systems project in the Complex Real-Time Embedded Systems research group at MDH.

Ashjaei, Mohammad, PhD student
Mohammad Ashjaei is a PhD student at Mälardalen University since April 2012. He studied Electrical Engineering in Tehran, Iran and received his B.Sc. in 2003. He has been working for Petrochemical Company in Tehran, Iran for three years. Then, he moved to Sweden in 2010 and studied computer science with emphasize on real-time embedded systems in Mälardalen University. Mohammad received his M.Sc. in 2012 and in the same year started his PhD in this University. Mohammad is a member of the Complex Real-Time Embedded Systems at Mälardalen Real-Time Research Center (MRTC).

Aslam, Mudassar, PhD student
Mudassar Aslam is a PhD student under the supervision of Prof. Mats Björkman. He is actively involved in different industrial research projects in collaboration with the Swedish Institute of Computer Science (SICS). He holds Masters in Information and Communication Systems Security from KTH. His research interests includes Trusted Computing, Security and Cloud Computing. He is currently working on leveraging Trusted Computing mechanisms to strengthen security and trust in the cloud environments.

Axelsson, Jakob, Professor
Jakob Axelsson received a M.Sc. from Linköping University in 1993, and a PhD in 1997 for a thesis on hardware/software codesign of real-time systems. He has been working at ABB Corporate Research and ABB Power Generation (now Alstom) in Baden, Switzerland, Volvo Technological Development (now Volvo Technology), Carlstedt Research & Technology, and Volvo Car Corporation, all in Göteborg, Sweden. He is currently with the Swedish Institute of Computer Science (SICS) in Stockholm, where he is director of software and systems engineering research. He is also professor in software and systems engineering at Mälardalen University in Västerås, where he is leading the research group Business-oriented Engineering of Software-Intensive Systems (BESS).
Behnam, Moris, Researcher
Moris Behnam has awarded a B.Eng., and M.Sc. in Computer and Control Engineering at the University of Technology, Iraq, and also M.Sc., Licentiate, and PhD in Computer Science and Engineering at MDH, Sweden, in 1995, 1998, 2005, 2008 and 2010 respectively. Moris has been a visiting researcher at Wayne State University, USA in 2009. His research interests include real-time hierarchical scheduling, synchronization protocols, multiprocessor/multicore systems, real-time communication and real-time control systems.

Bertheau, Göran, PhD student
Göran Bertheau works at Saab since ten years, now as a PhD student within the ITS-ESAY post graduate school. At Saab assignments have been development of software for safety-critical avionics systems including certification, as well as team-leader for those tasks. Other tasks such as process development, testing of tool for static analysis of source code and verification of avionics computers and software for them, have also been performed. Participation in the EU-project for integrated modular avionics, Scarlett, is another experience. The exam in Math and Computer Science from Lund University was complemented with Economics. Previous work was as a programmer, first within industrial automation then for mobile phones.

Baumgart, Stephan, PhD student
Stephan Baumgart is an industrial PhD student at Volvo Construction Equipment AB, Sweden in Eskilstuna. Stephan has studied Information Technology at Humboldt University in Berlin and received his informatics diploma (Dipl. Inf.) in 2008. He has been working at Audi AG and Volkswagen AG in Germany before moving to Sweden in 2010. Stephan has been working at Volvo Construction Equipment since then and is now working in the E&E Architecture department where he is also involved in the European Artemis funded SafeCer project. Stephan’s main research interest is working on methods and processes which support efficient functional safety certification in the context of product lines.

Bate, Iain, Visiting Professor
Iain Bate is a Senior Lecturer in Real-Time Systems at the University of York. He frequently performs consultancy related to the development and certification of systems for a range of international companies. He is the director of a University spin off working in the safety sector. Iain is a member of both the High Integrity Systems Engineering and Real-Time Systems groups at UoY, two of the internationally most reputed groups in their fields. UK Ministry of Defence, as well as Phillips, BAE SYSTEMS, and Airbus, are currently supporting his work. His research on novel approaches to developing and assuring dependable real-time systems is widely published in more than 80 papers in top conferences and journals, e.g., in 2009, he had five papers relevant to SYNOPSIS accepted in premier journals. He is also the Editor-in-Chief of the J. of Systems Architecture.

Aysan, Hüseyin, PhD student
Hüseyin Aysan is a PhD student at Mälardalen University since autumn, 2006. He received his B.Sc degree in Computer Engineering from Istanbul Technical University in 2004, and his M.Sc degree in Robotics from Mälardalen University in 2006. In the first half of 2006, he worked as a research engineer in Robotics at Mälardalen University. His research interests include dependable software engineering, development of run-time fault-tolerance techniques - particularly redundancy techniques -, fault-tolerant real-time scheduling and design-time dependability analysis of dependable real-time embedded systems built using component-based development approach. He is a part of the PROGRESS National Strategic Research Centre and Mälardalen Real-Time Research Centre (MRTC).
**Björkman, Mats, Professor**
Mats Björkman is Professor in Computer Communication at Mälardalen University since 2001. He received his MSc in Computer Science in 1986 from Uppsala University, and his PhD in Computer Systems in 1993 also from Uppsala University. Previously, Mats has worked as a researcher at the Swedish Institute of Computer Science (SICS) in Stockholm, Sweden, and at the University of Arizona in Tucson, Arizona.

**Björnander, Stefan, PhD student**
Stefan Björnander graduated as a Master of Engineering in Computer Science at Umeå University in 1995 and started as an industrial PhD student at CrossControl AB in Västerås in August 2011. He comes most recently from Mälardalen University, where he was a PhD student working with formal verification. At CrossControl AB he works with SafeCer, which is an ARTEMIS project targeting increased efficiency and reduced time-to-market by composable safety certification of safety-relevant embedded systems. The industrial domains targeted are within automotive and construction equipment, avionics, and railway. SafeCer will also develop certification guidelines for other domains. Stefan is due to defend his licentiate thesis in June 2012.

**Blomberg, Caroline, Research Coordinator**
Caroline Blomberg joined Mälardalen University in 2012 as a Research Coordinator at the School of Innovation, Design and Engineering. Caroline comes from a position as an International Coordinator at the City Executive Office at Västerås stad, working with internationalisation strategically for the municipality. Before that she worked as Director for the International Exchange Unit at Stockholm University (2007-2009) and as Head of the International Office at Stockholm Institute of Education (2005-2007). Caroline holds a MSc. in Business Administration from Mälardalen University.

**Bygde, Stefan, PhD student**
Stefan is a PhD student working with parametric Worst-Case Execution Time analysis since fall 2006. He has an licentiate degree in computer science from Mälardalen University, received in 2010.

**Carlson, Jan, Senior Lecturer**
Jan Carlson received his M.Sc. degree in Computer Science from Linköping University in 2000, and his doctoral degree from Mälardalen University in 2007 with the thesis entitled “Event Pattern Detection for Embedded Systems”.
**Ciccozzi, Federico, PhD student**
Adnamic is a PhD student in Model-Driven Engineering for Embedded Real-Time systems at Mälardalen University. He is from L'Aquila, Italy, and came to Mälardalen University in 2008 for the second and last year of his master studies in Software Engineering. His M.Sc. thesis, developed at ABB Corporate Research in Västerås, was entitled "Integration of wireless systems in process industry and business management". Federico is currently involved in the CHESS research project coordinated by Mälardalen Real-Time Research Center (MRTC).

**Cicchetti, Antonio, Senior Lecturer**
Dr. Antonio Cicchetti is a Postdoc Research Fellow at Mälardalen University. His interests include MDE, model versioning, metamodeling, model weaving, generative techniques in Web engineering and methodologies for Web development. He got his PhD in Computer Science in 2008 at the Computer Science Department of the University of L'Aquila with the thesis entitled "Differenee Representation and Conflict Management in Model-Driven Engineering". Currently, He is investigating several issues related to model versioning, as model differencing, delta document representations, difference operators, co-evolution, and change propagation. He holds the technical leadership of MDH efforts for the ARTEMISIA CHESS project and got funded by the EU Marie Curie Intra-European Mobility project.

**Cedergren, Stefan, Associate Senior Lecturer**
Stefan Cedergren is a senior researcher within the Software Engineering Laboratory. He defended his PhD thesis “Performance in product development - the case of complex products” in January 2011 and he received a M.Sc. in applied physics and electrical engineering from Linköping University 2003. His current research is funded by the KK foundation together with Volvo Construction Equipment. The overall aim of his research is to develop methods and tools for effectively managing performance in the development of complex products. Especially focusing on improving the processes and tools needed to handle future complexity.

**Causevic, Adnan, PhD student**
Adnan Causevic enrolled as a PhD student at Mälardalen University in February 2008. He is member of Dependability group within Software Engineering Laboratory at Mälardalen Real-Time Research Centre. He graduated at the Sarajevo University, Faculty of Electrical Engineering, Computer Science and Informatics Department in 2006.

**Causevic, Aida, PhD student**
Aida Causevic (formerly Delic) is a PhD student at MDH, in Formal Modeling and Analysis of Embedded Systems group. She graduated at the University Sarajevo (Faculty of Electrical Engineering) in 2007. Her diploma thesis (Program Evaluation Using Fuzzy Logic with Bad Smells as Inputs) is done under DAAD-BiHSP scholarship program and in cooperation of University Sarajevo (B&H) and University Paderborn (GER) with professors Zikrija Avdagic and Wilhelm Schaefer as mentors. She has finished her licentiate thesis with title Formal Approaches to Service-oriented Design: From Behavioral Modeling to Service Analysis under supervision of professor Paul Pettersson and dr. Cristina Seceleanu in June 2011.
Crnkovic, Ivica, Professor
Ivica Crnkovic is a professor of industrial software engineering at Mälardalen University. His research interests include component-based software engineering, software architecture, software configuration management, software development environments and tools. From 1985 to 1998, Ivica Crnkovic worked at ABB, Sweden, where he was responsible for software development. He was a project leader and manager of a group developing software configuration management systems and other software development environment tools and methods for distributed development and maintenance of real-time systems. From 1980 to 1984, he worked for the Koncar company in Zagreb, Croatia. M.Sc. in electrical engineering in 1979, M.Sc. in theoretical physics in 1984, and PhD in computer science in 1991, all from the University of Zagreb, Croatia.

Conmy, Philippa, Post Doc
Philippa works on the pSafeCer project, looking at safety and certification when using a Model Driven Development approach.

Dodig-Crnkovic, Gordana, Associate Professor
Gordana Dodig-Crnkovic is Associate Professor in Computer Science. She holds PhD degrees in Physics and Computer Science. Her current research is in Natural/Unconventional Computation, Computing and Philosophy, Information Science and Theory of Science. She teaches on graduate and undergraduate level. She published a book Information and Computation Nets in 2009 and two edited volumes: Information, Computation, Cognition with Susan Stuart in 2007 and Information and Computation with Mark Burgin in 2011. She is a scientific committee member of the International Science of Information Institute, steering committee member of European Computing and Philosophy Organization, member of the editorial board of the World Scientific Series in Information Studies and member of the editorial board of several journals.

Dobrin, Radu, Senior lecturer
Radu Dobrin is a Senior Lecturer at the Department of Computer Science and Engineering at Mälardalen University and the Chair of the Software Engineering Division. He has a background in scheduling of dependable real-time systems and is currently involved in both research and education-oriented projects.

Doganay, Kivanc, PhD student
Kivanc Doganay is an industrial PhD student at Mälardalen University, Embedded Systems division. Kivanc got his B.Sc. in Computer Engineering at Middle East Technical University, Ankara, Turkey. In 2008, he received M.Sc. in Computer Science at Mälardalen University. Since then he has been employed at SICS, Swedish Institute of Computer Science AB as a researcher and worked in various research projects with industrial focus. Kivanc is currently involved in ATAC project, which focuses on advanced methods for testing complex software-intensive systems.
Ekman, Mathias, PhD student
Mathias Ekman is a PhD student at the ITS-EASY industrial research school. He received a M.Sc from Mälardalen University, and a Licentiate Degree with a thesis on software instrumentation of embedded systems. Mathias currently works at Bombardier as a specialist in safety-critical embedded software products for rail vehicles.

Eldh, Sigrid, PhD
Sigrid Eldh is working as a researcher at Ericsson, serving in different positions across the company for many years. She has her PhD and Lic degree from Mälardalen University, a M.Sc in Computer Science from Uppsala University and a Diploma in Gestalt Therapy. In addition, she has a variety of studies in leadership, pedagogy, sociology and economics. She has published a book on Operating and Computer Systems. Her main interest is all aspects of software quality, process and improvements, with a main focus on software testing, verification and validation. She is a frequent speaker at international conferences, and teaches courses in those subjects. She has been a co-founder and of several associations in the software testing field, such as SAST, ASTA, ISTQB and SSTB and serves as a member of several program committees.

Enoiu, Eduard Paul, PhD student
Eduard is a PhD Student on software verification and testing at the Mälardalen Real-Time Research Center. Before starting the PhD studies, he studied Computer Engineering at the Polytechnic University of Bucharest, where he obtained his M.Sc. in Engineering. Also, he received an M.Sc. in Computer Science from Mälardalen University in 2011.

Feljan, Juraj, PhD student
Juraj Feljan is a PhD student at MDH and at the Faculty of Electrical Engineering and Computing (FER), University of Zagreb, Croatia. He received his M.Sc. degree in Computer Science at FER in 2008. He is involved in the Ralf 3 project.

Flemström, Daniel, Lecturer, Lab Manager
Daniel Flemström has been working at Mälardalen University since 2000. He received his M.Sc from Mälardalen University, in 1995. He is responsible for the Industrial Research and Innovation Lab, which is a top-talent initiative together with Ericsson AB and ABB AB. He is also teaching courses in Industrial System Development. His research interests include usage of Linux in embedded devices and issues when developing complex telecom applications.
Gallina, Barbara, Post Doc
Barbara Gallina is a Post-Doc Researcher within the Dependability group. Currently, she is involved in two projects: EU/ARTEMIS SafeCer and SSF SYNOPSIS. In the context of these projects, she mainly works towards the identification and systematization of commonalities and variabilities among the development processes defined in the safety standards (e.g. ISO 26262). She has a M.Sc. in Computer Engineering and a II-level Master in IT, both from Politecnico di Milano (Italy). She got her PhD in Computer Science from the University of Luxembourg (Luxembourg). Her research interests include dependability, transaction models, failure behavior analysis of component-based systems and reuse-based methods for software engineering and for systems certification.

Girs, Svetlana, PhD student
Svetlana Girs is a PhD student in the Wireless Communication group at Mälardalen University since September 2010. She received her B. Sc. and M.Sc. in Telecommunications from St.-Petersburg State Polytechnic University in 2009 and 2011 respectively. Her current research is focused on improving the reliability of wireless industrial sensor networks.

Gustafsson, Jan, Senior Lecturer
Jan Gustafsson is Senior Lecturer in Computer Engineering at Mälardalen University since 1985. He has been the head of the department 1993 - 1997 and 1998 - 1999, and is one of the founders of the department, its educational programmes and its research. He worked at ABB Västerås, Sweden 1975 - 1985 with development of real-time industrial control systems and was manager for the Base System Development (operating system, data communication and database system). He received a B.Sc. in Mathematics, Physics, Astronomy and Computer Science at Uppsala University, 1974, and a Licentiate degree in Machine Elements (Computer Controlled Mechanics) at KTH, Stockholm, Sweden, 1994. His current research concerns high-level analysis of real-time programs to calculate annotations to be used in WCET (Worst Case Execution Time) analysis.

Gustavsson, Håkan, Associated researcher
Håkan is an industrial researcher at Scania CV AB in Södertälje, Sweden. He has been been working with vehicle electronic systems integration and architecture since 2002. He recieved his B.Sc in Electrical Engineering at the Royal Institute of Technology 2002 after completing his studies with a final year at Fachhochschule Zentral Schweiz. His research area is systems engineering of vehicle electronics. His licentiatie thesis was accepted in 2008, where a method was presented on how to improve the decisions made during the early phases of E/E-system development. His current research focus on how Lean principles can improve the development process of software-intensive system. His PhD thesis investigates how lean thinking can be applied to system architecting and was defended in March 2011.

Gustavsson, Andreas, PhD student
Andreas Gustavsson is a PhD student at Mälardalen University since September 2009. He previously received his MSc in Automation and Mechatronics (focusing on Computer Science) from Chalmers University of Technology in December 2007. He is a member of the Programming Languages research group at the Mälardalen Real-Time research Center (MRTC).
Huang, Shihong, Visiting Researcher

Shihong Huang is an Associate Professor of Computer Science and Engineering at Florida Atlantic University, and a Visiting Researcher at MRTC. She has a PhD from the University of California, Riverside. Her research interests include reverse engineering, program comprehension, software systems redocumentation, software maintenance and evolution, and software process improvement. In recent years, she has expanded her research to health informatics and computer applications in clinical and therapeutic fields (particularly on computer based interactive system for children with Asperger’s syndrome), and software development modeling. She was the General Chair of the 24th ACM International Conference on Design of Communication (SIGDOC 2006), and is Program Co-Chair of the 9th IEEE International Symposium on Web Site Evolution (WSE 2007).

Hjertström, Andreas, PhD student

Andreas received his M.Sc in Computer Science from Mälardalen University 2007. He is now enrolled as a PhD student at the same university within the area of real-time embedded systems with a special interest in data management. The research is performed within the PROGRESS project with a primary focus to investigate how design-time data management and real-time database management can be integrated in the design and development of embedded real-time systems.

Hatvani, Leo, PhD student

Leo Hatvani is a PhD student at Mälardalen University. He graduated from the Faculty of Electrical Engineering in Sarajevo in January 2009. His diploma thesis was “Development of Fuzzy Inference Systems Using Fuzzy Toolbox”. He is currently working on developing formal verification techniques for adaptable embedded systems.

Hallmans, Daniel, PhD student

Daniel Hallmans is working at ABB Power Systems HVDC as a system architect for the MACH2 control system. The MACH2 control system is used in High Voltage Direct Current (HVDC) transmissions, like the 6400MW 800kV Xiangjiaba - Shanghai transmission link, and also for Static Var Compensation systems (SVC). He has a Master of Science in Engineering Physics from Umeå University and now attends the ITS-EASY research school.

Hansson, Hans, Professor

Hans Hansson is professor in Real-Time Systems at Mälardalen University since 1997. He is director of Mälardalen Real-Time Research Centre and the PROGRESS national strategic research centre, Scientific Leader of SICS Swedish ICT Västerås AB and the EU/ARTEMIS project SafeCer. He received an MSc (Engineering Physics), a Licentiate degree (Computer Systems), a BA (Business Administration), and a Doctor of Technology degree (Computer Systems) from Uppsala University (UU), Sweden, in 1981, 1984, 1984 and 1992. Prof. Hansson’s previous appointments include being director of the nat’l research programme ARTES, visiting prof. and dept. chair at the Dept. of Computer Systems, Uppsala University, and researcher and scientific advisor at the Swedish Institute of Computer Science (SICS) in Stockholm.
Inam, Rafia, PhD student
Rafia Inam is a PhD student at Mälardalen Real-Time Research Center, and holds a M.Sc. in Computer Science from Quaid-i-Azam University, Pakistan. Rafia has worked at Norsk Data Pvt. Ltd. in Pakistan as a Software Engineer for 2 years and then started teaching at Bhaudddin Zakariya University, Pakistan. In 2007 Rafia travelled to Sweden to write her master thesis on “Networks and Distributed Systems” at Chalmers university of Technology. Her PhD studies at MRTC are focusing on Deployment and Realization of Component-Based ProCom models in a distributed real-time environment.

Isovic, Damir, Associate Professor / Vice Dean
Assoc. Prof. Damir Isovic is Vice Dean of the School of Innovation, Design and Engineering and associate professor in computer science at MDH. He is actively involved in undergraduate teaching, and is a winner of several teaching awards, among others “Bayer Teaching Excellence” award and “Lecturer of the Year” award. Damir has been acting as head of internationalization, director of education and program coordinator at MDH. He has developed several teaching tools, including an internet-based platform for distance education. He is guest lecturer of Technical University of Eindhoven, Charles University, Prague, Royal Institute of Technology, Sweden, University of Sarajevo, Bosnia, and East China University, Shanghai. He has more than 40 research publications in international journals, conferences and books to his credit.

Johnsen, Andreas, PhD student
Andreas Johnsen is a PhD student working together with Prof. Kristina Lundqvist and Prof. Paul Pettersson on a project studying architecture-based verification of dependable software-intensive systems at Mälardalen Real-Time Research Centre. He received his M.Sc. in Robotics at Mälardalen University in 2010. His M.Sc. thesis work consisted of development of a fly-by-wire flight control system. In 2009, Andreas contributed to the “House on the moon” project in cooperation with NASA where he developed a vision system, using LIDAR (Light Detection And Ranging) technology, for the lunar-rover. He is currently a member of the Swedish Verification & Validation Excellence (SWELL) research school.

Jonsson, Henrik, PhD student
Henrik Jonsson is an industrial PhD student from Etteplan, Västerås, Sweden. He studied Molecular Biotechnology in Uppsala, Sweden and Computer Science in Gävle, Sweden. He received a M. Sc. from Uppsala University in 2001. Since then he has worked for the National Food Administration in Uppsala, the life-science company Biacore in Uppsala and Lantmäteriet in Gävle, Sweden, mainly in the roles as system analyst and tester. Since 2007 Henrik is a consultant at Etteplan Industry, Västerås and has mainly worked for ABB as a software developer, configuration manager and software process engineer. In March 2012 he joined the ITS-EASY industrial research school at Mälardalen University to research on software process improvement mainly in safety-critical system development.

Jägemar, Marcus, PhD student
Marcus Jägemar is currently working as a senior specialist for applied operating systems at Ericsson. He studied Computer Engineering at Mid Sweden University, Sundsvall, Sweden and at University of Greenwich, London, UK. He received a M.Sc. in Computer Engineering from Mid Sweden University in 2000. He has since then mainly been working at different companies within the Ericsson corporation both as a consultant and later as a regular employee. Currently he is attending the ITS-EASY research school with the main subject of “Migration of legacy Telecommunications Systems to a Multi-Core environment”.
**Kade, Daniel, PhD student**
Daniel Kade is an industrial PhD student at Mälardalen University and at Imagination Studios. His PhD is placed in the area of computer science and interaction design at the department of Innovation Design and Technology. The main research question that his work is placed around is on how to improve motion capturing shoots. This includes work with motion capturing, tracking, visualization and mediated technologies. As the thesis also includes interaction design and considers design perspectives, methods from this field of research are also considered. He completed his M.Sc in Germany in 2011. The focus for the M.Sc was on software engineering and mobile devices. For his double degree B.Sc was completed in Germany and in France. The studies were focused on real-time and embedded programming, web programming and HCI.

**Larsson, Magnus, Adjunct Professor**
Magnus Larsson is a Research manager at ABB Corporate Research where he is responsible for software research within ABB Sweden. The software research focus on software architecture and user experience. He received a B.Sc in computer engineering from Mälardalen University in 1993 and a M.Sc. in computer science from Uppsala University in 1995. Magnus achieved a PhD in computer science 2004 studying how to predict quality attributes in component-based software systems. Magnus current research interests are component-based software engineering and software architecture. During his years at ABB, Magnus participated in the development of object management facility (OMF), a distributed object oriented middleware, which was awarded the second prize in the OMG/Object Worlds competition for the best use of object technology in 1997.

**Larsson, Thomas, Senior Lecturer**
Thomas Larsson is a teacher and researcher in Computer Science at Mälardalen University. In 2008, he was promoted to Senior Lecturer / Assistant Professor on pedagogic skills. He received a Bachelor and Master Degree in 1996 and 1999, respectively, in computer engineering. His PhD degree in computer science was completed in 2009. Currently, his research focuses mainly on real-time computer graphics, interactive systems, and parallel data structures.

**Lisper, Björn, Professor**
Björn Lisper is professor in Computer Engineering at Mälardalen University since 1999, where he leads the Programming Languages research group. He received his MSc (Engineering Physics) 1980, and Doctor of Technology (Computer Science) 1987, both from KTH, Sweden, where he also was appointed “docent” in Computer Systems (1991). He is a member of the board of the Vinnova-supported CNS competence center at SICS. Prof. Lisper is the coordinator of the Marie Curie IAPP project APARTS, and he has been a Core Member of the FP7 NoE ArtistDesign where he was the leader of the timing analysis activity. He coordinated the FP7 ICT project ALL/TIMES. He is also a member of IFIP WG 10.2 on Embedded Systems.
Lu, Yue, PhD student
Yue Lu has a licentiate degree in embedded systems. He received a M.Sc in Mechatronics from University of Southern Denmark, which was followed by a half-year work at Sony Ericsson (Beijing) as a test developer. At his PhD work together with a five-month research intern at INRIA Nancy-Grand Est (FR), he typically has learned the knowledge and practiced his skills in using statistics and probability theory (e.g., extreme value theory, GOF hypothesis test, non-parametric statistics, resampling methods, etc) to perform risk analysis of real-time embedded systems from system timing perspective. His other specialties lie in simulation optimization using meta-heuristics, model-based development in software engineering, Monte Carlo simulation, C#, C, Visual Studio 2008, model checking, etc.

Lundqvist, Kristina, Professor
Kristina Lundqvist serves as the Professor of Dependable Software Engineering at the School of Innovation, Design and Engineering at Mälardalen University. Her research group on Safety-critical engineering focuses on bridging the gap between the theoretical foundations of dependability and industrial software development practices of complex dependable systems. Additionally, Prof. Lundqvist is the Director of Education in Embedded Systems, and the Director of studies for the ITS-EASY Industrial research school. She received a PhD in Computer Systems from Uppsala University in 2000. Prior to coming to Mälardalen University in 2007, she served on the faculty of the Department of Aeronautics and Astronautics at Massachusetts Institute of Technology (MIT).

Lüders, Frank, Senior Lecturer
Frank Lüders is senior lecturer in software engineering at the School of Innovation, Design and Engineering at Mälardalen University. He received a B.Sc. in electronics engineering from Vestfold College, Norway in 1993, an M.Sc. in electrical engineering/computer systems from the Technical University of Denmark in 1997, and a PhD in computer science and engineering from Mälardalen University in 2006. Frank worked with software development at ABB A/S in Norway until 1999 and at ABB Automation Technologies AB in Sweden until 2003. His research interests include component-based and model-driven development/engineering of industrial software and systems. The research is mainly conducted using empirical methods such as case studies, experiments, and surveys.

Maras, Josip, PhD student
Josip Maras is a PhD student at the Faculty of Electrical Engineering, Mechanical Engineering and Naval Architecture (FESB), Split, Croatia and Mälardalen University. He graduated at FESB in January, 2009, and received his M.Sc. degree in computer science. His current area of research is code reuse in web application development.

Marinescu, Raluca, PhD student
Raluca Marinescu is a PhD student at Mälardalen University, working in the Formal Modeling and Analysis of Embedded Systems group. She has received a M.Sc. in Electronics from Politehnica University of Bucharest in June 2009 and a M.Sc. in Computer Science from Mälardalen University in June 2011. Her main research interests are model-based analysis and testing of embedded systems.
Nima Moghaddami Khalilzad is a PhD student at Mälardalen University since May 2011. He received his B.Sc. in software engineering from Arak University (Iran) in 2009. Afterwards, he studied the master program in intelligent embedded systems at Mälardalen University and received his M.Sc. in computer science (specialized in real-time systems) from MDH in 2011. Nima is a member of the Complex Real-Time Embedded Systems at Mälardalen Real-Time research Center.

Saad Mubeen is a PhD student at the School of Innovation, Design and Engineering at Mälardalen University. He holds a B.Sc. in Electrical Engineering with a major in Communication from NWFP University of Engineering and Technology, Pakistan, 2006. Then he followed a move to Sweden and received his M.Sc. in Electrical Engineering specialization in Embedded Systems from Jönköping University, in 2009. He received his Licentiate degree in Computer Science and Engineering from Mälardalen University in 2012.

Dr. Jukka Mäki-Turja is a senior lecturer at Mälardalen University. He received his PhD in Computer Science from Mälardalen University, Sweden (2005). The current research goal is to find theories, methods and tools that will make software development cheaper, faster and yield higher quality software. More concretely the research consists of model based development of software for embedded control systems with emphasis on analysis of temporal and spatial resources. The research is often conducted with close industrial cooperation where the goal is to transfer novel research results to industry and getting new industrially relevant research questions back to academia.

Farhang is a PhD student at Mälardalen University in Sweden. Farhang received his B.Sc. in Computer Engineering from University of Tehran in 1997. He worked as a software developer from 1997 till 2002. He received his M.Sc. in Computer Science from Uppsala University in 2006. His research area is Real-time systems in general, and in particular his research interests include (1) Scheduling and synchronization in multiprocessor/multi-core architectures. (2) Migrating real-time legacy systems to multiprocessor/multi-core architectures.

Ni Pengpeng is an industrial PhD student at SDL. She received her M.Sc in Computer Technology from Mälardalen University in 2003. Then she worked at Ardendo AB as software engineer.
Nolte, Thomas, Professor
Thomas Nolte was awarded a B.Eng., M.Sc., Licentiate, and PhD degree in Computer Engineering from Mälardalen University (MDH), Västerås, Sweden, in 2001, 2002, 2003, and 2006, respectively. He has been a Visiting Researcher at University of California, Irvine (UCI), Los Angeles, USA, in 2002, and a Visiting Researcher at University of Catania, Italy, in 2005. He has been a Postdoctoral Researcher at University of Catania in 2006, and at MDH in 2006-2007. Thomas Nolte became an Assistant Professor at MDH in 2008, and Associate Professor at MDH in 2009. 2012 he became Full Professor of Computer Science.

Norström, Christer, Professor
Christer holds a position as professor in Computer Science and Engineering at Mälardalen University since 2002. He is also managing director for SICS since February 2010. He was previously Vice President for Mälardalen University. Christer has many years experience from working in industry. His last position in industry was as Technology manager at ABB Robotics. His research interest is development of complex control systems from a business, management, processes and methods and technology perspective from an effectiveness and efficiency perspective. Christer has been working with collaboration initiatives and projects between industry and academia extensively the last 15 years. He is very interested in technology transfer from academia to industry and has manifested that through several successful transfers to the automotive industry.

Nyström, Dag, Senior Lecturer
M.Sc. in computer science in 2000 from Mälardalen University. Earned a PhD at Mälardalen University entitled “Data Management in Vehicle Control-Systems” in 2005. Founded the spin-off company DNKU with the purpose of commercializing his research results in 2006. Has worked as part time post-doc at IDT, and part time product manager at Mimer Information Technology AB, Uppsala. Currently working as senior lecturer at IDT, involved in academy management, undergraduate education and research.

Olsson, Tomas, PhD student
Tomas Olsson is a PhD student at MDH and a researcher at SICS, with a licentiate degree from Uppsala University. His research interests are in applied artificial intelligence, statistical machine learning and case-based reasoning.

Pei-Breivold, Hongyu, PhD
Hongyu Pei Breivold works within Software Architecture and Usability Group at ABB Corporate Research. She started working for ABB in 1994, and her experience includes participation of company-wide technology and software-intensive system development projects within different domains. She worked as a consultant in year 2001. Her main research interests include software architecture, software architecture analysis and evaluation, software evolution from architecture perspective.
**Petricic, Ana, PhD student**
Ana Petricic is a PhD student at Faculty of Electrical Engineering and Computing (FER), Zagreb, Croatia and Mälardalen University. She graduated at FER in July, 2008, and received M.Sc. degree in computer science. Her master thesis was achieved as a double degree program in cooperation with MDH.

**Punnekkat, Sasikumar, Professor**
Sasikumar Punnekkat is a professor in dependable software engineering at Mälardalen University and the leader of the Dependable systems research group. He has more than 15 years industrial experience as a scientist at the Indian Space research Organization, and was the Head of the Software test and reliability engineering. He was recipient of the prestigious Commonwealth Scholarship and was awarded D.Phil in Computer Science by the University of York, UK in 1997. He was a post-doctoral research fellow (1999-2000) and a senior lecturer (2004-2007) at MDH. He is the coordinator of a large EU-Asia mobility and cooperation project, EURECA, funded by the EU. He is the program director of the Master Programs in Software Engineering at MDH. His research interests include multiple aspects of Real-time Systems, Dependability, and Software Engineering.

**Ray, Apala, PhD student**
Apala Ray is a PhD student at Mälardalen University and associate scientist at ABB Corporate Research. She studied engineering in India. She has received her B.Sc in Electronics and Communication Engineering from West Bengal University of Technology and M.Sc in Information Technology specialized in Networking and Communication from International Institute of Information Technology, Bangalore. She has done a short stint at Technical University Kaiserslautern, Germany for her master thesis which is on BLAST Architecture (MIMO System) in 2008. She has been working with ABB in the area of wireless and mobile technologies since 2008. Currently she is pursuing her PhD at Mälardalen University as industrial PhD student from ABB in the area of security in industrial communication.

**Pettersson, Paul, Professor**
Paul Pettersson, Professor of Real-Time Systems (specialised in modelling and verification), is Director of Research in Embedded Systems at the School of Innovation, Design and Engineering at Mälardalen University. He received a PhD in Computer Systems from Uppsala University in 1999 for his thesis on theory and practice of modeling and verification of real-time systems. After a Post Doc period at Aalborg University in Denmark, he joined Department of Information Technology at Uppsala University as Senior Lecturer in 2000. He was appointed Associated Professor (“Docent”) in Computer Science at Uppsala University in 2006, and joined Mälardalen University later that year.

**Rodriguez-Navas, Guillermo, Post Doc**
Guillermo Rodriguez-Navas is a Postdoctoral Researcher in the Real-Time Systems Design Group. He is currently involved in the SSF-funded SYNOPSIS project, which targets cost efficient safety certification in the context of component based development (CBD). He obtained the title of Telecommunications Engineer (M.Sc) by the University of Vigo, Spain, in 2001 and a PhD degree in Computer Science by the University of the Balearic Islands (UIB), Spain, in 2010. He is also a certified teacher of yoga IYENGAR® since 2010, and keeps studying this discipline under the guidance of Mr. Jordi Martí and Mr. Faeq Biria.
Rosqvist, Malin, Research Coordinator
Malin Rosqvist joined Mälardalen University in 2009 as a research coordinator at the School of Innovation, Design and Engineering. Malin specializes in running projects and activities in cooperation with the industry, as well as in PR and communication about the research at the school. Malin comes from a position as marketing manager at ABB Robotics, working globally with marketing and sales of industrial robots. Malin holds a MA from the University of Gothenburg, Sweden, and is Certified Project Manager (IPMA, International Project Management Association).

Rylander, David, PhD student
David Rylander received an M.Sc. in Electrical Engineering from Chalmers University of Technology, Sweden in 2006. David has since then worked at Volvo Technology in various positions as a researcher, engineering specialist, project manager and product area manager for internal as well as external collaboration projects within the domain of telema-tics, wireless ad-hoc networks and active safety. Since October 2011 David joined MDH and the ITS-EASY research school for industrial PhD students. David is also a member of the research group in Business-oriented Engineering of Software-Intensive Systems (BESS) at MDH. David’s main research interest is system design, utilizing wireless communication for automation and control with a business oriented approach.

Saadatmand, Mehrdad, PhD student
Mehrdad Saadatmand is an industrial PhD student at Mälardalen University. Mehrdad got his bachelor degree in Computer Science at Ferdowsi University of Mashhad, Iran. In 2009 he graduated as M.Sc. in Software Engineering from Mälardalen University. He has worked with the SAVE project team at MRTC as part of his master thesis. After graduation, he got employed by Enea and also started his PhD studies in Model-Based Engineering of Real-Time Embedded Systems. At Enea, he has been working in the scope of the CHESS European project. He is now employed by Xdin and working with Mälardalen University on the MBAT European project. Mehrdad is also responsible for organizing Open Seminars at the school.

Sapienza, Gaetana, PhD student
Gaetana Sapienza is currently working at ABB AB Corporate Research Center, Sweden. She is also enrolled as PhD student in the ITS-EASY Industrial Research School at Mälardalen University. The main research area is focused on modeling and architecting embedded systems in the automation and control domains. She holds a M.Sc. degree in Computer Science Engineering from the University of Catania, Italy. She started her career at ABB AB Corporate Research Center, working with the design of control algorithms for embedded applications. She continued her career at ABB AB Control Sweden, as responsible for the control simulation platform and advanced control algorithms.

Schmidt, Heinz, Adjunct professor
Heinz Schmidt is adjunct Professor of Software Engineering at Mälardalen Real-Time Research Centre.
**Seceleanu, Cristina, Senior Lecturer**

Cristina Seceleanu is a senior lecturer and Tech. Dr at MDH, Embedded Systems Division. She received a M.Sc in Electronics from Polytechnic University of Bucharest, Romania, in 1993, and a PhD in Computer Science from Åbo Akademi and Turku Centre for Computer Science, Åbo/Turku, Finland, in 2005. Her research focuses on developing formal models and verification techniques for constructing predictable real-time embedded systems.

**Seceleanu, Tiberiu, Adjunct professor**

Tiberiu Seceleanu is principal scientist at ABB Corporate Research Centre in Västerås, Sweden - where he leads several projects in the area of WSN and multiprocessing design methods, and adjunct professor at Mälardalen University. Primary research areas address topics in digital hardware design, with an emphasis on multiprocessor architectures, design methodologies, hardware description languages and formal methods. Tiberiu Seceleanu got his PhD degree in computer science from Åbo Akademi in Finland (2001), and a docentship in embedded computing from University of Turku, Finland (2007). He lead the team that developed the ARTEMIS strategic research activities in the area of multiprocessing (2006/7), and coordinated the Academy of Finland project DOMES on multiprocessing architectures.

**Sentilles, Séverine, PhD student**

Séverine Sentilles is a PhD student at MRTC, Mälardalen University. She received a M.Sc in Computer Science from the University of Pau (France) in 2006 and presented her licentiate thesis in 2009. She is involved in the specification of a component-based development approach for distributed embedded systems within PROGRESS and actively participates in the component model specification and in extra-functional property management. She is also responsible for leading the realization of the integrated development environment supporting the approach. She had been involved in the SAVE++ project as a member of the developing team with a specific responsibility for the design part (design of the metamodel and design tool development). Her main research interests include in CBSE and MDE.

**Sjödin, Mikael, Professor**

Mikael is focusing his research on new methods to construct software for embedded control systems in the vehicular and telecom industry. The current research goal is to find methods that will make software development cheaper, faster and yield software with higher quality. Concurrently, Mikael is also been pursuing research in analysis of real-time systems, where the goal is to find theoretical models for real-time systems that will allow their timing behavior and memory consumption to be calculated. Mikael received his PhD in computer systems 2000 from Uppsala University (Sweden). Since then he has been working in both academia and in industry with embedded systems, real-time systems, and embedded communications. In 2006 he joined the MRTC faculty as a full professor with specialty in real-time systems and vehicular software-systems.

**Srinivasan, Jayakanth, Senior lecturer**

Jayakanth “JK” Srinivasan is an Assistant Professor at MRTC. His research focuses on applying enterprise thinking to knowledge-intensive industries ranging from Aerospace & Automotive to Software Services. His book “Beyond the Lean Revolution: Achieving Successful and Sustainable Enterprise Transformation” (co-authored with Debbie Nightingale) presents transformation principles and holistic frameworks for understanding and analyzing enterprises. Dr. Srinivasan holds an undergraduate degree in computer engineering, graduate degrees in aeronautics and astronautics and avionics engineering, as well as a doctoral degree in computer science. He is a senior member of the Association of Computing Machinery.
**Sundmark, Daniel, Senior lecturer**
Daniel Sundmark is a part-time senior lecturer and assistant professor at IDT and a researcher in the Software Testing Laboratory. He received a MSc degree in Information Technology from Uppsala University in 2003, a licenciate degree from Mälardalen University in 2004, and a PhD degree from Mälardalen University in 2008. Daniel shares his time between MDH and the Swedish Institute of Computer Science (SICS).

**Thekkilakatil, Abhilash, PhD student**
Abhilash is a PhD student at Mälardalen University since 2011. He was awarded a M.Sc degree in software engineering from Mälardalen University in 2011 and a bachelor of technology degree in computer science and engineering from Amrita Vishwa Vidyapeetham, India, in 2009. He was an Erasmus Mundus scholar under the EURECA programme in 2009.

**Uhlemann, Elisabeth, Associate Professor**
Dr. Elisabeth Uhlemann got her M.Sc. degree in computer systems engineering from Halmstad University, Halmstad, Sweden, in 1998 and her PhD degree in communications theory from Chalmers University of Technology in 2004. She currently holds a position as associate professor in Wireless Real-Time Communications at the Centre for Research on Embedded Systems (CERES), Halmstad University, Halmstad, Sweden. Her research is directed towards real-time communications, concatenated codes, incremental redundancy, cooperative relay networks, cross-layer design and vehicular communications.

**Vulgarakis, Aneta, PhD student**
Aneta Vulgarakis is enrolled as a PhD student in the Division of Software Engineering at Mälardalen University, since October 2006. She is part of the PROGRESS centre and has graduated in July 2006 at the Faculty of Electrical Engineering, Skopje (Macedonia), with professional specialization in “Computer Science, Information Technology and Automation”. Aneta defended her licentiate thesis entitled “A Resource-Aware Component Model for Embedded Systems” in September 2009.

**Wallin, Peter, PhD**
Peter Wallin is engaged in the Software Engineering Laboratory and got his PhD degree from MDH in 2011. He received his M.Sc in computer science from Mälardalen University 2006. His research has been funded by VINNOVA and he has been in cooperation with Chalmers, Volvo 3P, Volvo Car Corporation and Volvo CE. After graduating from MDH, Peter works as a research coordinator at Volvo Construction Equipment.
Yin, Hang, PhD student
Yin Hang is a PhD student at MRTC. He studied Intelligent Embedded Systems at Mälardalen University since 2008 and got his M.Sc in 2010. During his master study, he exchanged to Eindhoven University of Technology (TU/e) in Eindhoven, the Netherlands for one semester. He started his PhD study directly after his graduation in 2010 and was engaged in the ARROWS project. His research area is Adaptive Embedded Systems and his recent focus is the mode switch logic design for component-based multi-mode systems.

Yu, Kan, PhD student
Kan Yu started his PhD studies at Mälardalen University in October 2010. He arrived in Sweden in 2008. Before that, he received his B.Sc. from Beijing University of Posts and Telecommunications in China in 2005 and worked in Huawei Tech. Co. Ltd. and Datang Tele. Co. as an embedded software engineer for three years. In 2010, he received a M.Sc. from Chalmers University of Technology in communication engineering program. Now his research interests are embedded systems and wireless sensor networks.

Zhou, Jiale, PhD student
Jiale Zhou is a PhD student at Mälardalen University since February 2011. He got a Bachelor Degree in Electronic Engineering at Shanghai Jiao Tong University (SJTU), China, in 2007. Jiale Zhou received a M.Sc. in Computer Science at MDH, in October 2010. During his master study, he stayed in Eindhoven University of Technology (TU/e), Holland, for half a year as an exchange student. His M.Sc thesis project is Telecom and Internet Services Mashup in Robotics - Design, Architecture and Prototyping. He is now working together with Prof. Kristina Lundqvist on a project focusing on Software Traceability at Mälardalen Real-Time Research Centre (MRTC). His research interests are now focusing on Software Verification and Validation, Software Traceability, and other related topics.

Widforss, Gunnar, Research Coordinator
Gunnar joined MDH 1999 as research officer in the central administration and the division of education and research. He was responsible for research related tasks at the university board and faculty board. Coordinator for the research administration and the administrative support to the boards of faculties, Deputy head of division 2002-2004, Substitute EU Liaison officer 2002, Substitute director of postgraduate studies 2004, Substitute head of division 2004-2005. Since 2005 he was part of the department of computer science and electronics and currently the school of innovation, design and engineering, as research coordinator. Since 2010 head of RECO. Gunnar is Certified Project Manager (IPMA, International Project Management Association).

Wiklund, Kristian, PhD student
M. Sc./Civ. ing. Chalmers 1997. Lic Chalmers 2000. When he is not doing research, he is working with quality and efficiency improvements for multi-standard radio base stations at Ericsson AB, where he has been employed since graduating in 2000.
Åkerberg, Johan, Adjunct Researcher
Holds a MSc (2007) and a PhD (2011) in Computer Science and Engineering from Mälardalen University. He is a IEEE Senior Member in IEEE Industrial Electronics Society and IEEE Communications Society since 2011. Besides from working at Mälardalen University he is also a global research area coordinator at ABB AB, Corporate Research.

Åsberg, Mikael, PhD student
Mikael Åsberg was enrolled as a research engineer in 2008 at Mälardalen University Västerås, Sweden. He started his PhD studies the following year (2009). Mikael received a M.Sc. in both Computer Science and Computer Engineering, at Mälardalen University, 2008. Mikael has been a visiting researcher at NXP Semiconductors/Research in Eindhoven (Holland), 2008. Mikael’s research includes real-time hierarchical scheduling, synchronization protocols, execution time monitoring, scheduling in Linux/VxWorks and AUTOSAR.

Özcan, Oguzhan, Professor
Oguzhan Özcan is a senior lecturer in Computer Science and Networks. He is formerly a professor of interactive media design in Istanbul Yildiz Technical University. He has founded one of the first interactive media design school in the world. Özcan is known in the field with his design methods named as “breaking the rule” and “re-reading the culture”. His articles are published in several leading journals such as Design Issues, Leonardo, Digital Creativity, Computers and Education.
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