Real Time Systems / Embedded Systems

The research interest of the RTSYS group is the systematic design and analysis of „computers, which are not perceived as such“, which is one definition of embedded systems. These systems appear in all contexts of daily life: miniaturized hearing aids, x-ray scanners, cell phones, airbag controllers, anti-lock brakes, fly-by-wire aircraft. Such systems not only have to provide the correct outputs to the environment, they also have to provide these in time. In other words, these are real-time systems. Of particular interest for us are the reactive systems, which continuously react to (mainly discrete) input events of the environment with corresponding output events.

Results

Current research activities concentrate on the development of reactive embedded real-time systems. Key areas are:

- The model-based design of complex reactive systems,
- Reactive processors, and
- Deterministic concurrency and synchronous languages.

The activities on the model-based design of complex reactive systems concentrate on the modelling pragmatics, that is, the practical aspects of creating, maintaining and visualizing graphical system models. The Kiel Integrated Environment for Layout Eclipse Rich Client (KIELER) is a prototypical modelling environment that serves as a test bed to explore and validate novel modelling approaches. A key enabler is the ability to automatically compute the layout of graphical models. This frees the user from the tedious task of manually drawing diagrams, and allows novel techniques such as customized views during simulation. Novel developments in 2010 include capabilities for the automatic layout of UML class diagrams, and a new graph editor with a graph analysis framework for assistance of algorithm engineering. KIELER’s layout capabilities have also been added to UC Berkeley’s Ptolemy system. KIELER is also an integral part of the MENGES project, which aims to develop a model-driven software toolchain for a new type of electronic railway control centre. The project started in January 2010 and will last to December 2012. MENGES is funded by the ZFW (Zukunftprogramm Wirtschaft), a program to support research and development in Schleswig-Holstein. Project partners are Funkwerk Information Technologies GmbH, Kiel, b+m Informatik AG, Melsdorf and the groups for Software Engineering (Prof. Hasselbring) and for Real-Time and Embedded Systems of Christian Albrechts University Kiel. MENGES is one of the initial projects associated with the Competence Federation Software Systems Engineering (Kompetenzverbund Software Systems Engineering, KoSSE).

Reactive Processors aim to implement reactive behaviour with deterministic behaviour and minimal resource usage. The Kiel Esterel Processor (KEP) is a reactive processor that supports concurrency through multithreading and offers highly predictable timing at minimal power consumption. In 2010, developments focused on compilation for the Kiel Lustre Processor, a reactive processor for the synchronous data-flow language Lustre.

The major result in the area deterministic concurrency and synchronous languages is the development of Synchronous C (SC) and Synchronous Java (SJ), which are light-weight mechanisms to embed deterministic concurrency in C and Java. SC and SJ are inspired by the reactive processing paradigm, but are implemented as macros/classes expressed in standard C/Java, available as open-source code. In 2010, the main developments were a first working prototype for SJ, and an improved, more structured syntax for SC (developed in cooperation with UC Berkeley).
Fig. 1: A mind map illustrating how the KIELER modelling environment is positioned in the Eclipse context [from Fuhrmann/v. Hanxleden, MoDELS’10]. KIELER focuses on pragmatics, which together with syntax and semantics constitutes the field of semiotics.

Fig. 2: Architectural overview of the Kiel Lustre Processor [from Traulsen/v. Hanxleden, SAC’10]. A priority-based scheduler interacts with a set of processors, to exploit maximal parallelism while still respecting data dependencies.

**Personnel**

Head of the group: Prof. Dr. Reinhard von Hanxleden; Secretary: Sandra Leismacher (50%), Gesa Walsdorf (Elternzeit) (50%)

Technical Staff: Tim Grebien (50%)

Scientific Staff:
- Dipl.-Inf. Hauke Fuhrmann 01.01.-30.09.2010 Landesmittel
- Dipl.-Inf. Hauke Fuhrmann 01.10.-31.12.2010 Drittmittel
- Dipl.-Inf. Christian Motika 01.01.-31.03.2010 Drittmittel
- Dipl.-Inf. Christian Motika 01.01.-31.03.2010 MENGES
- Dipl.-Inf. Jens Schönborn 01.-31.12.2010 Landesmittel
- Dipl.-Inf. Miro Spönemann 01.01.-31.12.2010 Landesmittel
Lectures, Seminars, and Laboratory Course Offers

Winter 2009/2010

MS1102: - Synchrone Sprachen, 4 hrs Vorlesung/Week, Reinhard von Hanxleden

Übung zu: Synchrone Sprachen, 2 hrs Übung/Week, Reinhard von Hanxleden (+ Claus Traulsen)

A5.3.3: Fortgeschrittenenpraktikum - Echtzeitsysteme/Eingebettete Systeme (Modellierung in Eclipse), 4 hrs Exercise/Week, Reinhard von Hanxleden (+ Miro Spönemann, Hauke Fuhrmann)

MS1101: Seminar - Echtzeitsysteme/Eingebettete Systeme (Modellierung und Ausführung Nebenläufiger Systeme), 2 hrs Seminar/Week, Reinhard von Hanxleden (+ Miro Spönemann, Hauke Fuhrmann)

Oberseminar, 2 hrs Seminar/Week, Reinhard von Hanxleden

Summer 2010

Inf-OAR: Organisation und Architektur von Rechnern, 3 hrs Vorlesung/Week, Reinhard von Hanxleden (+ Hauke Fuhrmann)

Übung zu: Organisation und Architektur von Rechnern, 2 hrs Übung/Week, Hauke Fuhrmann (+ Miro Spönemann)

W120: Entwurf eingebetteter Echtzeitsysteme, 4 hrs Vorlesung/Week, Reinhard von Hanxleden

Übung zu: Entwurf eingebetteter Echtzeitsysteme, 2 hrs Übung/Week, Christian Motika
Fortgeschrittenenpraktikum - Echtzeitsysteme/Eingebettete Systeme (Layout-Algorithmen), 4 hrs Praktikum/Week, Reinhard von Hanxleden (+ Hauke Fuhrmann, Miro Spönemann)

MSP1101: Masterprojekt - Echtzeitsysteme/Eingebettete Systeme (Layout-Algorithmen), 4 hrs Masterprojekt/Week, Reinhard von Hanxleden (+ Miro Spönemann, Hauke Fuhrmann)

WI124: Wahlpflichtmodul Informatik - Modellbasierte Entwurf (Layout-Algorithmen), 2 hrs Seminar/Week, Reinhard von Hanxleden (+ Miro Spönemann, Hauke Fuhrmann)

MSS1101: Seminar - Echtzeitsysteme/Eingebettete Systeme (Synchrone Sprachen), 2 hrs Seminar/Week, Reinhard von Hanxleden (+ Christian Motika)

Oberseminar, 2 hrs Seminar/Week, Reinhard von Hanxleden

Winter 2010/2011

Inf-BS: Betriebssysteme, 3 hrs Vorlesung/Week, Reinhard von Hanxleden

Übung zu: Betriebssysteme, 2 hrs Übung/Week, Reinhard von Hanxleden (+ Hagen Peters, Christian Motika)

MS1101: Modellierung nebendläufiger Systeme, 4 hrs Vorlesung/Week, Reinhard von Hanxleden (+ Rudolf Berghammer)

Übung zu: Modellierung nebendläufiger Systeme, 2 hrs Übung/Week, Reinhard von Hanxleden (+ Miro Spönemann)

MSP1101: Masterprojekt - Echtzeitsysteme/Eingebettete Systeme, 4 hrs Übung/Week, Reinhard von Hanxleden (+ Miro Spönemann, Christian Motika)

MSS1101: Seminar - Echtzeitsysteme/Eingebettete Systeme, 2 hrs Seminar/Week, Reinhard von Hanxleden (+ Christian Motika)

Oberseminar - Echtzeitsysteme und Eingebettete Systeme, 2 hrs Seminar/Week, Reinhard von Hanxleden

Third-Party Funds

Zukunftsförderprogramm Wirtschaft (ZPW), Modellbasierte Entwurfsmethoden für eine neue Generation elektronischer Stellwerke (MENGES), 01.08.2009-31.07.2012 (217.560 EUR)

DAAD Programm des Projektbezogenen Personenaustauschs (PPP) USA, Model Engineering and Predictable Processing, 01.01.2010-31.12.2011 (15.318 EUR)

Further Cooperation, Consulting, and Technology Transfer

Cooperation with Edward A. Lee, University of California, Berkeley, on the automatic layout of Ptolemy II diagrams and simulation of SyncCharts (funded by DAAD PPP).

Cooperation with the Software Engineering group (Prof. Hasselbring), b + m Informatik AG and Funkwerk Information Technologies GmbH on the model-based design of railway signalling applications (project MENGES).

Cooperation with ETAS/Bosch, on visual model exploration. Advisorship (R. v. Hanxleden) of a doctoral researcher (Matthias Schmeling, graduate of the CAU) at ETAS.

Cooperation with Michael Mendler, Bamberg University, on worst case reaction time analysis.
Cooperation with Petra Mutzel, University of Dortmund, on layout algorithms with port constraints.
Cooperation with Partha Roop and Sidharta Andalum, University of Auckland, New Zealand, on reactive processors and timing analysis.
Cooperation with CEA List (Saclay, Paris), on pragmatics of UML2 modelling.
Cooperation with the Daimler Center for Automotive IT Innovations (Berlin), on the automatic layout of Simulink diagrams.

**Diploma, Bachelor and Master Theses**

Sören Hansen, *(Bachelor Thesis)* Configurations and Automated Execution in the KIELER Execution Manager, 24.03.2010  
Michael Matzen, *(Diploma Thesis)* A Generic Framework for Structure-Based Editing of Graphical Models in Eclipse, 26.03.2010  
Adriana Lukaschewitz, *(Bachelor Thesis)* Transformation von Esterel nach SyncCharts in KIELER, 30.03.2010  
Matthias Schmelinger, *(Diploma Thesis)* A Graphical Editor for IEC 61499 Function Blocks, 17.04.2010  
Torsten Amende, *(Diploma Thesis)* Synthese von SC-Code aus SyncCharts, 22.05.2010  
Joachim Bleiđiessiel, *(Diploma Thesis)* A Domain Specific Language for Railway Control, 20.09.2010  
Ole Claussen, *(Diploma Thesis)* Implementing an Algorithm for Orthogonal Graph Layout, 29.09.2010  
Philipp Döhring, *(Bachelor Thesis)* Algorithmen zur Layerzuweisung, 29.09.2010  
Christian Kutschmar, *(Bachelor Thesis)* Planarisierung von Hypergraphen, 29.09.2010  
John Carstens, *(Bachelor Thesis)* Datenvisualisierung in grafischen Modellen, 30.09.2010  
Mirko Heinold, *(Bachelors Thesis)* Synchronous Java, 30.09.2010  
Paul Klose, *(Bachelor Thesis)* Beispiel Management in KIELER, 30.09.2010  
Martin Rieß, *(Bachelor Thesis)* A Graph Editor for Algorithm Engineering, 30.09.2010  
Niclas Köser, *(Bachelor Thesis)* SyncCharts in C auf Multicore, 20.10.2010

**Dissertations / Postdoctoral Lecture Qualifications**


**Publications**

Published in 2010

X. Li, R. von Hanxleden, *Multi-Threaded Reactive Programming - The Kiel Esterel Processor*, IEEE Transactions on


Presentations

C. Motika, KlePto - KIELER Leveraging Ptolemy Semantics - Executing SyncCharts with Ptolemy, Presentation at the Ptolemy group, Department of Electrical Engineering and Computer Sciences, University of California at Berkeley, Berkeley, USA, 09.03.2010


H. Fuhrmann, C. Motika, Metamodeling, Transformation and Code Generation in Eclipse, Presentation and interactive demo at the Ptolemy group, Department of Electrical Engineering and Computer Sciences, University of California at Berkeley, Berkeley, USA, 16.03.2010


R. von Hanxleden, Modellieren statt Malen - Ein pragmatischer Ansatz, Computer Science and Transport Symposium Kiel, Kiel, Germany, 05.05.2010

J. Bleidiesel, On the Pragmatics of Model-Based Design— The KIELER Approach, Invited presentation at the Irkutsk State University, Irkutsk, Russia, 26.05.2010

M. Spönemann, Pragmatik modellgetriebener Systementwicklung, Modellierung © CAU, Kiel, Germany, 20.07.2010


C. Motika, Simulating SyncCharts and Actor-Oriented Modeling in KIELER, Presentation and interactive demo at the Ptolemy group, Department of Electrical Engineering and Computer Sciences, University of California at Berkeley, Berkeley, USA, 21.09.2010


C. Schneider, G. Hoops, W. Goerigk, Integration von textueller und grafischer Modellierung - Pragmatik in MENGES, KoSSE-Workshop, Lübeck, Germany, 10.11.2010

R. von Hanxleden, H. Fuhrmann, Taming Graphical Modeling, Presentation at the 17th International Open Workshop on Synchronous Programming (SYNCHRON’10), Frejus, France, 29.11.-03.12.2010

C. Motika, Executing SyncCharts with Ptolemy, 17th International Open Workshop on Synchronous Programming
Further Activities and Events

H. Fuhrmann, C. Motika, C. Schneider, M. Spönemann:
reviewer for the International Conference on Embedded Software (EMSOFT).

R. von Hanxleden:

C. Motika, C. Schneider:
demonstration of the model-railway, Girls’Day 2010 (22.04.) and the Schnupperstudium (20.10.)


C. Traulsen:

Atin Ruia (Jadavpur University, India):
DAAD-WISE scholarship, for summer internship at the RTSYS group 01.06. - 31.07.