IST-004527 ARTIST2
Network of Excellence
on Embedded Systems Design

Spreading Excellence

Artist2 Technical Coordinator:
Bruno Bouyssounouse (Verimag)

with inputs from all NoE participants

The visibility of the ARTIST2 research effort in embedded systems design is now worldwide, and will be continue to be reinforced in Y4. This has clearly creating a significantly stronger European embedded systems design community, as witnessed by the positive evolution of major conferences in the area, stronger involvement with industry, and interaction between research teams.

A cornerstone effort to achieving this has been the effort for Spreading Excellence (JPASE).

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1. Vision and Strategy for Spreading Excellence - *Executive Summary*

1.1 Overall Vision and Strategy

Our actions for Spreading Excellence are at 2 levels:

- *Targeted towards affiliated partners*
  Affiliated partners are not core members in the consortium, but receive support for travelling to Artist2 meetings, and actively contribute to the implementation of the Joint Programme of Activities (JPA). These affiliated partners include industrial, SME, academic, and international collaboration affiliates.
- *Targeted towards the scientific and technical community in the large*
  This is achieved mainly bottom-up through the organisation of scientific events, publications, distribution of tools and components, industrial partnerships (not funded by Artist2), education; and through the Artist2 web pages.
- *Targeted towards students*
  A particular focus has been placed on the Artist2 Summer Schools this year – with a truly outstanding programme of lecturers, and the innovation of providing the lectures in video form on the Artist website.

Regarding Scientific events, we distinguish between conferences and workshops, schools, and high-level events mainly for International Collaboration.

High Level Events for International Collaboration
High-level Events are intended to gather together the very best world-leading experts from academia and industry, to discuss progress on the state of the art, relevant work directions.

Three Artist2 members are on the steering board for the ARTEMIS European Technology Platform. In this capacity, they participate in working groups for defining the overall European long term strategy in the area.

Publications
The Artist2 community has pusrsued a very active publishing policy, with a strong presence in scientific journals and conferences, as attested by the extensive list of publications provided in this document. Publication of research is a bottom-up process, which may seem chaotic – but this is intrinsic to research.

Tools and Components
The Artist2 community plays a leading role in the distribution of software tools and components, on verification/validation tools. Some tools are distributed free of charge, such as UPAAL, IF. Others are commercialised, such as AbsInt, SymTA/S. For many other tools used in the platforms, and shared between the Artist partners, a common dissemination policy has not yet been defined.

Industrial Liaison
Artist2 has a wide array of affiliated industrial and SME partners (see the Periodic Activity Report). Most of these partners have participated in some way in the Artist2 technical meetings and the overall effort. There is strong, high-level industry participation through the various Spreading Excellence events organised by Artist2. Our active involvement in the European Technology Platform ARTEMIS also could have a significant and long-term impact.

We believe that the strong involvement of four main Artist2 partners in the SPEEDS Integrated Project has a very positive impact on progress in the state of the art, in component-based embedded systems engineering.

1.2 Affiliated partners

Affiliated partners are not core members in the consortium, but receive support for travelling to Artist2 meetings, and actively contribute to the implementation of the Joint Programme of Activities (JPA). These affiliated partners include industrial, SME, academic, and international affiliates.

The affiliated partners have stabilized at the end of Artist2. At the end of Year 4, the NoE has 23 large industrial affiliated partners, 10 SMEs, 37 academic, and 17 international affiliated partners. All of these partners have participated in one or more of our technical events and work over the course of the Years 1-3. We have also had a very large number of participants from the wider research and industrial communities, who are not listed officially.

1.3 Scientific and Technical Community in the Large

A description of the Artist2 commmunity's interaction with other research teams is visibile in section 2.4 ("2.4 Interaction of the Cluster with Other Communities") of each cluster deliverable.

Interaction with these other scientific communities is achieved mainly bottom-up through the organisation of scientific events, publications, distribution of tools and components, industrial partnerships (not funded by Artist2), education; and through the Artist2 web pages.

Our sponsoring policy aims specifically at enforcing integration of existing scientific events in the area. This is sought in particular through the Embedded Systems Week (http://www.esweek.org/), in which we play a crucial role.

Another concrete example is our action within the DATE conference (http://www.date-conference.com/), in which we are working to shift the emphasis towards becoming the central European conference on embedded systems design, in collaboration with the ARTEMIS European Technology Platform.

Regarding Scientific events, we distinguish between conferences and workshops, schools, and high-level events mainly for International Collaboration.

The ARTIST2 community now clearly leads the initiatives for organizing the most significant conferences in the area. In Europe, it has a very strong presence in the DATE conference, which is becoming the main conference on embedded systems within Europe. Over the past 7 years, 6 general chairs of DATE have been leading Artist members, and the general chair of DATE 2009 will be Prof. Luca Benini, a prominent ARTIST member.

In international conferences, the ACM's flagship conference, EmSoft, has been initiated by leading members of Artist2. These researchers now chair the steering and executive committees. Artist partners are also in leading positions for conferences as RTSS (Real-Time Systems Symposium), CODES/ISS, Workshop on Languages, Compilers, and Tools for Embedded Systems (LCTES). Further details regarding sponsoring, as well as specific events and publications are given in this document.

Artist partners are also active members of the ACM's SIGBED, and the IEEE's upcoming Special Interest Group on Embedded Systems currently being set up. Artist members actively work for structuring international events on embedded systems.

This year the 4th edition of the Embedded Systems Week, including EmSoft and CODES/ISS has taken place Oct 19-24 in Atlanta (USA).

1.3.1 International Collaboration

In Year 4, we have organised the third Artist-China school on embedded systems. The school gathered 81 selected participants. Given the continuing success of this series, it has been decided to organise within ArtistDesign a 4th ARTIST2 school in China in 2009.

Furthermore, also within ArtistDesign, we are planning to organize a third Artist – South American school in Buenos Aires, in 2009.

1.3.2 Publications

The Artist2 community has continued to be very active in publishing in scientific journals and conferences, as attested by the list of publications provided in this document.

1.3.3 Tools and Components

The Artist2 community plays a leading role in the distribution of software tools and components, on verification/validation tools. Some tools are distributed free of charge, such as UPAAL, IF. Others are commercialised, such as AbsInt, SymTA/S. No new tools have started being distributed in year 4.

1.3.4 Industrial Liaison

Artist2 has a wide array of affiliated industrial and SME partners, as described in this document (section: "Affiliated Partners in the ARTIST2 Research Activities"). Most of these partners have participated in some way in the Artist2 technical meetings and the overall effort. There is strong, high-level industry participation through the various Spreading Excellence events organised by Artist2.

Our active involvement in the European Technology Platform ARTEMIS also could have a significant and long-term impact. Several Artist2 partners, including OFFIS, PARADES, VERIMAG; and TU Vienna, are actively involved in the ARTEMIS ETP.

In addition, each Artist2 partner has an outstanding track record for interaction with industry. Globally, the Artist2 consortium has a very strong impact on European R&D in embedded systems. This impact is visible via the achievements in Integrated Projects and STREPs (see below).

1.3.5 Course Materials

Artist2 disseminates recent, high-quality Course Materials via its web portal. We currently have materials
http://www.artist-embedded.org/artist/-Course-Materials-.html

This includes materials generated in Artist2 events, as well as pointers to high-quality materials from other sources.

2. International Collaboration

2.1 Year 4 Event: ARTIST2 South-American School for Embedded Systems 2008

http://www.artist-embedded.org/artist/-ARTIST-2-South-American-School-.html

August 25-29, 2008 *Universidade Federal de Santa Catarina, Florianopolis, Brazil*

Organised and funded by Artist.

2.1.1 Objectives

After the successful First ARTIST2 South-American School for Embedded Systems in Buenos Aires, Argentina, this second edition in Florianopolis, Brazil, strengthens the cooperation between Europe and South America in the area of embedded systems, both at educational and research levels. For this purpose, the goal of the school is to provide state-of-the-art courses on embedded systems oriented towards advanced students and young researchers.

We believe the school provides the ground for cross-fertilization between Europe and South-America with an expected mutual high added-value. Therefore, the lectures given by European researchers, were accompanied by talks and a poster session for participants to present and discuss their ongoing work.

2.1.2 Lecturers

The courses were given by ARTIST members Nicolas Halbwachs (VERIMAG), Peter Marwedel (TU Dortmund), and Lothar Thiele (ETHZ).

Lecturers

Nicolas Halbwachs

VERIMAG Laboratory, Grenoble, France

Nicolas Halbwachs obtained his "3rd Cycle Thesis" in 1979, at Grenoble University, under the supervision of P. Cousot, on the static analysis of linear properties invariantly satisfied by the numeric variables of a program. In 1984, he obtained his "State Thesis", at Institut National Polytechnique de Grenoble, under the supervision of P. Caspi, on formal modelling of real-time system behavior.

Since then, he was one of the main designers of the synchronous data-flow language Lustre. He successively worked on the language design, compilation to software and hardware, on verification and testing techniques for synchronous programs, and on the verification of numerical programs by abstract interpretation. He is strongly involved in the industrial transfer of Lustre technology. He was the coordinator of the ESPRIT-LTR ``SYRF'' project (1997-99).

N. Halbwachs entered the CNRS (French National Center of Scientific Research) in 1980. Since 1991, he is "Directeur de Recherche" at CNRS, working at Verimag Laboratory in Grenoble.

In 1992-93, he spent a year at Stanford University, as invited professor. In 2004, he was awarded with Paul Caspi, the Prize "Michel Monpetit" of the French Academy of Sciences. He is currently director of the Verimag laboratory.

Peter Marwedel

Technische Universitaet Kaiserslautern, Germany

Peter Marwedel received his Ph.D. in physics from the University of Kiel (Germany) in 1974. He worked at the Computer Science Department of that University from 1974 until 1989. In 1987, he received the Dr. habil. degree for his work on high-level synthesis and retargetable code generation based on the hardware description language MIMOLA.

Since 1989 he is a professor at the Computer Science Department of the Technical University of Dortmund. He served as the Dean of that Department between 1992 and 1995. His current research is focussed on software for embedded systems, with emphasis on code generation techniques for embedded systems, in particular memory and energy-aware compilers.

His publications include the books :
- "Code Generation for Embedded Processors",
- "Retargetable Compiler Technology" and
- "Embedded System Design", all published by Kluwer Academic publishers.

He received the teaching award of his University in 2003 and is a member of the ARTIST2 network of excellence on embedded and real-time systems in Europe.

Dr. Marwedel heads the ICD, a private technology transfer center at Dortmund and is actively promoting the use of research results in industry.

Lothar Thiele

ETH Zurich

Lothar Thiele received his Diplom-Ingenieur and Dr.-Ing. degrees in Electrical Engineering from the Technical University of Munich in 1981 and 1985 respectively. After completing his Habilitation thesis from the Institute of Network Theory and Circuit Design of the Technical University Munich, he joined the Information Systems Laboratory at Stanford University in 1987.

In 1988, he took up the chair of microelectronics at the Faculty of Engineering, University of Saarland, Saarbrucken, Germany. He joined ETH Zurich, Switzerland, as a full Professor of Computer Engineering, in 1994. He is leading the Computer Engineering and Networks Laboratory of ETH Zurich.

His research interests include models, methods and software tools for the design of embedded systems, embedded software and bioinspired optimization techniques.

In 1986 he received the "Dissertation Award" of the Technical University of Munich, in 1987, the "Outstanding Young Author Award" of the IEEE Circuits and Systems Society, in 1988, the Browder J. Thompson Memorial Award of the IEEE, and in 2000-2001, the "IBM Faculty Partnership Award". In 2004, he joined the German Academy of Natural Scientists Leopoldina. In 2005, he was the recipient of the Honorary Blaise Pascal Chair of University Leiden, The Netherlands.

2.1.3 Organisation

Scientific Committee

- Victor Braberman, Universidad de Buenos Aires, Buenos Aires, Argentina.
- Pedro D'Argenio, Universidad Nacional de Cordoba, Cordoba, Argentina.
- Jean-Marie Farines, Universidade Federal de Santa Catarina, Florianopolis, Brazil.
- Gerhard Fohler, University of Kaiserslauten, Kaiserslautern, Germany.
- Julius Leite, Universidade Federal Fluminense, Rio de Janeiro, Brazil.
- George Lima, Universidade Federal da Bahia, Bahia, Brazil.
- Alfredo Olivero, Universidad Argentina de la Empresa, Buenos Aires, Argentina.
- Rodrigo Santos, Universidad Nacional del Sur, Bahia Blanca, Argentina.
- Joseph Sifakis, CNRS-VERIMAG, Grenoble, France.
- Sergio Yovine, CNRS-VERIMAG, Grenoble, France.
- Flàvio Wagner, Universidade Federal de Rio Grande do Sul, Porto Alegre, Brazil.

Coordination Committee

- Leandro Becker, Universidade Federal de Santa Catarina, Florianopolis, Brazil.
- Jean-Marie Farines, Universidade Federal de Santa Catarina, Florianopolis, Brazil.
- Rômulo de Oliveira, Universidade Federal de Santa Catarina, Florianopolis, Brazil.
- Alfredo Olivero, Universidad Argentina de la Empresa, Buenos Aires, Argentina.
- Sergio Yovine, CNRS-VERIMAG, Grenoble, France.

2.1.4 Programme

The program consisted in 3 daily 2-hour long courses by Nicolas Halbwachs (VERIMAG-CNRS), Peter Marwedel (University of Dortmund), and Lothar Thiele (ETH, Zurich). The courses were interactive, and generated interesting discussions during coffee breaks and lunches in restaurants nearby. Courses were tape recorded. Videos should become available through the ARTIST2 web site as soon as the digitalization process would be completed.

Monday - August 25th 2008

8:30	**Introduction to synchronous programming: The data-flow language Lustre**	Nicholas Halbwachs
11:00	Poster session and talks	
13:30	**Specification Languages for Embedded Systems**	Peter Marwedel
16:00	**Software for Embedded Systems**	Lothar Thiele

Tuesday - August 26th 2008

8:30	**The imperative languages Esterel and Syncharts**	Nicholas Halbwachs
11:00	Poster session and talks	
13:30	**Efficiency improving transformations**	Peter Marwedel
16:00	**Scheduling Policies**	Lothar Thiele

Wednesday - August 27th 2008

8:30	**Compilation of synchronous languages**	Nicholas Halbwachs
11:00	Poster session and talks	
13:30	**Design Space Exploration of Embedded Systems**	Lothar Thiele
16:00	**Performance Analysis of Distributed Embedded Systems**	Lothar Thiele

Thursday - August 28th 2008

8:30	**Verification and test of synchronous programs**	Nicholas Halbwachs
11:00	Round-table discussion	
13:30	**Performance Analysis of Distributed Embedded Systems**	Lothar Thiele
16:00	**Exploitation of the Memory Hierarchy**	Peter Marwedel

Friday - August 29th 2008

8:30	**Current research trends in synchronous languages**	Nicholas Halbwachs
11:00	Round-table discussion	
13:30	**Compiler Optimization Algorithms for Embedded Systems**	Peter Marwedel
16:00	**Building a Compiler**	Peter Marwedel

2.1.5 Participants

The were a total of 66 registered participants, with a regular daily assistance to lectures of about 50. The large majority of participants were PhD students (28), mostly from Argentina (17) and Brazil (7). The scientific level of PhD students was recognised to be very good (many of them already published in top-ranked conferences and journals in the filed), as became apparent during the short presentations of their ongoing research works. The table below summarizes the distribution of participants according to their position and country.

2.1.6 Poster sessions.

There were daily short (20 minutes) poster presentations by South American PhD and Master students.

A total of 14 posters were presented. These were followed by discussions about research directions on embedded systems in South America, where connections with related work in Europe were pointed out to motivate forging new cooperations. The poster exhibition and short presentations were very important to spawn interactions between participants and lecturers.

2.1.7 Participants.

There were a total of 119 registered participants, from which 88 were selected, and 79 regularly assisted to School lectures. 30% were PhD students, 35% were Master students, and the 30% were Faculty members, and the remaining 5% were Research Engineers from academia and industry, and undergraduate students. The scientific level of PhD and Master students was recognized to be very good (many of them have already published scientific papers in conferences of the filed).

2.1.8 Conclusions

The courses were quite interactive, and generated interesting discussions during coffee breaks and lunches at the school's site, as well as during social dinners in restaurants nearby. The exhibition of posters greatly contributed to motive interactions between participants and lecturers. We believe this first edition achieved the desired purpose of the school of promoting and fostering research cooperations in the field of embedded systems between groups in Europe and South America. We are aware of several actions which have been undertaken in order to try to formalize cooperations, for instance, via research projects and collaboration networks. There has been a strong request to keep on organizing the school, with a general agreement to locate it in Brazil next year (the place is still to be decided, but there are already a couple of proposals).

2.2 Year 4 Event: Artist2 Summer School in China 2008

http://www.artist-embedded.org/artist/-Artist2-Summer-School-in-China-.html

July 12-18, 2008 Shanghai, China

Organised and funded by Artist.

2.2.1 Overview

This was the 3rd edition of a school on Embedded Systems Design.
This year, the school was organized in collaboration with the SEI/ECNU and the LIAMA.

This year, we were able to do a far stricter degree of selection amongst the candidates.
We selected 81– the fill list is available here.

Past Editions:

- 2007 Edition
- 2006 Edition

2.2.2 Lecturers

Prof. Luis Almeida

University of Aveiro, Portugal

http://sweet.ua.pt/~lda/

Luis Almeida is currently a professor at the Electronics, Telecommunications and Informatics Department (DETI) of the Universidade de Aveiro (UA), and member of the IEETA research unit (Instituto de Engenharia Electrónica e Telemática de Aveiro) at the same university. He is also a senior member of the IEEE, Computer Society. He has coordinated the Electronic Systems Lab (LSE) within IEETA since 2003, being currently interested in real-time communication protocols for embedded systems with an emphasis on mechanisms to support predictable operational flexibility as needed for dynamic QoS management, graceful degradation and open distributed real-time systems in general. He is also interested in control architectures for teams of autonomous mobile robots, focusing on distributed architectures to support global coordination and data fusion, and in flexible control approaches, particularly for networked control systems.

Prof. Ed Brinksma

Embedded Systems Institute, Netherlands

http://wwwhome.cs.utwente.nl/~brinksma/

Ed Brinksma is scientific director and chair of the Embedded Systems Institute in Eindhoven in The Netherlands, and a member of the Formal Methods research group at Eindhoven University of Technology. He also used to be professor and chair of the Formal Methods and Tools group at the University of Twente, to which he now is affiliated as a part-time full professor and is also acting as chair of the new group in Pervasive Systems.

Ed Brinksma is affiliated to the the Department of Computer Science at Aalborg University in Denmark as an adjoint professor.

Prof. Michael Gonzalez Harbour

University of Cantabria, Spain

http://www.ctr.unican.es/people/michael.html

Michael González Harbour is a Professor in the Department of Mathematics, Statistics and Computer Science at the University of Cantabria. He works in software engineering for real-time systems, and particularly in modelling and schedulability analysis of distributed real-time systems, real-time operating systems, and real-time languages. He is a co-author of "A Practitioner's Handbook on Real-Time Analysis". He has been involved in several industrial projects using Ada to build real-time controllers for robots. Michael has participated in the real-time working group of the POSIX standard for portable operating system interfaces.

Christoph Kirsch

University of Salzburg, Austria

http://cs.uni-salzburg.at/~ck/

Christoph Kirsch received the Dr.Ing. degree from Saarland University, Saarbruecken, Germany, in 1999 while at the Max Planck Institute for Computer Science in Saarbruecken. He then worked as Postdoctoral Researcher at the Department of Electrical Engineering and Computer Sciences of the University of California, Berkeley.

Since 2004, he is a full professor at the Department of Computer Sciences of the University of Salzburg, Austria. His research interests are in concurrent programming and systems, virtual execution environments, and embedded real-time software. Dr. Kirsch co-invented the Giotto and HTL languages, and leads the JAviator unmanned-aerial-vehicle project for which he received an IBM faculty award in 2007. He is a member of the ACM and IEEE, co-founded the International Conference on Embedded Software (EMSOFT), and is a general co-chair of the Embedded Systems Week (ESWEEK) in 2008. He has

served on program committees of CASE, Coordination, DATE, EMSOFT, EuroSys, LCTES, OOPSLA, RTAS, and VEE.

Associate Professor Jean-François Raskin

Université Libre de Bruxelles, Belgium

http://www.ulb.ac.be/di/ssd/jfr/

After long research stays at the University of California at Berkeley, Max-Planck Institute for Computer Science (Saarbrucken), and ENS Paris, he is now Associate Professor at the computer science department of the Université Libre de Bruxelles (ULB), Belgium.

His research interests are the formal methods for the verification of concurrent, real-time, and hybrid systems.

More precisely, his research focusses on:
- Logic formalisms, especially temporal logics and real-time logics;
- Automata formalisms and their extensions for real-time and hybrid systems;
- Abstract interpretation theory and its application to the verification of concurrent, real-time and hybrid systems ;
- Game theory for synthesis of controllers.

2.2.3 Programme

Model-Based Testing for Embedded Systems

Monday July 14th — Prof. Ed Brinksma, Embedded Systems Institute, Netherlands

Abstract: The lecture on model-based testing for embedded systems will consist of four parts. First, we provide a general introduction to model-based testing, where we introduce basic terminology and concepts, and relate our approach to other model-based approaches to testing. In the second part we present the basic theory for the derivation of functional tests from models in the form of input/output transition systems. An important feature of the theory is that absence of response by an implementation is treated as a special kind of output, known as quiescence. We demonstrate the test derivation and excution tool TorX that is based on this theory. TorX supports so-called on-line test derivation, in which the continuation of a test case are calculated during its execution. In the third part we show how both theory and tool can be extended to include real-time behaviour in specifications, implementations and tests. The fourth, and final part of our lecture is devoted to the problem of test selection and coverage, i.e. the problem of how to express and measure the quality of finite test suites of selected test cases.

Networks for Embedded Control Systems

Tuesday July 15th — **Prof. Luis Almeida**, University of Aveiro, Portugal

Abstract: The course will address the growing role of networks in control applications, from embedded control to process control, which led to the wide dissemination of distributed computer control systems (DCCS). Starting from the network, which is the central component in a DCCS, the course will focus on communication issues and associated timing aspects. This will allow understanding the impact that architectural options in the network side have on the services delivered to the application. Then, the course will look at the application side of DCCS and analyse the timing requirements and the impact of deviations. This latter aspect will build the motivation for higher operational flexibility in current DCCS, together with higher resource efficiency. The course will then address the impact imposed on the system architecture by such requirement for higher flexibility. Finally, several examples, real and simulated, will be used to illustrate the concepts presented along the course.

Designing a Compositional Real-Time Operating System

Wednesday July 16th — Prof. Christoph Kirsch, University of Salzburg, Austria

Abstract : This lecture is about the design and implementation of an open-source, real-time operating system called Tiptoe. A key feature of Tiptoe is that its process model is fully compositional in a temporal and spatial sense. For example, Tiptoe processes read sensors, compute something, allocate and free memory, write actuators but also access (virtual) disks and networks, all in real time, without affecting each others' real-time behavior. Moreover, the Tiptoe system can predict in constant time remaining resource capacities such as the available CPU time, memory, and I/O bandwidth for end-to-end real-time guarantees on all relevant process activities. The strong temporal and spatial isolation of Tiptoe processes will enable more principled and scalable real-time and embedded software engineering. There are already encouraging research results obtained with our prototype implementation of a compositional and (constant-time) predictable, real-time process scheduler and memory management system, which, unlike existing approaches, also guarantees low bounds on memory fragmentation in real time. The lecture will give an overview of the Tiptoe system and then cover design principles and experimental results of the process model and scheduler as well as the memory management and I/O systems.

Predictable Response Times in Event-driven Real-time Systems

Thursday July 17th — Prof. Michael Gonzalez Harbour, University of Cantabria, Spain

Abstract: This lecture is focused on the methods used to schedule event-driven real-time systems and to guarantee the predictability of their response times.

We will start by looking at simple single processor systems scheduled with fixed priorities, and we will then progress through dynamic scheduling and distributed systems.

We will briefly discuss the MAST modelling and analysis tools for schedulability analysis.

We will also review advanced flexible scheduling techniques that allow protection among different components of a complex application and provide the designer with services that facilitate building real-time applications at a higher level of abstraction.

Timed Automata and Extensions for Modeling, Verification and Synthesis

Friday July 18th

Associate Prof. Jean François Raskin
Université Libre de Bruxelles, Belgium

Abstract: In this course, we will first study the model of timed automata (as introduced by Rajeev Alur and David Dill) for modeling real-time systems at an abstract level.

We will study the foundations of that formalism as well as efficient data structures and algorithms which are used for their verification and implemented in tools like UppAal.

We will also consider the synthesis of timed controllers for timed automata. Then we will introduce weighted timed automata that extend timed automata with a notion of cost, and study the optimal-reachability problem and the optimal-control problem for those extended timed automata.

2.2.4 Organisation

Coordination Committee

- He Ji Feng, Academician of CAS, East China Normal University, Shanghai
- Vania Joloboff (LIAMA)
- Joseph Sifakis (Verimag)
- Bruno Bouyssounouse (Artist2 NoE)
- Wang Yi (Uppsala University)

Local Organisation

- Min ZHANG (SEI/ECNU)
- Naiyong JIN (SEI/ECNU)

2.2.5 Poster for the school

2.3 Year 4 Event: Foundations of Component-based Design

September 30th, 2007 Salzburg, Austria - within EmSoft / ES Week
http://www.artist-embedded.org/artist/-Foundations-of-Component-based-.html

Artist2 organised and funded this event, within Embedded Systems Week.

2.3.1 Objectives and scope

Discuss recent results on component-based design with emphasis on design frameworks for real-time systems encompassing heterogeneous composition and models of computation. Especially frameworks for handling non-functional and resource constraints, design under conflicting dependability criteria, trade-offs between average performance and predictability.

The workshop aims to gather together researchers from computer science and electrical engineering and will seek a synthesis between the the underlying paradigms and techniques. The focus is not only on fundamental results but also on their implementation in methods and tools and their concrete application in areas such as automotive, avionics, consumer electronics and automation.

The workshop will address specific challenges such as:

- Foundations and Expressiveness of System Description Formalisms
  - What are the basic concepts for describing components?
  - What types of component interaction that are directly supported?
  - What kind of resources can be modeled and are they first class citizens of the formalism (energy, memory, time, ...)?
  - How do you think the following models, styles and design principles are interrelated and can be combined:
    - synchrony vs. asynchrony
    - event-triggered/data-triggered/time triggered
    - separation of concerns

- Component-based Design, Methods and Tools
  - What kind of analysis methods are or should be supported?
  - Compositional verification techniques
  - resource usage (such as energy, time, memory)
  - What kind of design methods are or should be supported?
    - property preserving structuring principles
    - refinement/implementation relations
  - What kind of tradeoffs between predictability and efficiency can be exploited?
  - What kind of implementation methodologies do the proposed formalisms support and what kind of tools are or could be made available?
  - Application Scenarios and Relevant Case Studies
    - What kind of applications have been or should be looked at that illustrate the above issues?

Format
The workshop was comprised of invited presentations, as well as dedicated discussion sessions, ordered according to the topics.

The workshop also served as kickoff workshop for the Modeling and Validation cluster of the ArtistDesign Network of Excellence on Embedded Systems Design.

2.3.2 Participants

Johan Lilius	Åbo Akademi University
Ansgar Radermacher	CEA
Kim Larsen	CISS, Aalborg University
Luca Carloni	Columbia University
Naoki MATSUMOTO	DENSO CORPORATION
Ed Brinksma	ESI
Tom Henzinger	EPFL
Luis Lopes	Universidade do Porto
Peter Bertels	Ghent University
Fahad Bin Tariq	U. Paderborn
Philippe Baufreton	Hispano Suiza
Albert Benveniste	INRIA
Alain GIRAULT	INRIA / POP ART
Martin Torngren	KTH
Ivica Crnkovic	Mälardalen Univ.
Hans Hansson	MRTC/IDE/MDH
Inerner Damm	Offis EV

Eric Verhulst	Open License Society
David Parker	Oxford University Computing Laboratory
Lei Gao	RWTH Aachen University
BORDE Etienne	THALES
Paula Herber	TU Berlin
Doris Wild	TU Muenchen
EDWARD LEE	UC BERKELEY
Daniela Cancila	University of Padova
Eduardo Marques	University of Portugal
Roberto Passerone	University of Trento / Parades
Javier Fernandez Briones	UPM
Bengt Jonsson	Uppsala Univ.
Wang Yi	Uppsala Univ.
Ismail Assayad	VERIMAG
Ananda Basu	Verimag
Simon Bliudze	VERIMAG
Joseph Sifakis	Verimag

2.3.3 Organisation

Chairs

- Tom Henzinger (co-chair)
  Ecole Polytechnique Fédérale de Lausanne
- Werner Damm (co-chair)
  OFFIS

Publicity

- Bruno Bouyssounouse
  Verimag Laboratory

Logistics

- Karen Birkenstock
  OFFIS

2.3.4 Programme and Slides

Session 1: Components

Joseph Sifakis
Structuring Interaction in BIP

Alberto Sangiovanni-Vincentelli and Roberto Passerone
Contract-based formalisms for heterogeneous and hybrid systems

Martin Toerngren
A Holistic Approach to Model and Component-based Embedded Systems Engineering

Session 2: Embedded Software

Albert Benveniste
A Generic Model of Contracts for Embedded Systems

Christoph Kirsch
Tiptoe: A Compositional Real-Time Operating System

Ansgar Radermacher
Component based middleware for real-time embedded systems

Session 3: Dependability, Predictability, and Reliability

Ed Brinksma
TRADER: an industry-as-laboratory experiment in system dependability

Bengt Jonsson
GALP: Globally approximate, locally precise timing analysis for predictability

Alain Girault
The Length-Reliability Bicriteria Scheduling and Optimization Problem

Session 4: Verification

Kim Larsen
Performance Analysis and Synthesis

Dave Parker
Model checking of probabilistic systems

Johan Lilius
Specification and validation of non-functional constraints

2.4 Year 4 Event: Workshop on Embedded Systems Education (WESE 2007)

October 4-5, 2007 Salzburg, Austria (within ES Week)
http://www.artist-embedded.org/artist/-WESE-07-.html

Organised and funded by Artist

2.4.1 Overview

It is widely recognized that the embedded system domain is a multidisciplinary one, requiring a large variety of skills from control and signal processing theory, electronics, computer engineering and science, telecommunication, etc., as well as application domain knowledge.

This has motivated a recent but ever growing interest in the question of educating specialists in this domain and this has also been recognized as a particularly difficult problem.

This third workshop on the subject aims to bring researchers, educators, and industrial representatives together to assess needs and share design, research, and experiences in embedded systems education.Industrial needs regarding embedded systems education

2.4.2 Organisation

Chairs

- Jeff Jackson, The University of Alabama, USA
- Martin Törngren, Royal Institute of Technology, Sweden

Program Committee

- Reiner Hartenstein, Kaiserslautern University of Technology, Germany
- Yann-Hang Lee, Arizona State University, USA
- Jogesh Muppala, The Hong Kong University of Science and Technology, Hong Kong
- Kenneth G. Ricks, The University of Alabama, USA
- Falk Salewski, Aachen University, Germany
- Chi-Sheng (Daniel) Shih, National Taiwan University, Taiwan
- Stewart Tansley, Microsoft, Redmond, WA, USA
- Wayne Wolf, Princeton University, USA

2.4.3 Program

October 4, 2007 **: Embedded Systems Courses and Curricula I**

Jim Hamblen - Georgia Institute of Technology
An Undergraduate Embedded Systems Design Course Based on a Commercial Embedded Operating System

Embedded Systems Courses and Curricula II

Chen Tianzhou - ZheJiang University
The 7 Years Embedded System Education in China

Yu-Lun Huang - National Chiao-Tung University
The Curriculum and Teaching Laboratory for Embedded Systems

Kuo Chen Wu
The Development of Training Course for Embedded Middleware Design

Skills and Learning in Embedded Systems Education

Antti Piironen - EVTEK University
Problem Based Learning of Embedded Systems Design

Peter Bertels - Ghent University
Gathering Skills for Embedded Systems Design

SoC in Embedded Systems Education

Chian C. Ho - National Yunlin University
Design Methodology and Lab Example of Soft Speech Codec on Nios II Embedded Platform

Yi-Jung Chen - National Taiwan University
SoC System Design Program for Computer Science Majors

Roundtable Discussion I

Workshop attendee roundtable discussion: Current and Future Embedded Systems Education Issues

October 5, 2007: ***Higher-Level Issues in Embedded Systems Education***

Jeff Jackson - The University of Alabama
Addressing System-Level Concepts in Embedded Systems Education

Ting-Wei Hou - National Cheng Kung University
A Step toward Embedded Programming in High Level Languages

Roundtable Discussion II

Workshop attendee roundtable discussion: Where do we go from here?

2.5 Year 4 Event: ARTIST2 meeting on Integrated Modular Avionics

November 12-13, 2007 Roma, Italy
http://www.artist-embedded.org/artist/-ARTIST2-meeting-on-Integrated-.html

Organised and funded by Artist

2.5.1 Objectives

Today, the exponentially increasing diversity of airborne systems results in an ever increasing number of computers and controllers for system management, monitoring, and control. The development of specific ad-hoc solutions causes increases in costs, which in turn impacts purchase prices and operational costs. To overcome this, standardization principles and reuse of function units are now considered, via Integrated Modular Avionics.

Integrated Modular Avionics (IMA) has set the principles of standardized components and interfaces of hardware and software in aircraft. These principles have been applied for the first time in the development of the Airbus A380. Further developing IMA raises a number of issues that require fundamental research efforts, in tight coordination with engineering needs.

ARTIST2, the European Network of Excellence on embedded systems has organized, as part of its activity on "scientific challenges in specific industrial sectors", a two-day workshop dedicated to Systems, Software, and Architecture, aspects of IMA.

The workshop analyzed:

- the issues and difficulties encountered by aircraft manufacturers and their suppliers,
- the specific research problems that result from the above issues, and,
- the recent advances in research that may contribute to overcoming the above difficulties.

2.5.2 Organisation

This workshop is organised by the Artist2 Network of Excellence on Embedded Systems Design:

- Albert Benveniste (INRIA)
- Paul Caspi (Verimag)
- Bengt Jonsson (Uppsala)
- Werner Damm (Offis)
- Joseph Sifakis (Verimag)
- Bruno Bouyssounouse (Verimag)

It was co-chaired by:

- Albert Benveniste (INRIA, responsible for minutes)
- Alberto Ferrari or Alberto Sangiovanni-Vincentelli (PARADES, chairing sessions)

2.5.3 Program & Slides

- *Monday November 12th*

Alberto Ferrari or Alberto Sangiovanni-Vincentelli, PARADES
Welcome and introductory address

Jean-Bernard Itier, Airbus
A380 Integrated Modular Avionics - (*abstract*)

Thierry Cornilleau, Dassault-Aviation
Dassault Aviation feedbacks on its military and civil IMA applications - (*abstract*)

Peter Feiler, SAE AADL Committee
IMA: The Good, The Bad, and The Ugly - (*abstract*)

John Rushby, SRI (presented by Albert Benveniste)
Compositional Assurance for IMA - (*abstract*)

Paul Caspi, Verimag
Some issues about IMA in safety critical applications - (*abstract*)

Gert Doehmen, Airbus
Embedded System Development for Distributed Networked Computing Platforms - *(abstract)*

Roman Obermaisser, TU Vienna
Supporting Heterogeneous Applications in the DECOS Integrated Architecture (abstract)

Discussion and identification of the main points of the day

- Tuesday November 13th

Bruno Bouyssounouse, VERIMAG Laboratory
Overview of the Artist2 Network of Excellence

Kevin Driscoll, Honeywell
Honeywell requirements for IMA - *(abstract)*

Alex Wilson (Windriver), OS
The application of DO-297 to a COTS based ARINC 653 Environment - *(abstract)*

Chris J. Walter, WW Technology Group
Dependable solutions for IMA - *(abstract)*

Panel Session on expectations from research for IMA:
statements from speakers and recorded discussion.
This will be a structured panel involving the speakers, plus some additional panelists. Besides the usual statements and discussion, detailed conclusions and recommendations for research will be collected as part of the meeting minutes.

2.5.4 Full minutes

Minutes from the meeting are available here.

3. Organisation of Schools

3.1 Schools directly Organized and Funded by Artist2 in Year4

In Year 4, Artist2 has directly organized and funded the following schools and courses:

ARTIST2 South-American School for Embedded Systems 2008
August 25-29, 2008 Universidade Federal de Santa Catarina, Florianopolis, Brazil
http://www.artist-embedded.org/artist/-ARTIST-2-South-American-School-.html

After the successful First ARTIST2 South-American School for Embedded Systems in Buenos Aires, Argentina, this second edition in Florianopolis, Brazil, strengthens the cooperation between Europe and South America in the area of embedded systems, both at educational and research levels. For this purpose, the goal of the school is to provide state-of-the-art courses on embedded systems oriented towards advanced students and young researchers.

This school is described in detail above, in the section on International Collaboraiton.

Artist2 Summer School in China 2008
July 12-18, 2008 Shanghai, China
http://www.artist-embedded.org/artist/-Artist2-Summer-School-in-China-.html

This was the 3rd edition of a school on Embedded Systems Design.
This year, the school was organized in collaboration with the SEI/ECNU and the LIAMA.

This year, we were able to do a far stricter degree of selection amongst the candidates.
We selected 81participants – the fill list is available here.

This school is described in detail above, in the section on International Collaboraiton.

Real-Time Kernels for Microcontrollers: Theory and Practice
June 23-25, 2008 Pisa, Italy
http://www.artist-embedded.org/artist/-Real-Time-Kernels-for-.html

The course on Real-Time Kernels for Microcontrollers aims to introduce the basic concepts of Real-time Systems targeted to Embedded Systems, which are often implemented using microcontrollers. The course will briefly illustrate the theoretical background of real-time scheduling, resource-aware techniques, and wireless communication based upon the IEEE 802.15.4 protocol.

ARTIST2 Graduate Course on: Automated Formal Methods for Embedded Systems 2008
June 16-24, 2008 DTU - Lyngby, Denmark
http://www.artist-embedded.org/artist/-Automated-Formal-Methods-for-.html

In the lectures, we introduce a comprehensive set of state-based models as well as automatic procedures for their analysis. The exercise classes will complement this by providing hands-on experience with appropriate verification tools.

ARTIST2 Graduate Course on Embedded Control Systems
May 26-30, 2008 Stockholm, Sweden
http://www.artist-embedded.org/artist/-Graduate-Course-on-Embedded-.html

The course provides an account of state of the art theory and techniques that address the connection and integration of the areas of Control systems and Embedded systems.

3.2 Schools Sponsored by Artist2 in Year4

EPSD 2007
September 10-14, 2007 EPFL, Lausanne, Switzerland

Advanced engineering courses offered by the Swiss Federal Institute of Technology, Lausanne, Switzerland, during summer period 2007.

FOSAD 2007
September 9-15, 2007 Bertinoro, Italy
http://www.artist-embedded.org/artist/-FOSAD-2007-7th-International-.html

The International School on Foundations of Security Analysis and Design (FOSAD) has been one of the foremost events established with the goal of disseminating knowledge in this critical area. The main aim of the FOSAD school is to offer a good spectrum of current research in foundations of security - ranging from programming languages to analysis of protocols, from cryptographic algorithms to access control policies and trust management - that can be of help for graduate students and young researchers from academia or industry that intend to approach the field.

3.3 Special Year 4 Event: ARTIST2 Summer School 2008 in Europe

September 8-12, 2008 Autrans (near Grenoble), France
http://www.artist-embedded.org/artist/-ARTIST2-Summer-School-2008-.html
Organised and funded by Artist.

The Summer School offered a number of foundational tutorials, accompanied by a selection of lectures on exciting emerging technologies and industrial applications - given by leading scientific and/or industrial experts.

An innovative step has been to provide the lectures in the form of videos, available for free via the website (currently under preparation – this will be shown at the review).

3.3.1 Overview

The ARTIST Summer School 2008 was held in the beautiful Vercors mountains in Autrans, near Grenoble, Sept 8-12. The school was organised by the Artist2 European Network of Excellence on Embedded Systems Design, which gathers 42 top European institutions. Artist's mission is to coordinate European research in the area around an ambitious joint research agenda, and to spread excellence through targeted events such as international workshops, schools and seminars.

Artist has a strong tradition in organising top-quality schools. This is the fourth edition of yearly schools on embedded systems design, and is meant to be exceptional in terms of both breadth of coverage and invited speakers.

The topics covered include Modeling and Validation, Compilers and Timing Analysis, Adaptive Real Time Systems, Control for Embedded Systems, Execution Platforms and MPSoC. We seek a balance between foundational aspects and applications. Speakers included recognized leading researchers and engineers.

The school was open to PhD students, researchers, and engineers. Attendance will be limited to 80 selected participants.

3.3.2 Programme

Monday Sept 8th	Tuesday Sept 9th	Wednesday Sept 10th	Thursday Sept 11th	Friday Sept 12th
Invited Speaker: **Sanjoy Baruah** (U. N.C. at Chapel Hill) Multiprocessor Real-Time Computing: Formal Foundations	*Invited Speaker:* **Giovanni De Micheli** (EPFL) Heterogeneous Platforms for Embedded Systems	*Invited Speaker:* **Karl Johan Astrom** (LTH) Control System Architectures	*Invited Speaker:* **David Bacon** (IBM) Real-Time Programming in Java	*Invited Speaker:* **Tarek Abdelzaher** (U. Illinois U-Champaign) Feedback Control of Distributed Computing Systems
Klaus Havelund (NASA JPL) Rule-based Runtime Verification	**Giorgio Buttazzo** (Pisa) Real-Time Scheduling and Resource Management	**Reinhard Wilhelm** (Saarland) Timing Analysis and Timing Predictability	**Kai Richter** (Symtavision) Establishing Formal Scheduling Analysis in Automotive Design Processes	**Karl Erik Arzen** (Lund) **Pedro Albertos** (UP Valencia) Implementation of control systems in resource-constrained embedded systems
Ed Brinksma (ESI) Quantitative Testing Theory	**Michael Gonzalez** (U. Cantabria) Contract-based resource reservation and scheduling	**Lothar Thiele** (ETHZ) Performance analysis of distributed real-time systems	**Diederik Verkest** (IMEC) Mapping C code on MPSoC for Nomadic Embedded Systems	**Luis Almeida** (U. Aveiro) The challenges of flexible real-time communication
Kim Larsen (Aalborg) Quantitative Verification and Synthesis for Embedded Systems	**Hermann Haertig** (TU Dresden) Enforceable Component-Based Realtime Contracts	**Peter Marwedel & Heiko Falk** (TU Dortmund) Memory architecture aware compilation	**Rance Cleaveland** (University of Maryland, USA) An instrumentation - based Approach to Controller Model Validation	**Raj Rajkumar** (Carnegie Mellon University) Building Blocks for Large-Scale Wireless Sensor Networks
Marta Kwiatkowska (Oxford U.) Quantitative Probabilistic Verification of Systems	**Gerard Berry** (Esterel Technologies) The evolution of the synchronous model	**Marco Bekooij** (NXP) Dataflow analysis for predictable multiprocessor design	**Steve Vestal** (Honeywell) Automating compositional safety analysis for IMA systems	

NB: Schedudling constraints imply that there is not always a logical sequencing of topics.

3.3.3 Videos Will be Available online

Videos of the presentations from the summer school are in post-production, and should be online for the review. These will be provided free of charge to the general public.

A few previews are visible here:

- http://artist.imavox.ch/mardi/giovanni_de_micheli/
- http://artist.imavox.ch/vendredi/luis_almeida/
- http://artist.imavox.ch/mercredi/karl_johan_astrom/

We plan to extend these videos with further presentations from future ArtistDesign schools.

3.3.4 Participants

NB: We selected approximately one out of every two applicants.

Kim Larsen	Aalborg University	Denmark	Lecturer
Andreas Dahlin	Abo Akademy University	Finland	
Federico Ferrari	ALaRI - University of Lugano	Italy	
Leandro Fiorin	ALaRI - University of Lugano	Italy	
Antonio Taddeo	ALaRI - University of Lugano	Italy	
Panagiotis Katsaros	Aristotle University of Thessaloniki	Greece	
Doron Peled	Bar-Ilan University	Israel	
Ondrej Rysavy	BMO University of Technology	Czech Rep	
Raj Rajkumar	Carnegie Mellon University	USA	Lecturer
Ahmed Jerraya	CEA-LETI, MINATEC	France	
Tomas Bures	Charles University in Prague	Czech Rep	
Nalini Vasudevan	Columbia University	USA	
Kai Richter	CTO of Symtavision	Germany	Lecturer
Zdenek Hanzalek	Czech Technical University	Czech Rep	
Matthias Traub	Daimler AG	Germany	
Heiko Falk	Dortmund University of Technology	Germany	Lecturer
Peter Marwedel	Dortmund University of Technology	Germany	Lecturer
Hermann Haertig	Dresden University of Technology	Germany	Lecturer
Sebastian Voss	EADS Innovation Works	Germany	
Mike Holenderski	Eindhoven University of Technology	Netherlands	
Tanir Ozcelebi	Eindhoven University of Technology	Netherlands	
Ed Brinksma	Embedded Systems Institute	The Netherlands	Lecturer

Karsten Albers	Embedded Systems Ulm University	Germany	
Bobba Shashi Kanth	EPF Lausanne	Switzerland	
Giovanni De Micheli	EPF Lausanne	Switzerland	Invited Speaker
Seiculescu Ciprian	EPF Lausanne	Switzerland	
Zarko Milosevic	EPF Lausanne	Switzerland	
Dimitrios K. Mylonas	ESTEC-ESA	Netherlands	
Gérard Berry	Esterel Technologies	France	Lecturer
Kai Lampka	ETH Zurich	Switzerland	
Tobias Rein	ETH Zurich	Switzerland	
Simon Perathoner	ETH Zurich	Switzerland	
Nikolay Stoimenov	ETH Zurich	Switzerland	
Lothar Thiele	ETH Zurich	Switzerland	Lecturer
Carlos Canudas de Wit	GIPSA-LAB CNRS, Grenoble	France	
Steve Vestal	Honeywell	USA	Lecturer
David Bacon	IBM	USA	Invited Speaker
Muhammad Ali	IMEC	Belgium	
Narasinga Rao	IMEC	Belgium	
Diederik Verkest	IMEC	Belgium	Lecturer
Patrick Meumeu Yomsi	INRIA	France	
NadŠge Pontisso	IRIT-UMS CNRS 5505	France	
Ahlem Mifdaoui	ISAE	France	
Paulo Baltarejo Sousa	ISEP-IPP	Portugal	
Ricardo Severino	ISEP-IPP	Portugal	
Paolo Moroni	Katholieke Universiteit Leuven - IMEC	Belgium	
Martin Trautmann	Katholieke Universiteit Leuven - IMEC	Belgium	
Naeem Muhammad	Katholieke Universiteit Leuven & The Netherlands	Belgium & NL	
Magnus Persson	KTH	Sweden	
Tahir Naseer Qureshi	KTH	Sweden	
Martin Torngren	KTH	Sweden	
Imen Kahloul	LAAS, CNRS	France	
Sergiu Rafiliu	Linköping University	Sweden	

Soheil Samii	Linköping University	Sweden	
Ana Milosevic	Logitech Europe S.A.	Switzerland	
Joris Rehm	LORIA	France	
Karl Erik Årzen	Lund University	Sweden	Lecturer
Karl Johan Astrom	Lund University	Sweden	Invited Speaker
Mikael Lindberg	Lund University	Sweden	
Marcelo Santos	Mälardelen University	Sweden	
Cesar Sanchez	Madrid Institute for Advanced Studies (IMDEA-Software)	Spain	
Klaus Havelund	NASA Jet Propulsion Labratory	USA	Lecturer
Chen-Wei Huang	National Chiao-Tung University (NCTU)	Taiwan	
C,dric Mauclair	Onera	France	
Marta Kwiatowska	Oxford University	UK	Lecturer
Patrick Bellasi	Politechnico di Milano	Italy	
Shi Zheng	Real-time system research group, University of York	UK	
Gang Yao	ReTiSlab, CEIIC	Italy	
Yifan Wu	ReTiSlab, Scuola Superiore Sant?Anna	Italy	
Markus Ferch	Robert Bosch GmbH	Germany	
Anders Sandberg	Royal Institute of Technology and Mecel AB	Sweden	
Reinhard Wilhelm	Saarland University	Germany	Lecturer
Sebastian Altmeyer	Saarland University, Compiler Design Lab	Germany	
Joerg Herter	Saarland University, Compiler Design Lab	Germany	
Ahmet Onat	Sabanci University Istanbul	Turkey	
Niklas Pettersson	Scania CV AB	Sweden	
Mangesh Chitnis	Scuola Superiore Sant?Anna, Pisa	Italy	
Francesco Esposito	Scuola Superiore Sant?Anna, Pisa	Italy	
Dario Fagiolli	Scuola Superiore Sant?Anna, Pisa	Italy	
Luca Santinelli	Scuola Superiore Sant?Anna, Pisa	Italy	
Giorgio Buttazzo	Scuola Superiore Sant?Anna, Pisa	Italy	Lecturer

Philippe Bonnot	THALES	France	
Rolf Ernst	TU Braunschweig	Germany	
Anders Sejer Tranberg-Hansen	TU Denmark	Denmark	
Simon Barner	TU M nchen	Germany	
Michael Geisinger	TU M nchen	Germany	
Michael Zolda	TU Wien, Department of Computer Engineering	Austria	
Patricia Lopez Martinez	Universidad de Cantabria	Spain	
Julio Medina	Universidad de Cantabria	Spain	
Aniko Costa	Universidad Nova de Lisboa	Portugal	
Pedro Albertos	Universidad Politecnica de Valencia	Spain	Lecturer
Mohamed Abdel Maksoud	Universität des Saarlandes	Germany	
Marco Pradelli	Università di Modena	Italy	
Luis Almeida	University of Aveiro	Portugal	Lecturer
Rui Santos	University of Aveiro	Portugal	
Philipp Grabher	University of Bristol	UK	
Fabrizio Mulas	University of Cagliari	Italy	
Slobodan Matic	University of California at Berkeley	USA	
Michael Gonzalez	University of Cantabria	Spain	Lecturer
Guanhua He	University of Durham	UK	
Joachim Falk	University of Erlangen-Nuremberg	Germany	
Alessio Turetta	University of Genova	Italy	
Tarek Abdelzaher	University of Illinois Urbana-Champaign	USA	Invited Speaker
Marco Bekooij	University of Kaiserslautern NXP Semi Conductors	The Netherlands	Lecturer
Claus Traulsen	University of Kiel	Germany	
Rance Cleaveland	University of Maryland	USA	Lecturer
Toby Rahilly	University of New South Wales	Australia	
Sanjoy Baruah	University of North Carolina at Chapel Hill	USA	Invited Speaker
Marco Panunzio	University of Padua	Italy	
Theis Hjorth	University of Southern Denmark	Denmark	

Steffen Kollmann	University of Ulm	Germany	
Manfred Mücke	University of Vienna	Austria	
Simon Tschirner	Uppsala University	Sweden	
Ananda Basu	VERIMAG, Grenoble	France	
Saddek Bensalem	VERIMAG, Grenoble	France	
Simon Bliudze	VERIMAG, Grenoble	France	
Bruno Bouyssounouse	VERIMAG, Grenoble	France	Organisation Committee
Yliès Falcone	VERIMAG, Grenoble	France	
Susanne Graf	VERIMAG, Grenoble	France	
Yanhong Liu	VERIMAG, Grenoble	France	
Marc Poulhies	VERIMAG, Grenoble	France	
Joseph Sifakis	VERIMAG, Grenoble	France	General Chair
Sven B nte	Vienna University of Technology	Austria	

3.3.5 Organisation

- General Chair: Joseph Sifakis
- Programme Committee: Artist2 Strategic Management Board
- Local Organisation: Bruno Bouyssounouse

3.3.6 Grants

The Artist2 Network of Excellence provided grants for students attending the Summer School, covering:

- Registration for the school
- Meals during the school
- Transportation by bus from the Grenoble train & main bus station to the school, at the start and end of the school.
  If you need transportation at other times, be sure to make your own arrangements (not covered by the grant).

- Accommodations during the school, on a case-by-case basis.
  There are generally two persons per room.
  In many cases, a grant may be provided for all the above except for accomodations.

3.3.7 Poster for the school

4. Organisation of Workshops

These are all world-class events, featuring top speakers. See the links provided for details. As a rule, we always the slides and other pertinent materials available to the general public, via the Artist web portal.

4.1 Directly Organized and Funded by Artist2 in Year

In Year 4, Artist2 has directly organized and funded the following workshops.

MoCC 2008
July 3-4, 2008 Eindhoven, Netherlands
http://www.artist-embedded.org/artist/-MoCC-2008-.html
Embedded systems are omnipresent in modern society, and society crucially depends on their proper functioning. The complexity of embedded system design however is increasing rapidly, through the use of multiprocessor cores, through the integration of embedded systems in ubiquitous networks, and through the increasing interaction between embedded systems and their users and environments. To obtain a reliable operation of embedded systems while maintaining resource efficiency, the embedded system design process needs to be based on a solid basis of computational models.

WCET'08
July 1st, 2008 Prague, Czech Republic (with ERCTS 2008)
http://www.artist-embedded.org/artist/-WCET-08-.html
The goal of the workshop is to bring together people from academia, tool vendors and users in industry that are interested in all aspects of timing analysis for real-time systems. The workshop fosters a highly interactive format with ample time for in-depth discussions.

OSPERT 2008
July 1st, 2008 Prague, Czech Republic (in conjunction with ECRTS)
http://www.artist-embedded.org/artist/-OSPERT-2008-.html
This workshop is intended as a forum for researchers and practitioners of RTOS to discuss the recent advances in RTOS technology and the challenges that lie ahead.

Movep'08
June 23-27, 2008 Orleans, France
http://www.artist-embedded.org/artist/-Movep-08-.html
MOVEP brings together researchers, students and people from industry working in the fields of control and verification of concurrent and reactive systems.

COMES 2008
June 17-18, 2008 Sigtuna, Sweden
http://www.artist-embedded.org/artist/-COMES-2008-.html
Component-based development aims of separation of development of components from systems, and reuse of existing components. This approach brings many (known) advantages, but also many challenges of which some are specific or in particular important for embedded systems. Since for embedded systems non-functional properties and resource constraints are of particular importance, this workshop focus on component-based approaches that ensure predictability of the system properties.

Mapping of Applications to MPSoCs
June 16-17, 2008 Schloss Rheinfels, St. Goar, Germany
http://www.artist-embedded.org/artist/-Mapping-of-Applications-to-MPSoCs-.html
1st Workshop on Mapping of Applications to MPSoCs

DataFlow Modeling for Embedded Systems
May 5th, 2008 Pisa, Italy
http://www.artist-embedded.org/artist/-DataFlow-Modeling-for-Embedded-.html
The topic of this workshop is the dataflow model/language CAL (CAL Actor Language), that recently has been developed within the Ptolemy II project at University of Berkeley. CAL is currently being used within the FP7 STREP project ACTORS and by Xilinx for modeling FPGA applications. CAL is also in the process of being adopted as the specification language for codecs within the MPEG-4 standard.

The aim of this workshop is to bring together the groups that are working with CAL and to discuss how CAL can be used within the context of embedded systems. The workshop is a one day event with a number of invited speakers, both from industry and academia. It is aimed at the novice CAL programmer, as well as the more seasoned dataflow researcher.

APRES'08
April 21st, 2008 St. Louis, MO, USA
http://www.artist-embedded.org/artist/-APRES-08-.html
Adaptive systems can respond to environmental changes including hardware/software defects, resource changes, and non-continual feature usage. As such, adaptive systems can extend the area of operations and improve efficiency in the use of system resources. However, adaptability also incurs overhead in terms of system complexity and resource requirements. The purpose of the workshop is to discuss new and on-going research that is centered on the idea of adaptability as first class citizen and consider the involved tradeoffs.

SLA++P'2008
April 5th, 2008 Budapest, Hungary - an ETAPS'08 event.
http://www.artist-embedded.org/artist/-SLA-P-2008-.html
Model-driven High-level Programming of Embedded Systems, SLA++P'2008

ARTIST2 Timing Analysis activity meeting
March 13th, 2008 Munich, Germany
http://www.artist-embedded.org/artist/-ARTIST2-Timing-Analysis-activity-.html
Timing Analysis activity meeting within the Compilers and Timing Analysis cluster of ARTIST2 (in conjunction with the DATE'08 conference)

ATESST Open Workshop
March 3rd, 2008 Brussels, Belgium
http://www.artist-embedded.org/artist/-ATESST-Open-Workshop-.html
Model based development of embedded systems: the EAST-ADL approach for automotive applications - An ATESST project Event.

Synchron 2007
November 26-30, 2007 Bamberg, Germany
http://www.artist-embedded.org/artist/-Synchron-2007-.html
This workshop is devoted to all aspects of synchronous programming: languages, compiling techniques, formal methods, programming environments, execution platforms, semantics issues, code generation.

ARTIST2 meeting on Integrated Modular Avionics
November 12-13, 2007 Roma, Italy
http://www.artist-embedded.org/artist/Integrated-Modular-Avionics.html
Integrated Modular Avionics (IMA) has set the principles of standardized components and interfaces of hardware and software in aircraft, applied for the first time in the development of the Airbus A380.

WESE'07: WS on Embedded Systems Education
October 4-5, 2007 Salzburg, Austria (within ES Week)
http://www.artist-embedded.org/artist/WESE-07.html
This third workshop on the subject aims to bring researchers, educators, and industrial representatives together to assess needs and share design, research, and experiences in embedded systems education.

Foundations of Component-based Design
September 30th, 2007 Salzburg, Austria - within EmSoft / ES Week
http://www.artist-embedded.org/artist/Foundations-of-Component-based.html
Discuss recent results on component-based design with emphasis on design frameworks for real-time systems encompassing heterogeneous composition and models of computation.

Between Control and Software (in honor of Paul Caspi)
September 28th, 2007 VERIMAG - Grenoble, France
This workshop, synchronized with the retirement of Paul Caspi in autumn 2007, brought together experts in the field and collaborators of Paul at different periods for a series of lectures.
http://www.artist-embedded.org/artist/Between-Control-and-Software.html

4.2 Partially Organized and/or Funded by Artist2 in Year4

In Year 4, Artist2 has partially organized and/or funded the following workshops.

UML&AADL'2008
April 2nd, 2008 Belfast, Northern Ireland
http://www.artist-embedded.org/artist/-UML-AADL-2008-.html

All aspects of the representation, analysis, and implementation of Distributed, Real-time and Embedded systems (DRE) system behaviour and/or architecture models.

5. Keynotes, Tutorials provided to the Embedded Systems Community

Artist2 partners have a very deep impact on the global embedded systems community, as is attested in the following direct contributions.

5.1 Real-Time Components

ARTIST Summer School on embedded systems design
Autrans, France Sep. 8-12, 2008
This is the fourth such summer school organised by Artist in Europe, and it is meant to be exceptional in terms of both breadth of coverage and invited speakers. The topics covered include Modeling and Validation, Compilers and Timing Analysis, Adaptive Real Time Systems, Control for Embedded Systems, Execution Platforms and MPSoC. A balance is seeked between foundational aspects and applications. Speakers include recognized leading researchers and engineers.

http://www.artist-embedded.org/artist/ ARTIST2-Summer-School-2008.html

Workshop: EAST-ADL, AADL, MARTE, Autosar harmonization workshop
Paris -- Oct. 25, 2007

The workshop provided useful information exchange between the standardization initiatives and ***ATESST***. Approximately 25 participants from the automotive industry (apart from ATESST partners, VW, Audi and Continental attended), CMU/SEI and research universities/institutes were represented. Also invited were representatives from the recently started TIMMO project. It was agreed to maintain contacts, and to organize follow up meetings. Identified topics of common interest include Timing, Error modeling and Methodology. A common email list will be set up.

Workshop: FMCO 2007, 6th Int. Symposium on Formal methods for Components and Objects
Amsterdam – November 7-10, 2007

The objective of this symposium is to bring together researchers and practioners in the areas of software engineering and formal methods to discuss the concepts of reusability and modifiability in component-based and object-oriented software systems. VERIMAG is a co-organiser of this event. For 2007, we organised a special issue of this symposium bringing together groups of a set of related EU projects and NoEs; Artist is one of those groups.
http://fmco.liacs.nl/fmco07.html

In 2008, the idea experimented in 2007 has been taken up for a different selection of IST projects and by a fresh set of organisers. FMCO 2008 will take place in November in Nice.

Workshop: Model based development of automotive embedded systems - The EAST-ADL approach
Brussels -- March 3rd, 2008

At the workshop, the results from the ***ATESST*** research project were presented for the attending representatives (approx. 30 persons) from industry, research, the European commission and interest organizations (EUCAR). The results, challenges and future prospects for the project results were discussed.

Workshop : SafeCert 2008 International Workshop on the Certification of Safety-Critical Software Controlled Systems
ETAPS 2008
Budapest, Hungary – 29 March, 2008

In many domains like transportation, power generation, medical technology, manufacturing and space exploration, statutory obligations traditionally require a formalized certification for the development of high assurance products. Formal methods are part of the standard recommendations, in particular for the higher safety integrity levels. However, experience shows that certifiable development of high-assurance software needs a lot more than pure application of formal techniques and tools that are founded on a formal semantics and support in parts automated code generation, formal analysis, verification or error detection. The major question to be addressed in the workshop is how to embed formal methods and tools in a seamless design process which covers several development phases and which includes an efficient construction of a safety case for the product.
http://safecert08.offis.de/

Workshop: UML&AADL
Belfast -- April 2nd, 2008

This ARTIST workshop is held in conjunction with the 13th IEEE International Conference on Engineering Complex Computer Systems, ICECCS 2008. It gathered researchers and practitioners interested in all aspects of the representation, analysis, and implementation of DRE system behaviour and/or architecture models. http://www.artist-embedded.org/artist/-UML-AADL-2008-.html

Workshop: 1st International Workshop on Model Based Architecting and Construction of Embedded Systems

Toulouse -- September 29th, 2008

This ARTIST workshop is held in conjunction with MODELS 2008 as a follow-up workshop of the SVERTS and MARTE workshops organised in previous years, the objective of this workshop is to bring together researchers and practitioners interested in model-based software engineering for real-time embedded systems. We are seeking contributions relating to this subject at different levels, from modelling languages and semantics to concrete application experiments, from model analysis techniques to model-based implementation and deployment. Given the criticality of the application domain, we particularly focus on model-based approaches yielding efficient and provably correct designs. Concerning models and languages, we welcome contributions presenting novel modelling approaches as well as contributions evaluating existing ones. The organisers of this workshop are partners from the ASSERT and SPICES project; the ARTIST partners are CEA and Verimag. http://www.artist-embedded.org/artist/ACES-MB-08.html

Workshop: 1st IEEE International workshop UML and Formal Methods

Kitakyushu-City, Japan -- October 27th, 2008

Hold in conjunction with the 10th International Conference on Formal Engineering Methods, ICFEM 2008. For more than a decade now, the two communities of UML and formal methods have been working together to produce a simultaneously practical (via UML) and rigorous (via formal methods) approach to software engineering. The fact that the UML semantics is too informal has led many researchers to formalize it with different existing formal languages. The main objective of this workshop is to encourage new initiatives of building bridges between informal, semi-formal and formal notations.

http://www.artist-embedded.org/artist/UML-FM-08.html

Tutorial: UML Tutorial: MARTE
Forum on specification & Design Languages (FDL'07)
Barcelona, Spain - September 20, 2007

http://www.ecsi-association.org/ecsi/fdl/fdl07/programme.htm

Tutorial: MARTE: A New Standard for Modeling and Analysis of Real-Time and Embedded Systems UML Tutorial: MARTE
19th Euromicro Conference on Real-Time Systems (ECRTS 07)
Pisa, Italy - July 3, 2007

http://feanor.sssup.it/ecrts07/tutorial.shtml

Lecture: UML for the design of Real-Time Embedded Systems
ARTIST2 Winter School 2007 – MOTIVES (MOdelling, TestIng, and Verification for Embedded Systems)
Pisa, Italy - July 3, 2007
http://feanor.sssup.it/ecrts07/tutorial.shtml

Lecture: Towards Automated Test Generation for Timed Systems
TAROT Summer School 2008
Pisa, Italy - July 3, 2007

http://feanor.sssup.it/ecrts07/tutorial.shtml

Workshop : UML&AADL'2008
13th IEEE International Conference on Engineering of Complex Computer Systems
Belfast, Northern Ireland – April 2nd, 2008
New real-time systems have increasingly complex architectures because of the intricacy of the multiple interdependent features they have to manage. They must meet new requirements of reusability, interoperability, flexibility and portability. These new dimensions favour the use of an architecture description language that offers a global vision of the system, and which is particularly suitable for handling real-time characteristics. Due to the even more increased complexity of distributed, real-time and embedded systems (DRE), the need for a model-driven approach is more obvious in this domain than in monolithic RT systems. The purpose of this workshop is to provide an opportunity to gather researchers and industrial practitioners to survey existing efforts related to behaviour modelling and model-based analysis of DRE systems. This workshop seeked contribution from researchers and practitioners interested in all aspects of the representation, analysis, and implementation of DRE system behaviour and/or architecture models.
http://www.artist-embedded.org/artist/Topics,1199.html

Workshop : ACES^{MB} 2008, 1st International Workshop on Model Based Architecting and Construction of Embedded SystemsUML&AADL'2008
ACM/IEEE 11th International Conference on Model Driven Engineering Languages and Systems
Toulouse, France – September 29th, 2008
New real-time systems have increasingly complex architectures because of the intricacy of the multiple interdependent features they have to manage. They must meet new requirements of reusability, interoperability, flexibility and portability. These new dimensions favour the use of an architecture description language that offers a global vision of the system, and which is particularly suitable for handling real-time characteristics. Due to the even more increased complexity of distributed, real-time and embedded systems (DRE), the need for a model-driven approach is more obvious in this domain than in monolithic RT systems. The purpose of this workshop is to provide an opportunity to gather researchers and industrial practitioners to survey existing efforts related to behaviour modelling and model-based analysis of DRE systems. This workshop seeked contribution from researchers and practitioners interested in all aspects of the representation, analysis, and implementation of DRE system behaviour and/or architecture models.
http://www.artist-embedded.org/artist/ACES-MB-08.html

Workshop : ATESST Open Workshop 2008
Brussels March 2008
A dissemination activity where the results of the ATESST project was presented to an invited audience from the automotive industry and the ARTIST2 NoE.
www.attest.org

Workshop: EAST-ADL, AADL, MARTE, Autosar harmonization workshop
Paris -- Oct. 25, 2007
The workshop provided useful information exchange between the standardization initiatives and ATESST. Approximately 25 participants from the automotive industry (apart from ATESST partners, VW, Audi and Continental attended), CMU/SEI and research universities/institutes were represented. Also invited were representatives from the recently started TIMMO project. It was agreed to maintain contacts, and to organize follow up meetings. Identified topics of common interest include Timing, Error modeling and Methodology. A common email list will be set up.

Keynote : Adding SPEEDS to AUTOSAR.
Werner Damm, OFFIS - DATE 08, Automotive Session, Munich, Germany, March 12, 2008.
The invited talk discussed how AUTOSAR based design processes can be enriched with the SPEEDS enabled system leven analysis methods.
http://www.date-conference.com/

Keynote: Grand Challenges for Real-Time Systems
Thomas A. Henzinger - 20th Euromicro Conference on Real-Time Systems (ECRTS), Prague, Czech Republic, July 2008.
We summarized some current trends in embedded systems design and pointed out some of their characteristics, such as the chasm between analytical and computational models, and the gap between safety-critical and best-effort engineering practices. We called for a coherent scientific foundation for embedded systems design, and we discussed a few key demands on such a foundation: to provide support for building predictable and robust systems, to ncompass several manifestations of heterogeneity, and to achieve constructivity and compositionality in design. This talk was based on joint work with Joseph Sifakis.

Keynote:
Joseph Sifakis - 45th Design automation Conference, Anaheim, June 2008
http://www.dac.com/45th/PDFs/45thAdvPrgPoster.pdf

Keynote: The Quest for Correctness -- Beyond Verification
Joseph Sifakis - CAV 2008, Princeton, July 2008, http://www.princeton.edu/cav2008/

***Keynote:* "Embedded Systems Challenges and Research Directions"**
Joseph Sifakis - Onassis Foundation, The 2008 Lectures in Computer Science:Embedded Systems: Theory and Applications, July 2008, Heraklion Greece
http://www.forth.gr/onassis/lectures/2008-07-21/programme.html

Turing Lecture:
Joseph Sifakis - Embedded Systems Week, Atlanta, 20 October 2008
http://www.esweek.org/

Invited Lecture: Challenges in Embedded Systems Design: Predictability and Robustness
Thomas A. Henzinger - Royal Society Meeting: From Computers to Ubiquitous Computing, London, United Kingdom, March 2008.
We discuss two main challenges in embedded systems design: the challenge to build predictable systems, and the challenge to build robust systems. We suggest how predictability can be formalized as a form of determinism, and robustness, as a form of continuity.

Workshop: ARTIST International Workshop on IMA
Rome - November 12-13
On November 12-13, 2007, an ARTIST2 meeting on IMA (Integrated Modular Avionics)[1] was co-organized by Albert Benveniste (INRIA), Paul Caspi (Verimag), in close cooperation with John Rushby (SRI), and hosted by Alberto Ferrari (PARADES) in Rome, Italy. The workshop has gathered participants from aeronautics industry, including manufacturers (Airbus, Boeing, Dassault-Aviation), system suppliers (Honeywell, Wind River), service companies (WW Technology group), labs (SRI, SAE AADL Committee), and academics (TU Vienna, Verimag). Detailed minutes are available from ARTIST2 Web site[2]. Among the conclusions of this workshop we can briefly report some of the recommendations for research directions: How to mitigate the complexity of processors and architectures? Look at architectures that are going to mass market and look at how to accommodate them. We should develop concepts of platforms that allow getting desirable architecture on top of less desirable ones. We should develop research facilitating the reuse of partial certifications.

Workshop: Euromicro SEAA (Software Engineering and Advanced Applications), Component-Based Software Engineering (CBSE) Track
Parma, Italy, September 3-5, 2008
The goal of the CBSE track at Euromicro SEAA is to point out the overall challenges and problems of the component-based, or service-oriented, approach, and to show the new ideas, solutions and practices. The topics cover practice and research to improve the theories, technologies, and processes in component-based and service-oriented software development. Ivica Crnkovic, MdH, is co-chairing the workshop with Kung-Kui Lai.

PROGRESS Workshop on Component Models for Embedded Systems (COMES'08)
Sigtuna, Sweden, June 17th - 18th, 2008
The aim of the workshop was to i) present and discuss the current research and practical results in development of embedded systems using component-based development approaches ii) Discuss and point out the challenges and possible solution directions in applying the component-based approach to achieve predictability of component-based embedded software systems. The workshop was setup as a set of sessions in which each session focussed on particular challenges. Each session started with some introductory presentations and continued with discussions, hopefully leading to some conclusions. Orgranisers: HansHansson, Thomas Nolte, Ivica Crnkovic, http://www.mrtc.mdh.se/progress/COMES/

Summer school MOVEP 2008: Summer school on modeling and verifying parallel processes
Orléans, France – June 23-27, 2008
The purpose of MOVEP is to bring together researchers, students and people from industry working in the fields of control and verification of concurrent and reactive systems. The school seeks to offer a broad spectrum of current research in this area of theoretical and applied computer science. The topics covered by MOVEP include model checking, controller synthesis, software verification, temporal logics, real-time and hybrid systems, stochastic systems, security, etc. The program of the School consists of six 2h30 tutorials and five 1h30 talks.

Workshop SLA++P 2008: Model-driven High-level Programming of Embedded Systems European Joint Conference on Theory and Practice of Software ETAPS 2008
Budapest, Hungary – April 5th, 2008

[1] http://www.artist-embedded.org/artist/-ARTIST2-meeting-on-Integrated-.html
[2] http://www.artist-embedded.org/docs/Events/2007/IMA/Artist2_IMA_Minutes.pdf

SLA++P is a workshop dedicated to synchronous languages and the model-driven high-level programming of reactive and embedded systems. Firmly grounded in clean mathematical semantics, synchronous languages are receiving increasing attention in industry ever since they emerged in the 80s. Lustre, Esterel, Signal are now widely and successfully used to program real-time and safety critical applications, from nuclear power plant management layer to Airbus air flight control systems. At the same time, model-based programming is making its way in other fields of software engineering, too, often involving cycle-based synchronous paradigms. The purpose of the SLA++P workshop is to bring together researchers and practitioners who work in the field of languages and tools for the model-driven development of embedded applications both in hardware and software. The workshop is not limited to synchronous approaches but open to other engineering design approaches with strong semantical foundations providing a way to go from a high-level description to provable executable code.

http://www.artist-embedded.org/artist/SLA-P-2008,1231.html

Workshop : SafeCert 2008 International Workshop on the Certification of Safety-Critical Software Controlled Systems
ETAPS 2008
Budapest, Hungary –29 March, 2008, organized by TU Braunschweig and OFFIS

In many domains like transportation, power generation, medical technology, manufacturing and space exploration, statutory obligations traditionally require a formalized certification for the development of high assurance products. Formal methods are part of the standard recommendations, in particular for the higher safety integrity levels. However, experience shows that certifiable development of high-assurance software needs a lot more than pure application of formal techniques and tools that are founded on a formal semantics and support in parts automated code generation, formal analysis, verification or error detection. The major question to be addressed in the workshop is how to embed formal methods and tools in a seamless design process which covers several development phases and which includes an efficient construction of a safety case for the product.
http://safecert08.offis.de/

Tutorial: Contract-Based System Design - The SPEEDS Approach -- INCOSE 2008
Utrecht, The Netherlands – June 16, 2008

The aim of this half day tutorial was to disseminate the results of the SPEEDS project towards the community of the potential users of the developed technology. The tutorial focused on the contracts based development methodology being worked-out within the project. It aimed specifically at iterative development as opposed to the traditional waterfall requirement flow down. At the centre of the methodology is the definition of a rich component model which allows the capture of functional and non functional system properties in the form of contracts.
http://www.incose.org/symp2008/

5.2 Adaptive Real-Time

Keynote talks:

1. "Scheduling and Resource Management"
   Given by Giorgio Buttazzo (Scuola Superiore Sant'Anna, Pisa, Italy)
   Autrans, France – Septembe 9, 2008.

Workshops:

1. WCET 2008: Worst Case Execution Time Analysis
   Prague, July 1, 2008
   URL: http://www.artist-embedded.org/artist/WCET-08.html

2. RTN 2008: Real-Time Networks
   Prague, July 1, 2008
   URL: http://www.hurray.isep.ipp.pt/rtn08/index.php

3. OSPERT 2008: Worst-Case Execution Time Analysis
   Prague, July 1, 2008
   URL: http://www.cs.unc.edu/~anderson/meetings/ospert08/OSPERT.html

Courses:

1. P. Gai (Evidence), G. Buttazzo and M. Marinoni (Scuola Superiore Sant'Anna, Pisa). Course on "Real-Time Kernels for Microcontrollers: Theory and Practice", Pisa, Italy, June 23-25, 2008.
   URL: http://www.evidence.eu.com/content/view/271/275/

2. M. Velasco (University of Catalonia, Spain). Course on "Real-Time Control Systems", Pisa, Italy, April 2-17, 2008.

Competitions:

1. L. Almeida, N. Lau, P. Pedreiras and A. Pereira. CyberMouse@RTSS2007, Phoenix, USA, Dec. 2007. Students design competition within the scope of RTSS 2007. Similar to a satellite workshop but targetting students and where students have to develop the control software for a small robot and run it against the other teams. http://www.ieeta.pt/~lau/web_ciberRTSS07/

Contribution to Standards:

POSIX

The University of Cantabria (UC) has continued participation in the POSIX standard. There is currently a new revision of the standard being produced with technical corrigenda, and the UC participates in the debate and ballot process. Initial steps have been taken in the Real-Time System Services Working Group to start a revision of the POSIX.13 standard that defines the real-time profiles. The UC is also participating in the revision of the POSIX-Ada bindings, which is a project that is just starting.

OMG–MARTE

In this period we continue working in the technical activities of the OMG, attending the Technical Meeting in San Diego from 26 to 30 March 2007, and sending a preliminary submission in response to the UML Profile for Modeling and Analysis of Real-Time and Embedded systems (MARTE) request for proposals. The submission was presented to the RTESS (Real-Time Embedded and Specialized Systems) Platform Task Force and was very well received. The standard has now been approved.

UC will continue to work in the Finalization Task Force of the UML Profile for Modeling and Analysis of Real-Time and Embedded systems (MARTE), in order to solve the issues that may be raised by the industrial community about MARTE, and ensure its applicability in the modeling of platforms that can deal with flexible scheduling technologies.

Workshop Presentations

Workshop: RTN 2008: Real-Time Networks
Prague, Czech Republic, July 1, 2008, with ECRTS 08
Organizers: Anis Koubâa IPP-HURRAY Research Group, ISEP-IPP, (Portugal)
Objectives: RTN focuses on the current technological challenges of developing communication infrastructures that are real-time, reliable, pervasive and interoperable.
Topics: Distributed systems, communication protocols, wireless sensor networks, mobile ad-hoc networks.
Results: The workshop attracted 25 participants from different European countries and technical papers have been published in proceedings.
URL http://www.hurray.isep.ipp.pt/rtn08/index.php

Workshop: OSPERT 2008: Operating Systems Platforms for Embedded Real-Time Applications
Prague, Czech Republic, July 1, 2008, with ECRTS 08
Organizers: Jim Andersson, University of North Carolina, USA.
Objectives: This workshop is intended as a forum for researchers and practitioners of RTOS to discuss the recent advances in RTOS technology and the challenges that lie ahead.
Topics: Support for component based development; Scalability, from very small scale embedded systems to full-fledged OSes; Real-Time on Linux; Interaction with reconfigurable hardware; Support for embedded multi-processor architectures; Security and fault tolerance for embedded real-time systems; Power-aware operating systems..
Results: The workshop attracted 30 participants from different European countries and technical papers have been published in proceedings.
URL: http://www.cs.unc.edu/~anderson/meetings/ospert08/OSPERT.html

Workshop: Workshop ARTIST - NXP
Eindhoven, The Netherlands, Nov 15,16, 2008
Organizers: Liesbeth Steffens, NXP, Gerhard Fohler, TUKL.
Objectives: The workshop is intended to bring together researchers from ARTIST with engineers and researchers from NXP on application requirements for media processing and QoS management.
Topics: Application requirements for media processing and QoS management, specific questions/discussions, on actual engineering problems
Results: The workshop attracted 25 participants, copies of presentations and additional material have been made available to the participants within IPR limits.
URL: no public page due to IPR issuesl

Workshop: Workshop on Adaptive and Reconfigurable Embedded Systems APRES 2008 .
St. Louis, USA, 21st April 2008, satellite of the 14th IEEE Conference on Real-Time and Embedded Technology and Applications - RTAS 2008
Organizers: S. Fishmeister, L. Almeida, J. Proenza, I.
Objectives: Discuss new and on-going research that is centred on the idea of adaptability as first class citizen and consider the involved.
Topics: Capturing and modelling of flexible application and reconfiguration requirements, Tradeoff analysis and modelling, support and models for adaptability, Policies and algorithms for single and multi-resource reconfiguration.
Results: The workshop attracted 16 presentations and had a keynote on adaptivity in embedded systems. Technical papers have been published in proceedings.
URL: http://www.artist-embedded.org/artist/APRES08.html

Workshop: 1st International Workshop on Cyber-Physical Systems Challenges and Applications (CPS-CA'08)
Workshop Chair: Eduardo Tovar (Polytechnic Institute of Porto)
Santorini, Greece – 11/JUN/2008
This workshop was held in conjunction with the 4th IEEE International Conference on Distributed Computing in Sensor Systems (DCOSS'08). http://www.hurray.isep.ipp.pt/cps-ca08

Workshop: 7th International Workshop on Real Time Networks (RTN'08)
Workshop Chair: Anis Koubaa (Polytechnic Institute of Porto)
Prague, Czech Republic – 2/JUL/2008
This workshop was held in conjunction with the 20th Euromicro International Conference on Real-Time Systems (ECRTS'08). HomePage: http://www.hurray.isep.ipp.pt/rtn08/index.php

Seminar: Mobility Issues in Cyber-Physical Systems
Lecturer: Luis Almeida (U. Aveiro)
Stockholm, Sweden – 16/JUN/2008
Seminar given at the EU-US Workshop on Networked Information and Control Systems (http://www.access.ee.kth.se/EU-US08/)

Seminar: Networks for Embedded Control Systems
Lecturer: Luis Almeida (U. Aveiro)
Shanghai, China– 15/JUL/2008
Seminar given at the ARTIST2 Summer School 2008 in China (http://www.artist-embedded.org/artist/Artist2-Summer-School-in-China.html)

Keynote: Time for Cyber-Physical Systems
Lecturer: Alan Burns (University of York)
Santorini, Greece – 4/SEP/ 2008
Keynote talk at the International Workshop on Cyber-Physical Systems Challenges and Applications (CPS-CA'08). http://www.hurray.isep.ipp.pt/cps-ca08

Seminar: Challenges of Flexible Real-Time Communication
Lecturer: Luis Almeida (U. Aveiro)
Autrans, France – 8-12/SEP/2008
Seminar given at the ARTIST2 Summer School 2008 in Europe (http://www.artist-embedded.org/artist/ARTIST2-Summer-School-2008.html)

Seminar: Enabling ubiquitous computing and cyber-physical systems with wireless sensor/actuator networks: what is at stake?
Lecturer: Mário Alves (Polytechnic Institute of Porto)
L'Aquila, Italy – 4/SEP/2008
Seminar given in a doctoral school for PhD students in Computer Engineering (http://gii2008.dei.polimi.it)

Seminar: Guaranteeing QoS in large-scale distributed embedded systems using standard and COTS technologies: ongoing research at IPP-HURRAY
Lecturer: Mário Alves (Polytechnic Institute of Porto)
L'Aquila, Italy – 4/SEP/2008
Seminar given in a doctoral school for PhD students in Computer Engineering (http://gii2008.dei.polimi.it)

Seminar: Open-ZB: an open-source implementation of the IEEE 802.15.4/ZigBee protocol stack for TinyOS
Lecturer: André Cunha (Polytechnic Institute of Porto)
Pisa, Italy – 26/FEB/2008
Seminar given to a diverse audience in the SSSUP (http://retis.sssup.it/lab_events/openzb1).

Papyrus Tool Suite: A Schedulability-Aware Execution Framework for MARTE-based Models, Tutorial at the MARTE Information Day, OMG Meeting, June 2008, Ottawa.

Presentation on Component-Based Approaches at COMES'08 ARTIST workshop (without publication): http://www.artist-embedded.org/artist/-COMES-08-.html

Michael González Harbour and Mario Aldea Rivas. "The MaRTE OS run-time as a support platform for real-time programming in Ada 2005". Invited talk. Ada UK Conference, Manchester, September, 2007.

5.3 Compilers and Timing Analysis

Workshop : 8th Int'l Workshop on Worst-Case Execution Time Analysis (WCET'08)
Prague, Czech Republic – July 1st, 2008

The 8th International Workshop on Worst-Case Execution Time Analysis (WCET 2008) was held as a satellite event to the 20th Euromicro Conference on Real-Time Systems (ECRTS 2008) in July 1st 2008 in Prague. The goal of the workshop is to bring together people from academia, tool vendors and users in industry that are interested in all aspects of timing analysis for real-time systems. The workshop fosters a highly interactive format with ample time for in-depth discussions. It provides a relaxed forum to present and discuss new ideas, new research directions, and to review current trends in this area. The presentations are kept short to leave plenty of time for interaction of attendees.

The WCET 2008 event of this workshop has gained on popularity, it had 45 registered participants. This tendency may be interpreted that the real-time community becomes increasingly aware of the importance of WCET analysis. The workshop program included four regular sessions with 13 talks on WCET analysis. Additionally an invited talk on timing analysis at system level had been given by Prof. Rolf Ernst and the current results of the WCET Tool Challenge 2008 had been presented by its organizer, Niklas Holsti.

http://www.artist-embedded.org/artist/WCET-08.html

Tutorial Session: Derivation of Tight Execution-Time Bounds
11th IEEE International Symposium on Object/Component/Service-Oriented Real-Time Distributed Computing
Orlando, Florida, USA – May 5-7, 2008

This tutorial session was organized by Peter Puschner (TU Vienna) and consisted of three presentations, given by members of the ARTIST2 consortium, that presented the very different aspects of and views on the topic. The first presentation, by Raimund Kirner (TU Vienna), described the state of the art and open problems in WCET research. The second talk, by Christian Ferdinand (AbsInt), presented the industrial view and findings from a tool provider's perspective. In the final presentation, Jan Gustafsson (Mälardalen University) reported on the 2006 WCET challenge and its results. The presentations were followed by numerous questions and intensive discussions that underlined the relevance of the topic and the interest that the audience in the problem area and the diverse solution strategies. The topics covered ranged from different analysis techniques (static analysis versus measurement, complexity problems of WCET analysis, alternative architectures to that help to make WCET analysis easier, etc.).

Workshop : Software & Compilers for Embedded Systems (SCOPES) 2008
Munich, Germany – March 13-14, 2008

The influence of embedded systems is constantly growing. Increasingly powerful and versatile devices are developed and put on the market at a fast pace. The number of features is increasing, and so are the constraints on the systems concerning size, performance, energy dissipation and timing predictability. Since most systems today use a processor to execute an application program rather than using dedicated hardware, the requirements can not be fulfilled by hardware architects alone: Hardware and software have to work together to meet the tight constraints put on modern devices.

One of the key characteristics of embedded software is that it heavily depends on the underlying hardware. The reason of the dependency is that embedded software needs to be designed in an application specific way. To reduce the system design cost, e.g. code size, energy consumption etc., embedded software needs to be optimized exploiting the characteristics of the underlying hardware.

SCOPES focuses on the software generation process for modern embedded systems. Topics of interest include all aspects of the compilation process, starting with suitable modeling and specification techniques and programming languages for embedded systems. The emphasis of the workshop lies on code generation techniques for embedded processors. The exploitation of specialized instruction set characteristics is as important as the development of new optimizations for embedded application domains. Cost criteria for the entire code generation and optimization process include runtime, timing predictability, energy dissipation, code size and others. Since today's embedded devices frequently consist of a multi-processor system-on-chip, the scope of this workshop is not limited to single-processor systems but particularly covers compilation techniques for MPSoC architectures.

In addition, this workshop intends to put a spotlight on the interactions between compilers and other components in the embedded system design process. This includes compiler support for e.g. architecture exploration during HW/SW codesign or interactions between operating systems and compilation techniques. Finally, techniques for compiler aided profiling, measurement, debugging and validation of embedded software are also covered by this workshop, because stability of embedded software is mandatory.

SCOPES 2008 is the 11th workshop in a series of workshops initially called "International Workshop on Code Generation for Embedded Processors". The name SCOPES has been used since the 4th workshop. The scope of the workshop remains software for embedded systems with emphasis on code generation (compilers) for embedded processors.

SCOPES 2008 was organized by Heiko Falk from TU Dortmund and was held as DATE Friday Workshop.

http://www.scopesconf.org/scopes-08

Workshop : Dagstuhl Seminar 08161 "Scalable Program Analysis"
Schloss Dagstuhl*, Germany – April, 2008*

Organizers: Florian Martin (AbsInt), Hanne Riis Nielson (Technical University of Denmark), Claudio Riva (NOKIA Research Center - Helsinki), Markus Schordan (TU Vienna).

The goal of the seminar was to bring together researchers from academia and industry to discuss the strengths and weaknesses of state-of-the-art program analysis technology for industrial-sized software. To achieve that goal the seminar gathered 38 participants from 9 companies and 23 academic/research institutions.

The seminar showed how broad the field of program analysis has grown over the years. Traditionally used in optimizing compilers, program analysis has turned into a major discipline with techniques and commercial tools supporting understanding, maintaining, and engineering of software. It often turned out that an in-depth discussion of scalability requires further investigations. The scalability of analysis techniques is a major issue as the size of

software systems is rapidly growing and the automatic analysis of those systems is becoming yet more important in future. Many questions were raised about scalability - to address the scale of today's systems, analyses will have to be run as parallel programs in future, posing themselves as problem of being scalable on multiple cores, but also whether it can be applied to multiple parts of a system which may differ in structural properties of the code or even in used programming languages.

Raising the awareness about the many faces of scalability is the major achievement of the seminar. As the seminar progressed, increasingly more questions about scalability were raised, mostly asking for more extensive evaluations of the methods & tools in future. Discussions about the need and development of specific benchmarks for scalability were started and agreed to be continued past the seminar by different groups of the seminar. Carefully systematically designed sets of test cases, accompanied by test cases from industry, were considered a good setting for evaluating scalability.

http://www.dagstuhl.de/de/programm/kalender/semhp/?semnr=08161

Workshop : CoSy Community Gathering 2008
Amsterdam, The Netherlands, September 2008

The CoSy Community Gathering 2008 has been held at the Amsterdam Public Library. Researchers from RWTH Aachen and TU Berlin attended the event and reported on their CoSy related work.

http://www.opencosy.org/

Full Day tutorial: Peter Marwedel, Embedded Systems in a Nutshell, Spring School on Knowledge Discovery in Ubiquitous Systems,
Porto, Portugal, March 2, 2008

This tutorial provided a brief overview over specification techniques, hardware, scheduling and optimization of embedded systems for a community without any pre-existing knowledge on embedded systems.

http://www.kdubiq.org

Invited Course : Peter Marwedel, Heiko Falk, Embedded Systems with Emphasis On the Exploitation of the Memory Hierarchy
Advanced Institute of Information Technology
Seoul, Korea – August 11-15, 2008

The goal of this course is to provide an overview over key areas in embedded system design which should be taught at Universities. After attending the course, the attendees should be able to compare different approaches to embedded system design education and their advantages and limitations. The attendees will also become familiar with the contents of a course on embedded system design which aims targets second or third year students. The course should enable attendees to design the structure of embedded system education at their universities. In the last third of the course, attendees will be introduced to research topics regarding embedded system optimization. In particular, this last third will address the so-called memory wall problem (the problem resulting from the small performance improvements of memories). This problem is frequently seen as the key problem for further performance enhancements of future systems. This material would be appropriate for an advanced course in embedded system design.

Peter Marwedel and Heiko Falk from TU Dortmund lectured this one-week course for Korean professors (CS and EE) after an invitation by the Korean Advanced Institute of Information Technology.

http://ttt.aiit.or.kr

Tutorial: Peter Marwedel: Memory architecture aware compilation for Embedded Systems (5 lectures of 2 hrs each)
Artist South American Summer School
Florianopolis, Brazil, Aug. 25.-29., 2008

The tutorial focused on compilation techniques exploiting descriptions of the memory architecture.

Lecture : Peter Marwedel, Heiko Falk, Memory-architecture aware compilation
The ARTIST2 Summer School 2008 in Europe
Autrans, France – September 8-12, 2008

The memory system is increasingly turning into a bottleneck in the design of embedded systems. The speed improvements of memory systems are lower than the speed improvements of processors, eventually leading to embedded systems whose performance is limited by the memory. This problem is known as the “memory wall” problem. Furthermore, memory systems may consume the largest share of the system’s energy budget and may be the source of unpredictable timing behavior.

In their lecture during the ARTIST2 Summer School in Europe, Peter Marwedel and Heiko Falk from TU Dortmund present optimization techniques leading to high performance, low energy consumption and tight worst-case execution times by making efficient use of scratchpad memories and processor registers.

http://www.artist-embedded.org/artist/ARTIST2-Summer-School-2008.html

5.4 Execution Platforms

Tutorial : Formal methods in system and MpSoC performance analysis and optimization (R. Ernst, S. Charkaborty, Hans Sarnowsky, Marco Bekooj, M Jersak)

DATE 2008
Munich, Germany – March 10, 2008

The tutorial provided an introduction to formal platform performance analysis covering the main communication and resource modelling techniques and their application to embedded systems and MpSoC. It included industrial applications and experiences, use cases from automotive design, which demonstrated how to acquire the necessary model data, an overview on predictable MpSoC platform sharing using service shaping concepts, as well as an introduction on how to combine state-based and functional models for MpSoC in a single analysis to improve modelling precision.

Mini-Keynote : Load level modelling (R. Ernst)
MpSoC Conference

St. Gerlach, The Netherlands, June 23-27, 2008.

Current ESL methods and tools for verification focus on run-time efficient simulation. Simulation requires executable code and is, therefore, not applicable to early design phases where the software code is not yet available or is still subject to changes. In such cases, load models that are known from schedulability and network analysis can be used. Load models are compatible to the activation rules of application models, such as event driven data flow graphs or time driven Simulink models. The main limitation of classical schedulability analysis is its focus on worst-case design. The presentation will outline an extension to the classical load model that captures task execution time and communication variations. That model can raise platform design to a next level of abstraction, thereby supporting a design process where application development is separated from software implementation. Using this model, analysis can also highlight sensitivity to software and application modifications.
http://www.mpsoc-forum.org/

Lecture: A Theory of Duration Calculus with Applications
PhD school on Domain Modeling and Duration Calculus
Shanghai, China - September, 2007

Michael R. Hansen from DTU has given a lecture with the title “A Theory of Duration Calculus with Applications” at the PhD school in Shanghai, China.

Summerschool: Advanced Digital Systems Design
Lausanne, Switzerland – 10-14 September, 2007

ETH Zurich has given part of a summer school/advanced course on ADVANCED DIGITAL SYSTEMS DESIGN. The participants are from industry and university. This way, results from the integrated view of embedded system design will be brought to a much larger community.

Workshop: Models of Computation and Communication
Eindhoven, The Netherlands – 3-4th July, 2008

As a follow-up of the Models of Computation and Communication (MoCC) at the ETH last year, the TU/e organized the MoCC2008 workhop. It brought together scientists from various areas, i.e. formal methods, hardware design and software architecture,
http://www.artist-embedded.org/artist/MoCC-2008.html

Workshop: CASTENESS
15.-18th of January 2008

ETH Zurich has been organizing and participating in the CASTENESS Workshop, see www.casteness.org. The workhop put together the expertise of various EU projects such as ARTIST2, SHAPES, AETHER. In addition, ETH Zurich has been given a tutorial on issues that have been investigated in the ARTIST2 context: Analytic Performance Estimation, Mapping Algorithms to Architectures, Scalable SW Construction. The workshop has been sponsored by ARTIST2.

Tutorial: EMSOFT
30th of September 2007

Lothar Thiele from ETHZ has been given a tutorial at EMSOFT, the major conference in the area of embedded software. It covered methods for performance analysis of distributed embedded systems and presented outcomes of the ARTIST2 project.

Invited talk:
17th International Federation of Automatic Control (IFAC) World Congress
Seoul, Korea – 6-11 July, 2008

Jan Madsen from DTU gave an invited talk on “System-level Verification of Multi-core Embedded Systems using Timed-Automata”. The talk presented the MoVES modelling framework, which allows for cross-layer modeling and verification, covering the application layer, middelware layer (RTOS), and hardware layer. The modelling framework allows the designer to verify the impact of execution platform and application mapping on the schedulability (meeting hard real-time requirements), power consumption and memory utilization, while taking communication into account. The modeling framework is implemented using timed-automata in UPPAAL.

Conference: Industrial Embbed Systems
3rd International Symposium on Industrial Embedded Systems (SIES)
Montpellier, France – 11-13 June, 2008

Anders Tranberg-Hansen from DTU gave a talk on “A Service Based Estimation Method for MPSoC Performance Modelling”. The talk presented an abstract service based estimation method for MPSoC performance modeling, which allows fast, cycle accurate design space exploration of complex architectures including multi processor configurations at a very early stage in the design phase. To illustrate the method, a small MPSoC system, developed at Bang & Olufsen ICEpower was modelled and performance estimates were produced for various configurations of the systemimplementation.

Demo: Formal Verification of Design Properties of Hardware Architectures
DATE 2008
Munich, Germany – March 10, 2008

DTU has given a demo of their tool for formal verification of design properties of hardware architectures at the DATE University Booth. In a 2 hour slot, the tool was presented and discussed with academic and industrial peopole participating in the DATE conference.

PhD-course: Automated Formal Methods for Embedded Systems
Lyngby, Denmark – 16-24 June, 2008

DTU has organized the second ARTIST2 sponsored PhD course on “Advanced Topics in Embedded Systems”, that took place at IMM, DTU, Lyngby, Denmark, June 16-24, 2008. Lectures were given by ARTIST memebers from Oldenburg. The course was again a success and will be repeated in 2009.
http://www.artist-embedded.org/artist/Automated-Formal-Methods.html

Mini-keynote: Codesign
8th International Forum on Application-Specific Multi-Processor SoC (MPSoC)
St. Gerlach, The Netherlands, June 23-27, 2008.

Jan Madsen from DTU gave a talk on “*Adaptive Embedded Systems Challenges of Run-Time Resource Management”.* The mini-keynote addressed some of the challenges of run-time resource management in adaptive embedded systems. The challenges come from the often very complicated interplay between the application, the application mapping, and the underlying hardware architecture. With MPSoC, we have the technology to design and fabricate dynamically reconfigurable hardware platforms. However, such platforms will pose new challenges to tools and methods to efficiently explore these platforms at run-time.
http://www.mpsoc-forum.org/

Invited Lecture: Luca Benini - Optimization-centric embedded systems design: addressing the multi-core challenge ETHZ Computational Optimization mini-symposium, May 2008. The tutorial covered issues related to optimal, resource-aware allocation and scheduling for multi-core platforms

Tutorial: Lothar Thiele - Complex Embedded System Design. Lausanne, Sept. 10, 2007.

Tutorial: Lother Thiele - Analysis of Distributed Embedded Systems. CASTENESS WORKSHOP ROMA, Jan. 15-18, 2008.

Invited Talk: Lothar Thiele - Workshop Mapping Algorithms onto MPSOC. Germany, June 16-17. 2008.

Invited Talk: Lothar Thiele - MPSOC Conference. Aachen, Germany, June 23-27, 2008.

Summer School: Lothar Thiele - Embedded Systems, Florianopolis, Brasil, August 25-2, 2008.

Summer School: Lothar Thiele - Embedded Systems, Grenoble, France, Sept 8-12, 2008.

Invited talk: Petru Eles - Synthesis of Fault-Tolerant Embedded Systems DATE 2008 Conference, Munich, Germany - March 10, 2008 As part of the special day on Dependable Embedded Systems: With this occasion several results obtained in the ARTIST context have been made accessible to an international audience. They are related, in particular, to fault tolerance aspects of distributed real-time systems like those used in automotive applications.

Tutorial: Rainer Leupers, Peter Marwedel: Retargetable Compilation, (1 week course), ALARI, Feb. 11-15, 2008. This course is part of ALARI's master programmes for degrees in Embedded System Design (see www.alari.ch).

Tutorial: Peter Marwedel, Embedded Systems in a Nutshell (full day tutorial), Spring School on Knowledge Discovery in Ubiquitous Systems, March 2, 2008, Porto, www.kdubiq.org. This tutorial provided a brief overview over specification techniques, hardware, scheduling and optimization of embedded systems for a community without any pre-existing knowledge on embedded systems.

Workshop: Heiko Falk (Workshop Chair), Peter Marwedel (Workshop Publicity): SCOPES, March 13-14, 2008, Munich, www.scopesconf.org SCOPES is a specialized workshop on compilation and other software generation tools for embedded systems.

Tutorial: Peter Marwedel, Heiko Falk: Embedded Systems -with Emphasis on the Exploitation of the Memory Hierarchy- (Full week tutorial), Advanced Institute of Information Technology, Aug. 11-15, 2008, Seoul, ttt.aiit.or.kr/. The tutorial consisted of two parts: in the first part, an overview over specification techniques and techniques for mapping of applications to multiprocessor systems was provided. In the second part, the tutorial focused on compilation techniques exploiting descriptions of the memory architecture.

Tutorial: Peter Marwedel:, Memory architecture aware compilation for Embedded Systems (10 h tutorial), Artist South American Summer School, Aug. 25.-29., 2008, Florianopolis, Brazil, www.artist-embedded.org, The tutorial focused on compilation techniques exploiting descriptions of the memory architecture.

Invited talk: Peter Marwedel, Heiko Falk: Memory architecture aware compilation, Artist2 Summer School on Embedded Systems, Sept. 10, 2008, Autrans, www.artist-embedded.org. This was a 1 hour talk on the topic of the title.

Mini Keynote: Jan Madsen - Adaptive Embedded Systems Challenges of Run-Time Resource Management. 8th International Forum on Application-Specific Multi-Processor SoC, 23 – 27 June 2008, Château St. Gerlach http://www.chateauhotels.nl/ENG/index1.htm Valkenburg a.d. Geul, the Netherlands. This presentation addressed some of the challenges of run-time resource management in adaptive embedded systems. The challenges come from the often very complicated interplay between the application, the application mapping, and the underlying hardware architecture.

Keynote: Jan Madsen - On Line, Real Time Darwinism - Challenges of the Future. DIAG Conference 2008, September 4-5, Skjoldenæsholm, Jystrup, Denmark. This presentation gave an overview of the evolution of adaptive embedded systems platforms, with a focus on resource management such as performance, low power, and reliability.

Opening Keynote : Networks, multicore, and systems evolution - facing the timing beast (R. Ernst)
Emerging Technologies and Factory Automation Conference
Hamburg, Germany – September 16, 2008
Embedded systems rapidly grow in several dimensions. They grow in size, from local isolated networks with simple protocols to network hierarchies to large open heterogeneous networks with complex communication behaviour. They grow in performance, from simple microcontrollers to superscalar to multicore systems with many levels of memory hierarchy. And, they expand in the time dimension by moving from static system functions to open and evolutionary functions that change over time and require new design methods and autonomous system functions. All these development contribute to an ever increasing behavioural complexity with equally complex timing. Nevertheless, the fundamental requirements to reliability and performance predictability have stayed and even been enhanced. Embedded system technology has responded with new integration methods and software architectures supported by platform control methods using new service quality metrics, and with composable formal methods that scale with system size. The talk will give an overview on this exiting scientific field and will give practical examples
http://www.etfa2008.org/ETFA_2008/Keynote_Talks.html

Invited Talk : From WCET to system level analysis (R. Ernst)
Workshop on Worst Case Execution Time Analysis
Prague, Czech Republic – June 30, 2008
The goal of the workshop is to bring together people from academia, tool vendors and users in industry that are interested in all aspects of timing analysis for real-time systems. The workshop fosters a highly interactive format with ample time for in-depth discussions. It provides a relaxed forum to present and discuss new ideas, new research directions, and to review current trends in this area.
http://www.artist-embedded.org/artist/Program,1504.html

Invited Talk : ESL Design Education – How much software do we need? (R. Ernst)
European Workshop Microelectronic Education
Budapest, Hungary – May 29, 2008
This talk highlighted challenges for universities to address changing requirements for embedded system designers with an appropriate curriculum. In a growing number of embedded system designs, software development is no more employed as a hardware design companion, subject to an overall design process that starts with a unified system description. It rather comes as a discipline that creates its own layered architecture for a new system quality enabling flexibility, dynamic adaptation, resilience and evolution.
www.eda-publishing.org/ewme2008/htmls/pdfs/I6.pdf

Invited Talk as part of a special session of the DATE Automotive Day : Automotive system level performance analysis and optimization (R. Ernst)
DATE 2008
Munich, Germany – March 12, 2008

Tutorial : Formal methods in system and MpSoC performance analysis and optimization (R. Ernst, S. Charkaborty, Hans Sarnowsky, Marco Bekooj, M Jersak)

DATE 2008
Munich, Germany – March 10, 2008
The tutorial provided an introduction to formal platform performance analysis covering the main communication and resource modelling techniques and their application to embedded systems and MpSoC. It included industrial applications and experiences, use cases from automotive design which demonstrated how to acquire the necessary model data, an overview on predictable MpSoC platform sharing using service shaping concepts, as well as an introduction on how to combine state-based and functional models for MpSoC in a single analysis to improve modelling precision.

Mini-Keynote : Load level modelling (R. Ernst)
MpSoC Conference
St. Gerlach, The Netherlands, June 23-27, 2008.
Current ESL methods and tools for verification focus on run-time efficient simulation. Simulation requires executable code and is, therefore, not applicable to early design phases where the software code is not yet available or is still subject to changes. In such cases, load models that are known from schedulability and network analysis can be used. Load models are compatible to the activation rules of application models, such as event driven data flow graphs or time driven Simulink models. The main limitation of classical schedulability analysis is its focus on worst case design. The presentation will outline an extension to the classical load model that captures task execution time and communication variations. That model can raise platform design to a next level of abstraction, thereby supporting a design process where application development is separated from software implementation. Using this model, analysis can also highlight sensitivity to software and application modifications.
http://www.mpsoc-forum.org/

Panel : Unifying or overrated – System level design strategy.
DATE 2008, Executive Panel Session
Munich, Germany – March 10, 2008

Invited talk: Synthesis of Fault-Tolerant Embedded Systems (Petru Eles)
DATE 2008 Conference, as part of the special day on Dependable Embedded Systems:
Munich, Germany – March 10, 2008
With this occasion several results obtained in the ARTIST context have been made accessible to an international audience. They are related, in particular, to fault tolerance aspects of distributed real-time systems like those used in automotive applications.

Tutorial: Complex Embedded System Design (L. Thiele).
Lausanne, Sept. 10, 2007.

Tutorial: Analysis of Distributed Embedded Systems (L. Thiele).
CASTNESS WORKSHOP
Rome, Italy, Jan. 15-18, 2008.
http://www.castness.org/twiki/bin/view/CASTNESS/CastNess08

Invited Talk: Workshop Mapping Algorithms onto MPSOC (L. Thiele).
Germany, June 16-17. 2008.

Mini-Keynote : Closing the Loop: Exploration and Estimation (L. Thiele).
MpSoC Conference
St. Gerlach, The Netherlands, June 23-27, 2008.

The talk describes an environment to map applications to MPSoC platforms. The corresponding platform enables the specification, simulation, performance evaluation and mapping of distributed algorithms. Major characteristics are scalability and multi-resolution methods for validation and estimation that combine simulation-based and analytic approaches.
http://www.mpsoc-forum.org/

ARTIST2 South-American School for Embedded Systems 2008 (L. Thiele),
Florianopolis, Brasil, August 25-2, 2008.
After the successful First ARTIST2 South-American School for Embedded Systems in Buenos Aires, Argentina, this second edition in Florianopolis, Brazil, seeks to strengthen the cooperation between Europe and South America in the area of embedded systems, both at educational and research levels. For this purpose, the goal of the school is to provide state-of-the-art courses on embedded systems oriented towards advanced students and young researchers.
http://www.artist-embedded.org/artist/-ARTIST-2-South-American-School-.html

Artitst2 Summer School: Embedded Systems (L. Thiele),
Grenoble, France, Sept 8-12, 2008.
http://www.artist-embedded.org/artist/ARTIST2-Summer-School-2008.html

Tutorial : Ambient intelligence systems, from enabling technologies to applications – Luca Benini

Invited Tutorial – Università di Padova
Padova, Italy, 13/05/08
The purpose of the tutorial was to give an overview of power optimization techniques embedded networked sensors, with special emphasis on energy management techniques and on power management of hardware resources. Approximately 15 people were present, graduate students and faculty members.

5.5 Control for Embedded Systems

Invited lectures

By Martin Törngren:

- KnowIT-Architecture seminar, Stockholm, Sweden, Nov. 20-21, 2007. *Trends in Software architecting for embedded systems.*
- Dagstuhl seminar on Model-Based Engineering of Embedded Real-Time Systems, Nov. 2007. *Towards a framework and methodology for model based engineering of embedded real-time systems*.
- Second International Workshop on Foundations of Component-based Design, Sept. 30, 2007, in conjunction with the Emsoft conference, Salzburg. *Model and Component based development of embedded systems.*

By Karl-Erik Årzen and Pedro Albertos:

- ARTIST2 Summer School 2008 in Europe September, 12, 2008. *Implementation of control systems in resource-constrained embedded systems*

By Karl-Erik Årzen and Pedro Albertos:

- *ADAPTIVITY IN EMBEDDED SYSTEMS - WHY, WHAT AND HOW,* Workshop on Adaptive and Reconfigurable Embedded Systems, April 21st, 2008.

Workshops

See above in Section 2.4.2 describing workshops organized by, or in connection with, the Control for embedded systems platform activities..

Graduate courses

Graduate Course on Control for embedded systems. The annual Artist2 control for embedded systems course was held in Stockholm in May 2008. The course included overviews and hands-on work on tools (Torsche, TrueTime and traditional control and real-time systems tools) - *http://www.artist-embedded.org/artist/-Graduate-Course-on-Embedded-.html*

The control for embedded systems cluster organized a special workshop at the IFAC world congress, July 2008 in Soeul, Korea. The purpose was to present tools and platforms developed by the partners of the control for embedded systems cluster - *http://www.ifac2008.org/ttws/ws4.pdf*

ARTIST2 Summer School 2008 in Europe September, 12, 2008, with several speakers being invited and provided by the Control for embedded systems cluster, including Karl-Johan Åström, Tarek Abdelzaher, Steve Vestal, Karl-Erik Årzen and Pedro Albertos.

Workshop: Beyond Software and Control (in honour of Paul Caspi)

Location: Grenoble, Sep 28, 2007. Presentations of several of the members of the RT-Components cluster + from Årzén of the Control cluster.

Workshop: "Dataflow Modelling for Embedded Systems"

Location: Pisa, 5 May, 2008 Organized jointly by members of the ART cluster and the Control cluster. Co-organized with the ACTORS project.

Keynote: "Adaptivity in Embedded Systems - Why, What and How": By Karl-Erik Årzén
Conference name: Workshop on Adaptive and Reconfigurable Embedded Systems (APRES), St Louis, US, April 21, 2008

Workshop: "Embedded Control Systems: From Design to Implementation", in association with the IFAC World Congress, Seoul, Korea, 6 July, 2008

Summer School: Fourth Artist2 Graduate School on Embedded Control Systems. All cluster members
Location: KTH, May, 2008

Summer School Participation: Four lectures at the ARTIST2 Summer School in Autrans 8-12 September, 2008 were initiated and/or given by the cluster. The presentations were a keynote by Karl Johan Åström, Lund and three presentations by Karl-Erik Årzén and Pedro Albertos, Tarek Abdelzaher (UIUC), and Steve Vestal (Honeywell).

Keynote: P. Albertos (UPVLC) "New Control Challenges in the Design of Embedded Control Systems." **Location:** Plenary session in IEEE Multi-conference on Systems and Control, Singapore, October 1-3, 2007

Keynote: Karl Henrik Johansson (KTH)
Location: 6th International Symposium on Modeling and Optimization in Mobile, Ad Hoc, and Wireless Networks (WiOpt), Berlin, Germany, March 31-April 4, 2008

Invited Lecture: Karl Henrik Johansson (KTH)
Location: Tutorial Session on Communication Challenges in Networked Control Systems, American Control Conference, Seattle, USA, 2008

Workshop: "Embedded Control Systems: From Design to Implementation", All cluster members.
Location: In association with the IFAC World Congress, Seoul, Korea, 6 July, 2008

Workshop: DataFlow Modeling for Embedded Systems, LUND and Ericsson together with members from the ART cluster.
Location: Pisa, 5 May, 2008

Workshop: ACCESS Industrial Workshop, 13 March, 2008, KTH 150 participants. Several speakers and participants from Artist2

Workshop: EU-US Workshop, 16 June 2008, at KTH, Stockholm. The aim of the workshop was to gather key researchers from academia and industry to discuss research challenges and emerging industrial trends on next generation networked embedded systems. About 50 participants. Several speakers and participants from Artist2.

Workshop: Feednetback Workshop on Networked Control, 25 Sep 2008, KTH. 40 participants from KTH, UNIPD, Seville, Grenoble.

Workshop: "Embedded Control Systems: From Design to Implementation", in association with the IFAC World Congress, Seoul, Korea, 6 July, 2008. All cluster members.

Summer School: Fourth Artist2 Graduate School on Embedded Control Systems. All cluster members
Location: KTH, May, 2008

Summer School Participation: Four lectures at the ARTIST2 Summer School in Autrans 8-12 September, 2008 were initiated and/or given by the cluster. The presentations were a keynote by Karl Johan Åström, Lund and three presentations by Karl-Erik Årzén and Pedro Albertos, Tarek Abdelzaher (UIUC), and Steve Vestal (Honeywell).

5.6 Testing and Verification

Keynotes and Tutorials

T. Jeron, invited talk at SBMF 2008, Symbolic model-based test selection, In Brazilian Symposium on Formal Methods (SBMF 2008), Salvador, Bahia, Brazil, August 2008, to appear in ENTCS. http://www.lasid.ufba.br/sbmf2008/

Kim G. Larsen. 'Timing and Performance Analysis: Static Analysis versus Model Checking'. Invited Talk on the Honoris Causa to Professor Dr. Reinhard Wilhelm from RWTH Aachen. Germany. October 24, 2008.

Kim G. Larsen. Model-driven Test and Verification of Real-Time and Embedded Systems. Test Conference, Aalborg University. Denmark. October 20, 2008.

Kim G. Larsen: Verification, Performance Analysis, and Controller Synthesis for Real-Time Systems. Invited talk. Marktoberdorf Summerschool. Marktoberdorf, Germany. August 5-16, 2008. http://asimod.in.tum.de/

Nicolas Markey. Timed Systems - Model Checking and Games, Invited tutorial, 8th School on Modelling and Verifying Parallel Processes (MOVEP'08), Nouan-le-Fuzelier, France, 2008.

Patricia Bouyer. Model-Checking Timed Temporal Logics. Invited talk at TFIT'08 (Taipei, Taiwan, March 2008)

Patricia Bouyer. Quantitative timed games. Invited tutorial at theGAME'08 annual meeting (Warsaw, Poland, September 2008)

Thomas A. Henzinger, Games in System Design and Verification, invited keynote lecture, Eighth International Conference on Logic and the Foundations of Game and Decision Theory (LOFT), Amsterdam, The Netherlands, July 2008.

Thomas A. Henzinger, Three Sources of Infinity in Computation: Nontermination, Real Time, and Probabilistic Choice, invited lecture, First International Conference on Infinity in Logic and Computation (ILC), Cape Town, South Africa, November 2007.

Jean-Francois Raskin. Invited Talk. ``Timed automata: verification, control and optimality''. Artist 2 Summer School in China. Shanghai. July 2008.

Jean-Francois Raskin. Invited Talk. Fixpoint-based Abstraction Refinements, LABRI, U Bordeaux, France, June 12, 2008.

Jean-Francois Raskin. Invited Talk. "An Introduction to Games Played on Graphs", University of Luxembourg, May 26, 2008.

Jean-Francois Raskin. Invited Talk. ``Controller Synthesis using Lattice Theory''. IEEE CDC2007. December 2007. New-Orleans, USA.

Jean-Francois Raskin. Invited Talk. "Fixpoint-based Abstraction Refinements", LIAFA, U Paris 7, France, October 8, 2007.

Thomas Brihaye. Invited Talk "Optimal reachability problem for weighted timed automata and games", October 2007, in the AlgoSyn meeting organized by the University of Aachen in Rolduc (Netherlands)

Bernard Boigelot. Invited Talk. A Generalization of Cobham's Theorem to Automata over Real Numbers, LABRI, U Bordeaux, France, January 2008.

Bernard Boigelot. Invited Talk. A Generalization of Cobham's Theorem to Automata over Real Numbers, LIAFA, U Paris 7, France, January 2008.

Bernard Boigelot. Invited Talk. On the Sets of Real Numbers Recognized by Finite Automata in Multiple Bases, Dagstuhl Seminar ``Beyond the Finite'', Dagstuhl, Germany, April 2008.

Bernard Boigelot. Invited Talk. Automata-based Representations of Arithmetic Sets, Automata and Verification Workshop, Mons, Belgium, August 2008.

Veronique Bruyere and Jean-Francois Raskin. Organization of the workshop "Automata and Verification", University of Mons-Hainaut, Belgium, August 25-26, 2008.

T. Jeron, invited talk at SBMF 2008, Symbolic model-based test selection, In Brazilian Symposium on Formal Methods (SBMF 2008), Salvador, Bahia, Brazil, August 2008, to appear in ENTCS.

Kim G. Larsen. 'Timing and Performance Analysis: Static Analysis versus Model Checking'. Invited Talk on the Honoris Causa to Professor Dr. Reinhard Wilhelm from RWTH Aachen. Germany. October 24, 2008.

Kim G. Larsen. Model-driven Test and Verification of Real-Time and Embedded Systems. Test Conference, Aalborg University. Denmark. October 20, 2008.

Kim G. Larsen: Verification, Performance Analysis, and Controller Synthesis for Real-Time Systems. Invited talk. Marktoberdorf Summerschool. Marktoberdorf, Germany. August 5-16, 2008.

Kim G. Larsen. Quantitative Verification and Synthesis for Embedded Systems. Invited Talk. ARTIST2 Summer School Autrans (near Grenoble), France. September 8-12, 2008.

Ed Brinksma. Quantitative Testing Theory. Invited Talk. ARTIST2 Summer School Autrans (near Grenoble), France. September 8-12, 2008.

Kim G. Larsen. Priced Timed Automata and Games. Automata and Verification Workshop University of Mons-Hainaut. Mons, Belgium. August 25, 26, 2008.

Kim G. Larsen. Modeling, Verification and Synthesis of Timed Systems. Invited Talk at The Centre for Interdisciplinary Computational and Dynamical Analysis (CICADA) Launch Event. Manchester University, England. July 1, 2008.

Kim G. Larsen. Model-driven Testing of Real-Time and Embedded Systems. Invited Talk at Pan-European Conference Systematic Testing. Berlin, Germany. June 5, 2008.

Kim G. Larsen. Playing Games with Timed Interfaces. Invited Talk. Foundation for Interface Theory (FIT). Budapest, Hungary. April 5, 2008.

Kim G. Larsen. Model Checking Embedded and Real Time Systems. Invited Talk. 9th International Workshop on Discrete Event Systems (WODES). Gothenburgh, Sweden. May 28-30, 2008.

Kim G. Larsen. Validation, Performance Analysis and Synthesis of Embedded Systems. Invited Talk. 3rd intl Workshop on Systems Software Verification (SSV08). Sidney, Austrailia. February 25-27, 2008.

Kim G. Larsen. Performance analysis, scheduling and synthesis of embedded systems . Invited Talk. Final Workshop of Centre for Dependable Computing (CDC). Tallinn, Estonia. January 21-22, 2008.

Kim G. Larsen. Verification, optimization and synthesis for timed systems: from theory to tools. Invited talk given at the receipt of Dr Honoris Causa from LSV, ENS Cachan. Cachan, France. November 26, 2007.

Workshops

7th International Workshop on Parallel and Distributed Methods in verifiCation - PDMC 2008. Affiliated to ETAPS 2008, March 29-April 6, 2008. http://pdmc.informatik.tu-muenchen.de/PDMC08/

Dagstuhl seminar on Distributed Verification and Grid Computing. 10.08.08 - 14.08.08, Seminar 08332, Organized by: Henri E. Bal (Vrije Universiteit Amsterdam, NL),Lubos Brim (Masaryk University, CZ), Martin Leucker (TU München, DE). http://www.dagstuhl.de/de/programm/kalender/semhp/?semnr=08332

10th International Workshop on Verification of Infinite-State Systems (INFINITY'08)

15th International Symposium on Temporal Representation and Reasoning (TIME'08)

7th International Workshop on Parallel and Distributed Methods in verifiCation - PDMC 2008. Affiliated to ETAPS 2008, March 29-April 6, 2008.

Dagstuhl seminar on Distributed Verification and Grid Computing. 10.08.08 - 14.08.08, Seminar 08332, Organized by: Henri E. Bal (Vrije Universiteit Amsterdam, NL),Lubos Brim (Masaryk University, CZ), Martin Leucker (TU München, DE)

Co-organization of the summer school Movep (http://www.univ-orleans.fr/movep2008/) about modeling and verifying parallel processes in June 2008, partially funded by Artist 2.

RTSS08 track on Design and Verification of Embedded Real-Time Systems,
the 29th IEEE Real-Time Systems Symposium. Barcelona, Spain. November 30 - December 3, 2008. (organizer Wang Yi)

ARTIST summer school on embedded systems design, Su Zhou, China. Aug. 1-12, 2007. (co-organizer Wang Yi)

Foundations of Interface Technologies, FIT 2008. Satellite events of ETAPS 2008 and sponsored by ARTIST2. Budapest, Hungary. April 5, 2008.

The conference series CAV, Computer-Aided Verification, is a key conference for this cluster and with members of the cluster taking a leading role. As such the first conference in the series was held in Grenoble in 1989.
Later – in 1991 the conference was hosted in Aalborg. In 2007 Werner Damm (OFFIS) was co-chair for CAV 2007.

In 2009, Verimag will organise CAV, the Conference on Computer-Aided Verification in Grenoble, where it had all started in 1989. This will be the 21th in a series dedicated to the advancement of the theory and practice of computer-aided formal analysis methods for hardware and software systems. CAV considers it vital to continue its leadership in hardware verification, maintain its recent momentum in software verification, and consider new domains such as biological systems. http://www-cav2009.imag.fr/

6. Artist2 Web Portal

6.1 Objectives and Background Information

These objectives and background information have remained unchanged since Year 3.

The Artist2 Web Portal is a major tool for Spreading Excellence within the Embedded Systems Community. Its aim is rather ambitious: to be the focal point of reference for events and announcements of interest to the embedded systems community.

The web portal disseminates information about contacts (Artist2 core and affiliated partners), the Artist2 JPA activities, as well a fairly thorough set of links to sites of interest to the embedded systems community.

As can be seen, a great deal of effort has been put into the web site, both for ergonomics/graphical quality, as for the contents.

The web site includes several features that help keep it coherent and up to date:

- Authorised users (principally, the Artist2 partners) can access the back end of the site to modify and update information directly. The changes are immediately visible on the site, which greatly streamlines the updating process.
- It's possible to track changes and go back to previous versions of individual web pages.
- Events are automatically sorted by date, and transferred to 'Past Events'. When appropriate.
- Structural information (hierarchy of pages) is maintained automatically.
- Ergnomics are set for the entire site. The "look and feel" of the site is always homogeneous thoughout the site. It's possible to change these ergonomics, and these changes are applied homogeneously throughout the site, via automated machanisms.

6.2 Structure

The structure of the Artist2 web site is visible on the Site Map:
http://www.artist-embedded.org/artist/spip.php?page=plan).

6.3 Evolution: Google Maps

In Year4, we have added a simple-to-use interface for web pages referring to events.

Simply by inserting the search string for a given location (eg: Ave de Beaulieu 33; Brussels) as one of the attributes to a web page, the ARTIST website will then display the corresponding google map for that location.

It is also possible to show the path from one location (eg: the airport or train station), and the event location.

6.4 Evolution: Videos of presentations at the Artist Summer School in Europe

Videos of the presentations from the summer school are in post-production, and should be online for the review. A few previews are visible here:

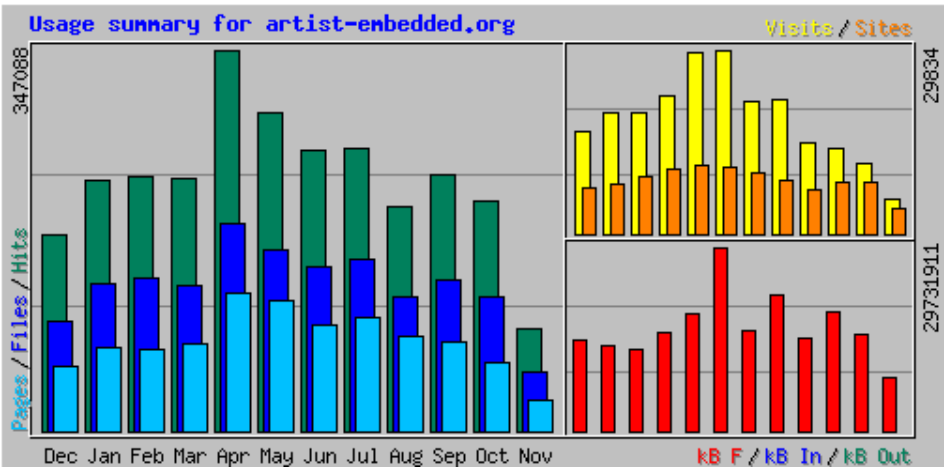
- http://artist.imavox.ch/mardi/giovanni_de_micheli/
- http://artist.imavox.ch/vendredi/luis_almeida/
- http://artist.imavox.ch/mercredi/karl_johan_astrom/

6.5 Analysis of Visits to the Portal

As was the case at the end of Year3, the main conclusion from this analysis is that visits to the site are largely driven by the Artist2 events organised (workshops, conferences, schools), and that this drives visits to the other sections: “Embedded Systems Links”, and “Research and Integration”.

It is important to note that a deep analysis of the pertinence and effectivity of the web portal would need to go beyond the numerical analysis provided here. The real impact of a website is in whether or not the members of the community find the information relevant, and how it helps them in their daily tasks.

6.5.1 Number of Visits over the past Year



In comparison with last year, the curve of visits is much flatter. This probably corresponds to the more even distribution of events over the course of the year.

A detailed view of the visits over the past year is provided here. The total number of hits over a one-year period is slightly higher: 2663540 last year, and 2759886 this year.

Summary by Month

Month	Daily Avg				Monthly Totals							
	Hits	Files	Pages	Visits	Sites	kB F	kB In	kB Out	Visits	Pages	Files	Hits
Nov 2008	6224	3586	1838	380	4223	8499716	0	0	5700	27584	53793	93368
Oct 2008	6775	3960	2011	367	8501	15481758	0	0	11402	62353	122777	210046
Sep 2008	7777	4589	2714	460	8307	19215054	0	0	13813	81436	137690	233319
Aug 2008	6801	4082	2858	492	7282	15029062	0	0	14786	85753	122478	204043
Jul 2008	8284	5023	3339	698	8758	21855053	0	0	21639	103512	155714	256833
Jun 2008	8513	5004	3197	713	10007	16159878	0	0	21408	95927	150146	255401
May 2008	9364	5346	3832	962	10847	29731911	0	0	29834	118810	165735	290310
Apr 2008	11569	6306	4172	982	11090	19019742	0	0	29476	125171	189198	347088
Mar 2008	7413	4258	2579	721	10549	15967274	0	0	22379	79971	131999	229804
Feb 2008	8004	4811	2560	679	9325	13225439	0	0	19696	74245	139524	232140
Jan 2008	7376	4329	2451	630	8014	13833353	0	0	19544	76004	134229	228666
Dec 2007	5769	3223	1909	534	7388	14723278	0	0	16567	59187	99922	178868
Totals						**202741518**	0	**0**	**226244**	**989953**	**1603205**	**2759886**

6.5.2 Visits Distribution

The table below shows the current distribution of visits to the various parts of the portal.

- 54.5% of the visits are to the "Dissemination" section, which provides information and pointers about Artist2 events and results. This is up from 40.9% last year. Of these, a full 31.7% (30.3% last year) of the total visits to the portal are to the Workshops section, where the home pages of many Artist2 workshops are located.
- The "Schools and Seminars" section has registered a very large upswing, from 6% last year, to 19.1% this year.

▶ 15. About the Artist2 NoE	1.5%
▶ 20. Participants	10.8%
▶ 25. Research and Integration	7.4%
▼ 30. Dissemination	54.5%
▶ 20. Workshops	31.7%
▶ 30. Schools and Seminars	19.1%
60. Publications	2.1%
▶ 70. Contributions to Standards	1.6%
▼ 35. Embedded System Links	20.4%
10. Journals	2.5%
▶ 20. Conferences	1.8%
30. Standards	0.7%
▶ 35. Tools and Platforms	3.7%
▶ 40. Main Projects	2.7%
50. Position Papers	1.2%
55. Roadmaps	0.9%
60. Newsletters and Magazines	1%
▶ 70. Announcements	5.6%
▶ 40. intranet	1.1%
▶ 70. Artist2 Reviews	3%
71. ArtistDesign Reviews	0.6%
76. Reporting on Mobility	0.7%

7. Industrial Liaison

7.1 Approach

The approach is unchanged with respect to last year.

Artist2 has a wide array of affiliated industrial and SME partners. Most of these partners have participated in some way in the Artist2 technical meetings and the overall effort. There is strong, high-level industry participation through the various Spreading Excellence events organised by Artist2.

Our active involvement in the European Technology Platform ARTEMIS also could have a significant and long-term impact. Several Artist2 partners, including OFFIS, PARADES, VERIMAG; and TU Vienna, are actively involved in the ARTEMIS ETP, in particular leadership and active contribution to the Working Groups for the Strategic Research Agenda (SRA).

In addition, each Artist2 partner has an outstanding track record for interaction with industry. Globally, the Artist2 consortium has a very strong impact on European R&D in embedded systems, through participation in the three main Integrated Projects: DECOS, ASSERT, and RUNES. This impact is visible via the achievements in these Integrated Projects, related to time-triggered architectures and modelling and validation at the architectural level.

We believe that the strong involvement of four main Artist2 partners in the recently accepted SPEEDS Integrated Project will also have a very positive impact on progress in the state of the art, in component-based embedded systems engineering.

Here is a non-exhaustive list of highlights of Artist2 impacts on industry in Year 4. It is completed by information in the cluster and activity deliverables.

7.2 "Real Time Components" Interaction with Industry

7.2.1 Interaction with the automotive industry

Specific effort has been dedicated to interacting with the automotive industry. Recall that the automotive industry is one of the two driving sectors for drastic changes to embedded systems design methods, and is certainly *the* sector where changes have been deepest and quickest. This effort was made possible thanks to prior personal strong ties that some key participants (including: Werner Damm (OFFIS), Alberto Ferrari and Alberto Sangiovanni-Vincentelli (PARADES), Martin Törngren (KTH), Rolf Ernst (U. Braunschweig), Sébastien Gérard (CEA)), and affiliates (including: Stefan Kowalewski (RWTH Aachen)) of ARTIST2 had with the Autosar consortium. Albert Benveniste (INRIA) and Werner Damm (OFFIS) jointly organized the *ARTIST2 Workshop* ***Beyond Autosar***[3], held in Innsbruck on March 23-24 2006. The workshop discussed in particular issues related to timing in the Autosar model (the so-called *timing model* of Autosar). More generally, the workshop helped making the academic community aware of the research issues raised by this approach from automotive industry. An elaboration of the results has been presented at EMSOFT 2006 and at a GM Workshop in Bengalore (January 2007).

[3] http://www.artist-embedded.org/FP6/ARTIST2Events/Events/Innsbruck06/

OFFIS has become a development member of Autosar. This move was proposed to OFFIS by BMW, following in depth technical discussion on the link between the SPEEDS HRC meta-model and the Autosar meta-model regarding timing and safety aspects.

The integrated project SPEEDS has developed a layered meta-model of heterogeneous rich components (HRC) and standardized approaches for the integration of commercial industry standard modeling tools to assemble system-level design models with rich interface specifications by combining models expressed in any authoring tool compliant to the integration standard. A SPEEDS Automotive Day was organized to discuss with the automotive industry how the AUTOSAR methodology can be supported by SPEEDS technologies striving to reconcile the advantage of early system-level analysis with the overall AUTOSAR objective of decoupling function design from its implementation. These results have been presented in several highly visible events, including the DATE 2008 Automotive Day, and a keynote presentation at the Annual Mathworks Automotive Conference 2008 in Stuttgart. More in depth technical discussion on the relation between Speeds HRC model and Autosar were conducted at meetings with BMW, Bosch, and Daimler; see also section on standardization.

Sébastien Gérard (CEA) and Henrik Lönn (Volvo Tech) are organizing a workshop in the context of the ATESST project which aims are inviting key persons working on the context of automotive domain in order to share experience on the usage of standards like MARTE, AADL and Autosar especially in the context of the Architecture Description Language for Automotive, EAST-ADL. They also have setup a new project, ADAMS, (in collaboration with Laurent Rioux from Thales and Julio Mdeina from Cantabria) dedicated to promote the usage of MARTE in the contect of the automotive domain. Let's notice also that this project has to deal also with the aeronautics domain.

MDH has strategic long-term co-operations with seven companies: ABB Corporate Research, ABB Robotics, Arcticus Systems, Bombardier Transportation, CC-Systems, Ericsson, and Volvo Construction Equipment. In recent years, the cooperation has been extended to international subsidiaries and partners of these companies. In addition to this strategic cooperation we have cooperation also with several other Swedish and international companies[4]. The strategy has resulted in substantial industrial support, including a 9.6 MSEK donation from ABB, close to 30 graduate students funded by industry, an industrial lab (currently been set up in cooperation with Ericsson and ABB), a top-talent program for recruitment of international master level students, Ajdunct industrial professors from ABB and Volvo, as well as a large number of national and international joint research projects. The cooperation includes the following concrete results:

- further development of the Rubus component model inspired by the Save component model and its implementation in, e.g., Volvo Construction Equipment,
- development of component repository used at CC systems, including components and additional artefacts such as requirements, models and implementations, tests,
- model extraction tools used experimentally at ABB Robotics for modelling real-time properties of legacy systems,
- introduction of model-based approaches for modelling and developing applications in Ericsson,

[4] Additional national cooperation includes PhD-students funded by Ardendo, Level21, Prevas, and Scania, as well as joint projects with around 10 SMEs; internationally we cooperate both with giants, such as Nokia, Philips, and Tata, as well as with SMEs, such as Symtavision, Absint, and Rapita Systems.

- work on software decomposition of legacy systems and transformation of development to product-line development at ABB Substation Automation,
- development of a real-time database in cooperation with Mimer,
- in cooperation with core partners building a master program in industrial software engineering focussing on design, architectural analysis, component-based development and dependability of embedded systems.

PARADES has tight links with the ST automotive division and with the Joint Development Group ST-Freescale and has helped in defining roadmaps for design methodologies, tools and architectures for fault tolerant products. It has a number of interactions with Tier 1 companies including Bosch and Nippon Denso on this very topic. Alberto Sangiovanni Vincentelli is a member of the GM Science and Technology Advisory Board and has fostered joint work with General Motors on distributed embedded system design. In addition, PARADES has contributed to the design of an advanced intelligent component in a tire that consists of a set of sensors, a computing engine, an energy scavenger and wireless communication with Pirelli.

7.2.2 Interaction with the aeronautics industry

Specific effort has been launched to interacting with the aeronautics industry. This effort was made possible thanks to prior personal strong ties that some key participants (including: Werner Damm (OFFIS), Albert Benveniste (INRIA), and Paul Caspi (Verimag)) had with this industry in EU. RTC cluster felt that it was important that the research community around ARTIST2 was made aware of the scientific and technical issues raised by the move to Integrated Modular Avionics (IMA) approach. Recall that the aeronautics industry is one of the two driving sectors for drastic changes to embedded systems design methods, and is certainly *the* sector where changes are most demanding.

Albert Benveniste (INRIA) and Paul Caspi (Verimag), in tight cooperation with John Rushby (SRI, Stanford), have organised an ARTIST2 workshop on IMA, held on November 12-13 2007 in Rome at PARADES location. Speakers include key persons from Airbus, Dassault-Aviation, Israeli Aerospace Industries, Honeywell and Windriver, plus John Rushby and ARTIST2 participants.

Verimag has recently started a direct collaboration with the European Space Agency ESA which has the objective to adapt results of the OMEGA and the ASSERT project to the needs of the engineers at ESA. A first step consists in an adaptation of the IF tool for UML to UML 2 and to the current version of Rhapsody.

7.2.3 Cross-sectorial Interaction with Industry

Since April 2008, the INRIA team has started a cooperation with a electronics faculty and a local SME (DeltaDore). This company is a national leader in the domain of home and industrial building equipment. A framework for cooperation has been set up in order to transfer know-how on timed component based architectures. This domain of industry is a promising field for the dissemination of embedded, soft real time component architectures. The challenges of this field lie in the frequent evolutions of deployed architectures. These evolutions call for self configurable and self adaptable components.

In future and many state-of-art projects a convergence of different application domains can be observed for different industrial applications (for example, a multipmedia system and safety-critical functions are integrated in a car). In January 2009, the EU STREP project GENESYS (http://www.genesys-platform.eu/) has started with coordination by TU Vienna. The objective of the GENESYS project is to develop a cross-domain reference architecture for embedded systems that can be instantiated for different application domains to meet the requirements and constraints documented in the ARTEMIS strategic research agenda. These requirements are composability, networking, security, robustness, diagnosis, integrated resource management and evolvability. The project will result in a conceptualization of the cross-domain architecture, a specification of cross-domain core services and optional services for the selected application domains, and four exploratory prototypes that will demonstrate and help to evaluate the feasibility of selected central architectural concepts in the different application domains. The analysis of the requirements and the definition of an architectural style with fundamental principles for cross-domain embedded systems have been completed. The next steps will be the definition of the architectural services, the completion of the methodology framework, the implementation of the prototypes and the assessment of the architecture.

The Inria Triskell team is now part of the S3 (Software Services and Systems) European network of excellence. This network started in March 2008 and will end in 2012. The Inria Triskell team is involved in two joint research activities: adaptation and monitoring principles, techniques and methodologies for service based systems, and End to end quality provision and service level agreement conformance. The Triskell team intends to adapt results gained from Artist cooperation on timed components and use these results in the S3 collaborations in the joint research activities mentioned above. The crossbreed between components for embedded systems (Artist2) and service based architectures (S3) will be supported by experiments in the building automation industrial field. Software architectures in this field require real time, reliability, predictability as well as openness and dynamic reconfiguration.

Within the German Competence Cluster SafeTRANS, two SafeTRANS Industrial focussing on V&V methods and on architecture assessments have been organized, with participants from automotive, aerospace, and rail industries. OFFIS is a founding member of SafeTRANS, with Werner Damm being the SafeTRANS Chairman. SafeTRANS has – through its role as a founding cluster of EICOSE - been as well instrumental in deriving research priorities and subprograme formation for the Artemis Joint Undertaking, see below.

OFFIS is also represented through Werner Damm at the Steering Board level of the German Innovation Alliance on Embedded Systems SPES 2020, which is about to be launched in November 2008. This alliance puts together Academic Institutions and Industrial Stakeholders in Embedded Systems development, providing a foundational basis for applications in multiple industrial sectors, including automation, automotive, aerospace, energy, and medical.

Within the Artemis Innovation Cluster on Transportation, EICOSE, the European Expert Group on Transportation has in several meetings identified research priorities for embedded systems from the perspective of the transportation sector, leading to a proposal of the three candidates for subprogrammes (on cost-efficient methods for the development of safety relevant embedded systems, SP1; on Computing Environemnts for Embedded Systems, SP5, and on Human Centred Design for Embedded Systems, SP8) for the Joint Undertaking Artemis. All three proposals for subprogrammes were after modification integrated in the Artemins Multi-Annual Strategic Work-Plan. All subprogrammes are cross-sectorial in nature, addressing in particular all transportation sectors. From Artist2, Werner Damm from OFFIS as well as Didier Juvien from CEA are members of the Eicose Steering Board, with Werner Damm serving as EICOSE chairman until May 2008.

7.3 "Adaptive Real Time" Cluster Interaction with Industry

7.3.1 Overview

The industrial sectors that can benefit from adaptive real-time technology include Consumer Electronics, Industrial Automation, and Telecommunications.

Consumer Electronics (CE) products range from miniature cameras and MP3 players to advanced media servers and large displays. Mainly driven by Moore's law, the evolution in the CE industry is very fast [Bou05]. Utilizing available hardware and software resources in an optimal fashion is crucial both to save costs and to keep the competitive edge. Moreover, multimedia systems exhibit a highly dynamic behavior, since task execution times are often dependent on input data that are difficult to predict [Riz06]. As a consequence, these systems are prone to intermittent overload conditions that could degrade the performance in an unpredictable fashion [Wus05, Loo03]. To address these problems, the ART cluster aimed at integrating the most recent research results achieved in the real-time community to build flexible as well as predictable real-time systems that can react to load changes and perform QoS adaptation in a controlled fashion.

In the area of Industrial Automation there is a trend to use distributed solutions for connecting the general plant actuators, sensors and the controllers. At the same time, there is an increase of demands for new options and improvements in the automation results, fetching more control of plant secondary data. This imposes a continuous increment in processing power and memory capacity that requires adaptivity at different levels of system operation. The contribution of the ART cluster in this domain was to investigate how to achieve predictability and adaptivity in distributed systems.

Embedded systems for telecommunications applications are mainly targeted to the interfaces between communication technologies and to coding/decoding operations. They may be considered real-time as they have timeliness requirements for some of the critical operations they must perform. The referred systems are microprocessor based platforms, often integrating a second processor (e.g., a DSP) devoted to specific functions, like MPEG coding. From the software point of view, a modern mobile phone typically consists of several million lines of code with use-cases involving large number of concurrent activities. A system supporting ``memory and temporal protection'' would allow safely mixing real-time and non real-time applications with the benefit of achieving a more scalable platform. The work on resource reservation carried out in the ART cluster was of crucial importance to manage the increased complexity of the applications in this domain.

7.3.2 Interaction with the consumer electronics industry

Thanks to the International Collaboration Days organized within the ARTIST2 project, the ART cluster got in contact with two major companies, Philips and Ericsson, acting in the domain of consumer electronics. After a tight interaction with the engineers responsible for the software development process, a number of industrial needs have been identified, that would make new generation products more robust and flexible.

To cope with a constantly increasing complexity of software applications (already consisting of several million lines of code and hundreds of concurrent activities), a system supporting memory and temporal protection would allow safely mixing real-time and non real-time applications with the benefit of achieving a more scalable platform. Therefore, the work on resource reservation carried out within the ART cluster is of crucial importance to manage the increased complexity of the applications in this domain.

In addition, multimedia systems exhibit a highly dynamic behavior, since task execution times are often dependent on input data that are difficult to predict. As a consequence, these systems are prone to intermittent overload conditions that could degrade the performance in an unpredictable fashion. Again, the expertize existing in the ART cluster on overload management is of high interest for these companies, since it allows building flexible as well as predictable real-time systems that can react to load changes and perform QoS adaptation in a controlled fashion.

7.3.3 Interaction with the electronics industry

A new interaction of the ART cluster with Microchip Technology has been started on real-time embedded platforms for monitoring and control. In particular, the expertize existing in the ART cluster on real-time embedded control applications and real-time operating systems is extremely actractive for Microchip, who is interested in pushing the development of real-time embedded applications using 16-bit microcontrollers (as the dsPIC30 and the dsPIC33).

In this context, a big opportunity for the ART cluster is to find an agreament with Microchip to define the characteristics of a small real-time embedded platform for sensory acquisition and motor control that can be used (in conjunction with a wireless card) as a node of a mobile wirelss network. This unit would be more powerful and flexible than a mote and could be used to carry out experiments on sensor networks, embedded control, mobile robot teams and distributed control systems.

7.4 "Compilers and Timing Analysis" Interaction with Industry

During the course of the project, the main interaction and impacts on industry for this cluster have been:

- **Timing Analysis**: During the previous years, timing-analysis tools entered industrial practice and are in routine use in the aeronautics and automotive industry. AbsInt's timing-analysis tool, aiT, has been used in the certification of time-critical subsystems of the Airbus A380 and has thus acquired the status of a *validated* tool. WCET estimations are relevant for all industrial sectors using hard real-time systems. Therefore, industrial sectors in this case include avionics, automotive, defence and some areas where control systems are applied. Especially in the automotive and the aeronautical domains, there is a need to have precise knowledge on the worst-case timing behaviour of safety critical software. This need is underlined by the fact that the worst-case timing of large parts of the software used within the new Airbus A380 has been analyzed using AbsInt's aiT.
- **Compilers:** The work performed in the cluster is relevant for all industrial sectors using embedded software. This includes semiconductor houses, system houses, companies working on audio processing, video processing, data streaming applications in the TV, Set Top boxes, DVD players and recorders, mobile phones, base stations, printers and disk drives. Efficiency of embedded software, in particular the efficiency of memories, is relevant for high-speed embedded systems. It is expected that most mobile devices will provide some kind of multimedia processing.

- **Link between timing analysis and compilers**: The availability of precise timing analyses does not fulfil all industrial needs. Since the code of safety critical applications is typically generated by a compiler, the compiler should also be aware of worst-case timings. Currently, this is not the case leading to the unacceptable situation that, whenever it is detected that an application does not meet its real-time constraints, manual code transformation, recompilation and timing analysis need to be done repeatedly.

Also:

- The partners have agreed on standard tool architecture and a set of textual interfaces. Experiments with interfacing through these textual interfaces have been successfully performed.
- Several professional components of aiT and Bound-T are being offered by the industrial partners to be used by the academic partners.
- AbsInt's aiT tool and Tidorum's Bound-T tool have been used in industrial case studies by the Mälardalen team.
- Tidorum and York (through Rapita Systems Ltd) have completed a project for the European Space Agency, to adapt their timing analysis tools to the LEON2 (SPARC V8) processor and to evaluate the tools on real on-board satellite software. This includes integration between the tools: Tidorum's Bound-T tool can now be used as a front-end for York's measurement-based analysis as implemented in the RapiTime tool from Rapita Systems.
- Tidorum and York (through Rapita Systems Ltd) continue to work for the European Space Agency, now focusing on cache-aware code layout.
- TU Vienna and University of York worked on issues of how systematic measurements can be used for WCET analysis.

7.5 "Execution Platforms" Interaction with Industry

7.5.1 Automotive Industry

The automotive industry is currently in a fast and spectacular evolution towards the intelligent, safe, environmental, interconnected, and economic car. Electronics is at the basis of most of this development. New features such as automatic intelligent parking assist, blind-spot information system, navigation computers with real-time traffic updates, car-to-car communication, not to mention electronically controlled brakes or electronic power steering, are out and running in most recent high-end cars. This development is going to continue with new functionality being adopted not only in premium cars but also in the mass-market. Consequently, estimates are that up to 80% of the innovations are directly dependent on embedded systems. This, of course, comes at a cost. Automotive electronics, currently accounts for 22% of a vehicle's cost and is predicted to increase to 40% by 2010 (www.altera.com).

This evolution brings a series of challenges in all steps of the development cycle. How to specify and model such a complex system? There is a need for a component based modelling, analysis, and synthesis approach in which independently designed hardware and software components can safely be combined into a working system. How to achieve the ever increasing demand on functionality and safety, at an affordable cost? Modern automotive electronic systems are highly distributed networks with components interacting over various infrastructures. How to achieve a safe and predictable system at such a huge level of complexity and heterogeneity? A well defined methodology is needed for mapping the complex functionalities on predefined distributed automotive platforms. This assumes well defined standards, middleware layers, analysis tools, software generation tools, design exploration and optimisation approaches.

A recent trend in automotive is the application of multi-core components. In the powertrain domain, single core solutions have reached the restrictions in power and heat dissipation for the resource hungry applications, so multi-core is an option for obtaining more processing performance at less electrical energy. The second domain is body electronics, where the highest (and very cost efficient) software integration density is achieved, enabled by standardization such as AUTOSAR. Here, many European OEMs work towards a single high-performance central control module connected to very small “smart sensors/actuators” via cost efficient buses like LIN. This shall replace current practice with several CAN-connected ECUs. So, multi-core is an important issue for automotive that adds another level of topological complexity that is known from the system-on-chip (SOC) world for quite some time: shared memories, crossbar switches, on-chip communication and last not least shared resources in a multi-processor setting. This must be incorporated into the analysis as it has a vast impact on the schedules.

Due to ARTIST2 activities, (e.g. the ARTIST workshop “Beyon AUTOSAR” in Innsbruck) several technical meetings between TU Braunschweig and leading automotive suppliers in the AUTOSAR context held place. As a main topic it was discussed how compositional performance verification methods can be utilized in the automotive design process to facilitate the network integration problem. TU Braunschweig was invited to the SAE world congress 2007 in Detroit to present recent results in compositional performance verification. In addition, ESI continued its Artemis activities in this area, e.g. by working on the Artemis/Artemesia Research Agenda and Multi-Annual Strategic Plan together with OEMs and suppliers, e.g. Daimler, Fiat, Volvo, Infinion and others.

7.5.2 Mechatronic Industry

Traditionally, the development of mechatronic systems was a rather sequential process. First the mechanical part was designed, next the hardware infrastructure was fixed, and finally the embedded software was developed. Typically, this leads to many proplems at systems integration, because only then the interference of design decisions from the disciples became visible. To improve this process and to shorten the time-to-market, there is a clear trend towards concurrent engineering. To be able to detect problems earlier in the development cycle, there a strong need for high-level models allowing early analysis of system-level design decisions. Moreover, there is an increasing interest in the use of models to improve the early testing process; for instance, one would like to test the embedded software before its environment is available.

Concerning the execution platforms used, one can observe the need for a flexible process where one can easily switch between various solutions, such as the amount of distribution, the topology used, the communication infrastructure, and the operating system. Often in a first release of a high-tech system the execution platform is overdimensioned. For instance, one might choose a highly distributed architecture to avoid scheduling problems. In a later version, a strong cost reduction has to be achieved by combining more functionality on a single node. One major problem is to foresee at an early stage of the design whether a particular hardware platform is feasible for a given software system. Hence there is a strong need for methods that can help engineers to make a well-founded choice for an execution platform. This need arose already more than a decade ago for resource-constraint embedded applications, e.g. in the area of streaming multi-media. Techniques that were developed in this area are now being extended and adapted to deal with control-dominated high-tech applications as well.

An increasing interest in the application of model-driven design techniques can be observed. These techniques emphasize the explicit separation between the application logic and the execution platform and allow models to be analyzed and systemically refined through model transformations.

7.5.3 Information Technology

Microelectronic technology is continuing to grow according to Moore's law. However, the need for computation power in industry is growing even faster. This is the case with traditional areas such as technical/scientific computation, and, more recently, modern applications, for instance interactive multimedia, high bandwidth communication, or speech recognition. Many of these applications are running on mobile computer, which makes issues even more complicated: an unprecedented amount of computation power has to be delivered with very low energy consumption. So, instead of just running after high performance, industry is out after a good performance - energy product. These unprecedented performance/energy requirements cannot be achieved by further pushing processor technology along the traditional Pentium lines. New architectures are needed in which several lower performance (and less energy hungry) computation nodes are cooperating in order to globally achieve the expected performance. Modern MPSoC and NoC architectures are developed along these lines.

Another clear trend is towards reconfigurable architectures, in general, and configurable processors, in particular. The generic goal is to achieve a high degree of flexibility (traditionally available only with software implementation) at a power consumption which is much lower than achievable with a traditional software implementation using general purpose processors.

The emerging trend for multimedia applications on mobile terminals, combined with a decreasing time-to-market and a multitude of standards have created the need for flexible and scalable computing platforms that are capable of providing considerable (application specific) computational performance at a low cost and a low energy budget.

Hence, in recent years, the first multiprocessor System-on-Chip components have emerged (like e.g. TI OMAP, ST Nomadik, Philips Nexperia, IBM/Toshiba/Sonys CELL). These platforms contain multiple heterogeneous, flexible processing elements, a memory hierarchy and I/O components. All these components are linked to each other by a flexible on-chip interconnect structure. These architectures meet the performance needs of multimedia applications, while limiting the power consumption.

To effectively utilize these emerging technologies, new design methodologies are being developed. This includes application and architecture modelling, mapping but especially also design-space exploration techniques that aid in finding optimal trade-offs.

7.6 "Control for Embedded Systems" Interaction with Industry

Embedded control systems are vital in most industrial application areas, e.g., automotive, avionics, manufacturing, and automation. In many areas it is the quality and performance of the control systems that distinguishes a product or company. Therefore implementation techniques for embedded control systems that are resource-efficient and give good performance are very important. There is still a debate whether control systems best are implemented using time-triggered approaches or whether a more event-based implementation is sufficient. This is something that varies from industry sector to industry sector, and which also depends on the level of safety required and the need for formal guarantees.

The use of feedback-based (adaptive) resource management is of particular interest for soft real-time applications, e.g., multimedia applications within consumer electronics systems. The main applications of control of computer systems can be found at companies like IBM or HP. However, also large users of server technology such as Amazon have in-house application development within this area.

The introduction of multicore platforms also in embedded applications creates new design challenges. A particular problem compared to uniprocessor platforms is the WCET analysis. Due to the shared memory access WCET analysis runs the risk of being very conservative. This will most likely hamper the application of hard real-time techniques based on static analysis. Hence, the market for more dynamic or adaptive resource reservation based on feedback from the true resource utilization and/or the application quality-of-service can be expected to increase in the future.

Controllers are in most cases based on periodic sampling and assume a negligible or constant latency between input and output (sampling and actuation). This is something that in many cases can be difficult or costly to achieve. Time-triggered solutions based on static scheduling are one solution, but are sometimes too inflexible or are incompatible with the rest of the system software. In event-based solutions, pre-emption, blocking, execution time variations and non-deterministic kernels generate sampling jitter and latency jitter. The same holds for event-based network protocols. The problem can be approached in different ways. Robust design can be applied to guarantee a certain level of temporal robustness. Techniques can be used to compensate for the timing variations, either passively based on off-line information about the characteristics of the variations, or actively using measurements. The interaction between control and real-time computing becomes extra important in situations where the computing and communication resources are severely limited, e.g., in embedded control system applications, where separation of concerns-based design principles, with strict interfaces between control and computing, may be unfeasible. Instead it is necessary to take both computing and control aspects into account simultaneously. This requires theory and tools that support codesign. From a pure real-time systems approach it is also desirable to provide more flexible ways of allocating computing resources to different applications or tasks. The area of adaptive or feedback-based resource scheduling is one example of this.

Taking implementation issues and limited resources into account in the control design is covered by the terms resource-aware control and implementation-aware control. The development in this area needs to be matched with the similar developments within the real-time field. It is necessary to create models of computation and scheduling, and system software and hardware, which are tailored to the true needs of control applications. This is covered under the terms of control-aware computing and networking.

Model integration and management constitute key challenges in the design of embedded systems; this is also relevant for embedded control systems. Consider for example the design of an embedded automotive ABS braking system. One obvious concern is that of the core motion control functionality, especially the control logic and algorithms and the dynamic behaviour of the system. However, this is only one out of several aspects. Other aspects include safety, security, network communication, mechanical design, IO, power, etc. These aspects and components are in addition typically handled by different specialists, employing different modelling languages and tools, and moreover belonging to different organizational entities. There is therefore a strong industrial need for solutions that support model and tool integration, as well as model management. There are several related research issues including model transformations and methodology. Some confusion is inevitable in this area since it is approached from so many directions (engineering disciplines, information management, tool specific solutions, standardization etc.). We believe that establishing modelling frameworks that characterize the problem and solution space are very important for the progress of the area.

A relatively new area is control of computer software systems, e.g., large eCommerce servers. These servers are complex dynamic systems with high levels of uncertainty. The need for control arises at several levels, e.g., admission control, delay control, and utilization control. Several new challenges apply. Since the servers are engineering artefacts, first principles do not apply, at least not on the macroscopic level. Several competing modelling formalisms needs to be combined, e.g., continuous-time flow models, queuing models, and various types of event-based models. System stability has an unclear meaning, and the whole issue of how to write controllable and observable software system is still largely unexplored.

7.7 Testing and Verification Interaction with Industry

The testing and verification techniques and tools developed and disseminated within the cluster have relevance and potential impact on literally *all* industrial sectors developing or using embedded systems solutions. Within the Strategic Research Agenda of the ARTEMIS research platform[5] *Design Methods and Tools* is one of the three research priorities put forward. Here model- and component-based approaches are proposed as necessary for coping with the growing complexity of systems while meeting “time-to-market” requirements. Methods and tools for testing and verification are to play a central role in the ARTEMIS research strategy, as can be seen from the following citations:

- “.. methods and tools for simulation, automatic validation and proving, and virtual Verification and Validation (V&V). Methods and tools for developing product lines of embedded systems.”
- “.. reduce the cost of the system design by 50%. Matured product family technologies will enable a much higher degree of strategic reuse of all artifacts, while component technology will permit predictable assembly of Embedded Systems.”
- “.. achieve 50% reduction in development cycles. Design excellence will aim to reach a goal of “right first time, every time” by 2016, including Validation, Verification and certification (to the same and higher standards as today).”
- “..manage a complexity increase of 100% with 20% effort reduction. The capability to manage uncertainty in the design process and to maintain independent hardware and software upgradeability all along the life cycle will be crucial.”
- “.. reduce by 50% the effort and time required for re-validation and recertification after change, so that they are linearly related to the changes in functionality.”

[5] http://www.artemis-office.org/

The industrial needs for improved tools and methods for system validation have also been witnessed by a number of industrial and industry inspired case-studies and projects using model-based testing and verification carried out by the individual partners. Detailed information of these (and others) is to be found in the ARTIST2 Open Repository for Test and Verification Case Studies (https://bugsy.grid.aau.dk/artist2), and include:

- Danfoss (Aalborg): The project has two main goals. One is to develop an automated test execution environment for system level testing of the EKC series refrigeration controllers. The other is to improve model-based online testing given the experiences from the first trials
- ESI (Embedded Systems Institute, Eindhoven) has carried out (is carrying out) large industrial case studies with Océ, ASML, Philips Semiconductors (now NXP), Philips Medical Systems, Vanderlande Industries.
- Ericsson Telebit (Aalborg): The goal of this project has been to use Live Sequence Charts in a model-driven approach to the testing of TCP/IP internet protocols. Live Sequence Charts are used to capture (informal) RFC in a formal, yet intuitive, way.
- Novo Nordisk A/S. (Aalborg) Automaic generation of test cases from UML statechart models of MMI (man machine interface) for medical devices. Each statechart model describe a specific class of usage scenarios, and test cases are derive in two steps. First the model is translated into an equivalent timed automata. Then the automata is analysed based on various parameters (coverage criteria, search depth, etc) reslting in a number of test cases expressed in the company specific scripting language. The obtained coverage and possibly unreachable states are reported.
- OFFIS, University of Freiburg, Aalborg University: The "Single-tracked Line Segment" (SLS) case study stems from an industrial partner of the UniForM-project . It is the specification of a control system for a single-tracked line segment for tramways. It is implemented by distributed PLC automata. We took three different models of the SLS case study as examples. As the safety property to verify, we chose the mutual exclusion of drive permissions, i.e., the control system never gives permission to both directions simultaneously.
- OFFIS; Univ. of Oldenburg; Albert-Ludwigs-Universität Freiburg; Max-Planck-Institut für Informatik: The flap controller (high-lift) case study is derived from a case study for Airbus, a controller for the flaps of an aircraft. The flaps are extended during take-off and landing to generate more lift at low velocity. They are not robust enough for high velocity, so they must be retracted for other periods. The controller can perform a load-relief function to correct the pilot's commands if he endangers the flaps. Additionally, there is also an extensive monitoring of the health of its sub-systems, checking for instance for hardware failures. Typically this will give rise to large discrete state spaces when model checking models derived from the flap controller.
- OFFIS, Univ. of Oldenburg : Automating verification of cooperation, control, and design in traffic applications. Here we present a verification methodology for cooperating traffic agents covering analysis of cooperation strategies, realization of strategies through control, and implementation of control. For each layer, we provide dedicated approaches to formal verification of safety and stability properties of the design. The range of employed verification techniques invoked to span this verification space includes application of pre-verified design patterns, automatic synthesis of Lyapunov functions, constraint generation for parameterized designs, model-checking in rich theories, and abstraction refinement. We illustrate this approach with a variant of the European Train Control System (ETCS), employing layer specific verification techniques to layer specific views of an ETCS design.

- Scott/Tiger Validate (Aalborg): From timed automata design models the verification engine of UPPAAL is used for off-line generation of test-sequences which covers the model. In the project a tool for translating these logical test-sequences to test-scripts executable in, e.g., QTP of Mercury's Test Director. The resulting tool-chain has been applied to automatic testing of web-services of TDC (Danish Telecom). A commercial spin-off tool (V+) has been developed.
- Skov A/S (Aalborg): In this work, we provide a complete tool chain for automatic controller synthesis using UPPAAL Tiga and Simulink. The tool chain is explored using an industrial case study for climate control in a pig stable. The problem is modelled as a game, and UPPAAL Tiga is used to automatically synthesize a safe strategy that is transformed for input to Simulink, ´which is used to run simulations on the controller and generate code that can be executed in the actual pig stable. The models allow for guiding the synthesis process and generate different strategies that are compared through simulations.
- Dependable Systems and Software (DSS) group at Saarland university, Formal Methods and Tools group (FMT) and Design and Analysis of Communication Systems (DACS) group at the university of Twente: Arcade models. These include two case studies found in the literature, namely a Distributed Database Architecture and a Reactor Cooling System. Arcade tool was used which is based on the input/output interactive Markov chains formalism.
- DSS group at Saarland university, FMT and DACS groups at the university of Twente: Dynamic Fault Tree (DFT) models These include four case studies that also appeared in the literature, namely the cascaded PAND system, the cardiac assist system, the multi-processor distributed computing system, and the fault-tolerant parallel processor. Coral tool was used which is based on the input/output interactive Markov chains formalism.
- Software engineering group and FMT group at the university of Twente: Open-source Media Player. This case study was conducted on a publicly available open-source media player called MPlayer (http://www.mplayerhq.hu/). We have modeled the recovery mechanism implemented for the MPlayer and analyzed the availability of the system. Few tools were used including the FLORA framework and the CADP tool set (http://www.inrialpes.fr/vasy/cadp/). The input/output interactive Markov chains formalism was used.
- Uppsala University: As a case study, we have developed a formal model for a Biomedical Sensor Network (BSN). The sensor nodes of the network are constructed based on the IEEE 802.15.4 Zig-Bee standard for wireless communication. The UPPAAL tool is used to tune and validate the temporal configuration parameters of the network in order to guarantee the desired QoS properties for a medical application scenario. The case study shows that even though the main feature of UPPAAL is model checking, it is also a promising and competitive tool for efficient simulation.

Based on the above case-studies, it seems that the actual financial benefits of using a model-driven approach are likely to be even greater than those of the ARTEMIS goals, due to the capabilities of capturing functional as well as non-functional problems early on in the development process.

8. Joint Papers

Joint publications reflect deep and lasting integration between participants, while at the same time spreading the results to the wider research community.

8.1 Real-Time Components

A. Benveniste, B. Caillaud, L.P. Carloni, P. Caspi, and A.L. Sangiovanni-Vincentelli. Composing Heterogeneous Reactive Systems, ACM Transactions on Embedded Computing Systems, Vol. 7, No. 4, July 2008.

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