

Real Time Systems / Embedded Systems

The research interest of the RTSYS group is the systematic design and analysis of “computers that 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, and 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 *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:

- Pragmatics-aware model-based design of complex reactive systems,
- Automatic layout of graphical models,
- Deterministic concurrency and synchronous languages.

The **pragmatics-aware model-based design** concentrates on the practical aspects of creating, maintaining, and visualizing graphical system models, with the goal of enhanced designer effectiveness and productivity. 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 2012 include developments in the automatic generation of light-weight transient views of model components developed in the KIELER Light-weight Diagrams project (KLighD), and extended simulation capabilities for SyncCharts. Since 2010 KIELER’s layout capabilities are also part of UC Berkeley’s Ptolemy system, in 2012 they were further improved.

The major result in the area **deterministic concurrency and synchronous languages** is the development of a novel model of computation, termed *Sequential Constructiveness*, which combines deterministic, synchronous concurrency with sequential scheduling information inherent in traditional programming languages such as C or Java. This builds on a large body of theoretical work that has emerged from the synchronous programming community since the 1980s but is also of practical interest for designing safety-critical systems. Sequential Constructiveness has emerged from collaboration with colleagues working in theoretical computer science, notably Prof. Michael Mendler (U Bamberg), and with industrial users, notably National Instruments.

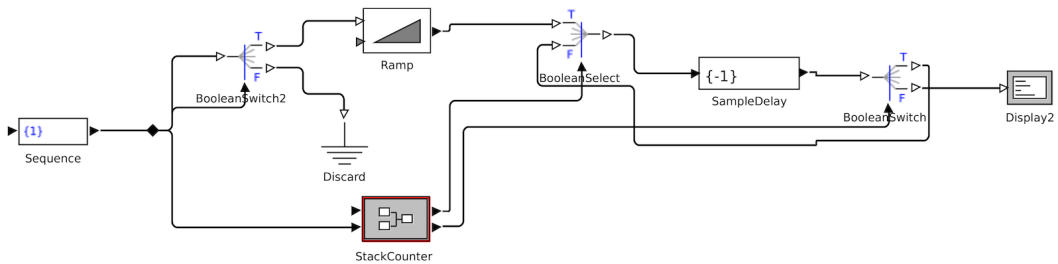
Personnel

Head of the group: Prof. Dr. R. von Hanxleden; Secretary: G. Walsdorf (50%)

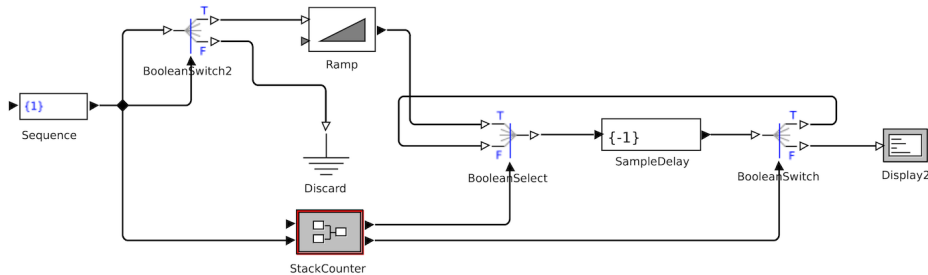
Technical Staff: T. Grebien (50%)

Scientific Staff:

Dipl.-Inf. Ass. iur. I. Fuhrmann PRETSY	15.03.-31.12.2012	DFG
Dipl.-Inf. C. Motika	01.01.-31.12.2012	CAU
Dipl.-Inf. C. Schneider MENGES	01.01.-31.12.2012	EU



(a) Layout using [Spönemann et al. 2009] (3 edge crossings, 30 edge bends)



(b) Layout using improved algorithm (1 edge crossing, 14 edge bends)

Fig. 1: A Ptolemy model representing a stack, illustrating recent improvements in the automatic layout of dataflow diagrams (example by Edward A. Lee, UC Berkeley, adapted from [Klauske et al. 2012]).

Dipl.-Inf. C. D. Schulze

01.01.-31.12.2012

CAU

Dipl.-Inf. M. Spönemann

01.01.-31.12.2012

CAU

Lectures, Seminars, and Laboratory Course Offers

Winter 2011/2012

MS1102: Synchrone Sprachen, 4 (+ 2) hrs Lecture (+ Exercises)/Week,

R. von Hanxleden

Übung zu: Synchrone Sprachen, 2 hrs Exercise/Week,

R. von Hanxleden (+ C. Motika)

MSP1101: Praktikum Echtzeitsysteme/Eingebettete Systeme, 4 hrs Practical/Week,

R. von Hanxleden (+ C. Motika)

BA6.1: Projektmodul - Echtzeitsysteme/Eingebettete Systeme, 6 hrs Practical/Week,

R. von Hanxleden

Inf-Sem-Echtz: Bachelorseminar Echtzeitsysteme / Eingebettete Systeme (Layoutalgorithmen für Graphen), 2 hrs Seminar/Week,

R. von Hanxleden (+ M. Spönemann)

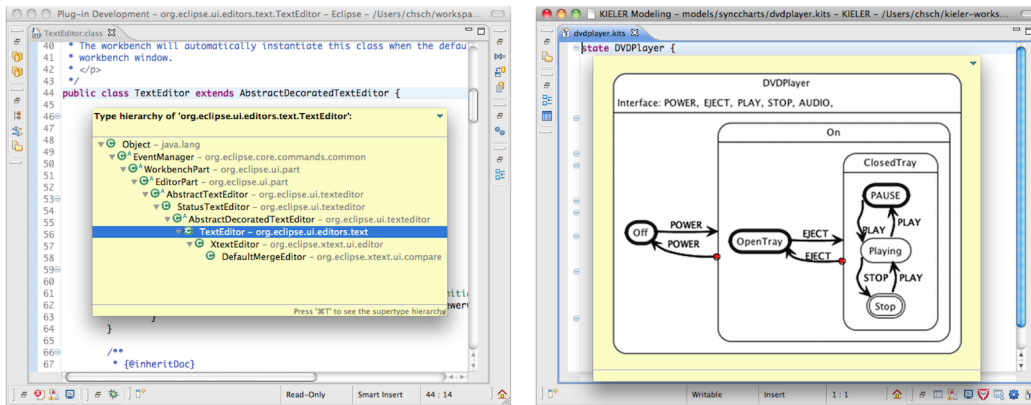
MSS1101: Masterseminar Echtzeitsysteme / Eingebettete Systeme (Layoutalgorithmen für Graphen), 2 hrs Seminar/Week,

R. von Hanxleden (+ M. Spönemann)

MSS1102: Masterabschlussseminar - Echtzeitsysteme / Eingebettete Systeme, 2 hrs Seminar/Week,

R. von Hanxleden

Summer 2012



(a) Inheritance hierarchy of a class. (b) Proposal: transient Statechart diagram.

Fig. 2: Illustration of transient views. Given some textual model, one can automatically generate abstract, graphical views that highlight certain aspects (adapted from [Schneider et al. 2012]).

Inf-OAR (G2.2): Systemorientierte Informatik II - Organisation und Architektur von Rechnern, 3 (+2) hrs Lecture (+ Exercises)/Week,

R. von Hanxleden

Übung zu: Systemorientierte Informatik II - Organisation und Architekturen von Rechnern, 2 hrs Exercise/Week,

R. von Hanxleden (+ C. D. Schulze, M. Spönemann)

MS1101: Modellierung nebenläufiger Systeme, 4 (+2) hrs Lecture (+ Exercises)/Week,

R. von Hanxleden

Übung zu: MS1101: Modellierung nebenläufiger Systeme, 2 hrs Exercise/Week,

R. von Hanxleden (+ M. Spönemann)

MSP1101: Praktikum Echtzeitsysteme/Eingebettete Systeme (Modellbahn), 4 hrs Practical/Week,

R. von Hanxleden (+ C. Motika)

BA6.1: Projektmodul - Echtzeitsysteme/Eingebettete Systeme (Modellbahn), 6 hrs Practical/Week,

R. von Hanxleden (+ C. Motika)

Inf-Sem-Echtz: Bachelorseminar Echtzeitsysteme / Eingebettete Systeme (Synchrone Sprachen), 2 hrs Seminar/Week,

R. von Hanxleden

MSS1101: Seminar - Echtzeitsysteme / Eingebettete Systeme (Synchrone Sprachen), 2 hrs Seminar/Week,

R. von Hanxleden (+ C. Motika)

MSS1102: Masterabschlussseminar - Echtzeitsysteme / Eingebettete Systeme, 2 hrs Seminar/Week,

R. von Hanxleden

Winter 2012/2013

Inf-AP-ES: Abschlussprojekt - Echtzeitsysteme/Eingebettete Systeme (Eclipse Modeling), 6 hrs Practical/Week,

W. Hasselbring (+ C. D. Schulze, M. Spönemann)

MSP1101: Masterprojekt - Echtzeitsysteme/Eingebettete Systeme (Eclipse Modeling), 4 hrs Practical/Week,

W. Hasselbring (+ C. D. Schulze, M. Spönemann)



Fig. 3: Participants of the seminar "Layoutalgorithmen für Graphen", WS 2011/12 (06.02.)

Third-Party Funds

Zukunftsprogramm 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, *Multi-View Modeling and Pragmatics*, 01.01.-31.12.2012 (9.634 EUR)

DFG Sachbeihilfe, *Precision-Timed Synchronous Reactive Processing (PRETSY)*, 01.11.2011-30.10.2014 (251.925 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.

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 Zoran Salcic, University of Auckland, New Zealand, on reactive processors and timing analysis.

Cooperation with the Daimler Center for Automotive IT Innovations (Berlin), on the automatic layout of Simulink diagrams.

Cooperation with Irkutsk State University, on model-based design and reactive processors (funded by DAAD,

Diploma, Bachelor's and Master's Theses

- T. Mahnke-Nissen, (*Diploma Thesis*) *soq - Eine verteilte Anwendung zur einfachen Erfassung und Propagation von Forschungsdaten*, 30.01.2012
- I. Fuhrmann, (*Diploma Thesis*) *Layout of Compound Graphs*, 15.02.2012
- A. Bosy, (*Bachelor Thesis*) *Synthese von graphischen Darstellungen aus einer textuellen Verhaltensbeschreibung*, 31.03.2012
- S. Gundlach, (*Bachelor Thesis*) *Synthese von Datenflussdiagrammen aus annotierten C-Programmen*, 31.03.2012
- T. Grebien, (*Diploma Thesis*) *Managing Academic Eclipse-Based Projects*, 17.08.2012
- J. Carstens, (*Master Thesis*) *Node and Label Placement in a Layered Layout Algorithm*, 27.09.2012
- P. Klose, (*Master Thesis*) *A Generic Framework for Topology-Shape-Metrics-Based Layout*, 12.10.2012
- B. Duderstadt, (*Diploma Thesis*) *SCCharts: A Sequentially Constructive Statecharts Dialect*, 26.11.2012

Publications

Published in 2012

- X. Li, R. von Hanxleden, *Multi-Threaded Reactive Programming - The Kiel Esterel Processor*, IEEE Transactions on Computers, **61(3)**, 337 - 349 (2012)
- R. von Hanxleden, E. A. Lee, C. Motika, H. Fuhrmann, *Multi-View Modelling and Pragmatics in 2020 - Position Paper on Designing Complex Cyber-Physical Systems*, In Pre-Proceedings of the 17th International Monterey Workshop on Development, Operation and Management of Large-Scale Complex IT Systems, Oxford, UK, (2012)
- C. Schneider, M. Spönemann, R. von Hanxleden, *Transient View Generation in Eclipse*, Technical Report, Christian-Albrechts-Universität zu Kiel, Department of Computer Science, **1206**, (2012)
- S. Banerjee, *Timing Analysis for the Precision Timed ARM Processor*, Technical Report, Christian-Albrechts-Universität zu Kiel, Department of Computer Science, **1212**, (2012)
- C. Schneider, M. Spönemann, R. von Hanxleden, *Transient View Generation in Eclipse*, Proceedings of the First Workshop on Academics Modeling with Eclipse, Kgs. Lyngby, Denmark, (2012)
- L. K. Klauske, C. D. Schulze, M. Spönemann, R. von Hanxleden, *Improved Layout for Data Flow Diagrams with Port Constraints*, Proceedings of the 7th International Conference on Diagrammatic Representation and Inference (DIAGRAMS'12), Cambridge, UK, **volume 7352 of LNAI, Springer**, 65 - 79 (2012)
- C. Motika, R. von Hanxleden, M. Heinold, *Synchronous Java: Light-Weight, Deterministic Concurrency and Preemption in Java*, Technical Report, Christian-Albrechts-Universität zu Kiel, Department of Computer Science, **1213**, (2012)
- C. Motika, H. Fuhrmann, R. von Hanxleden, E. A. Lee, *Executing Domain-Specific Models in Eclipse*, Technical Report, Christian-Albrechts-Universität zu Kiel, Department of Computer Science, **1214**, (2012)
- R. von Hanxleden, N. Holsti, B. Lisper, J. Gustafsson, N. M. Islam, E. Ploedereder, W. Fellger, S. Gepperth, F. Krause, R. Wilhelm, A. Bonenfant, H. Casse, M. de Michiel, C. Rochange, S. Bünte, L. Kovacs, W. Puffitsch, M. Zolda, J. Zwirchmayr, D. Kästner, S. Wegener, R. Kirner, M. C. Olesen, A. Prantl, M. Schoeberl, *The WCET Tool Challenge 2011*, Technical Report, Christian-Albrechts-Universität zu Kiel, Department of Computer Science, **1215**, (2012)
- R. von Hanxleden, E. A. Lee, C. Motika, H. Fuhrmann, *Multi-View Modelling and Pragmatics in 2020 - Position Paper on Designing Complex Cyber-Physical Systems*, Proceedings of the 17th International Monterey Workshop on Development, Operation and Management of Large-Scale Complex IT Systems, Oxford, UK, **volume 7539 of LNCS**, (2012)
- W. Goerigk, R. von Hanxleden, G. Hasselbring, G. Hennings, R. Jung, H. Neustock, H. Schaefer, C. Schneider, E. Schultz, T. Stahl, S. Weik, S. Zeug, *Entwurf einer domänenspezifischen Sprache für elektronische Stellwerke*, Software Engineering 2012: Fachtagung des GI-Fachbereichs Softwaretechnik, Berlin, Lecture Notes in Informatics,

Presentations

- R. von Hanxleden, E. A. Lee, C. Motika, H. Fuhrmann, *Multi-View Modelling and Pragmatics in 2020 - Position Paper on Designing Complex Cyber-Physical Systems*, 17th International Monterey Workshop on Development, Operation and Management of Large-Scale Complex IT Systems, Oxford, UK, 19.-21.03.2012
- C. Schneider, *Modellieren statt Malen - Ein pragmatischer Ansatz*, LACTOSE-Workshop Fraunhofer FIRST, Berlin, Germany, 19.04.2012
- R. von Hanxleden, *Tipps zur Antragstellung aus der Sicht eines Antragsgutachters*, Informationsveranstaltung EU-Forschungsrahmenprogramm im Bereich Informations- und Kommunikationstechnologien - IKT, Kiel, Germany, 31.05.2012
- R. von Hanxleden, *The Sequentially Constructive Model of Computation*, Presentation at Laboratoire d'Informatique de l'École normale supérieure (ENS), Paris, France, 13.06.2012
- R. von Hanxleden, M. Spönemann, C. D. Schulze, *Pragmatics-Aware Modelling with the Kiel Integrated Environment for Layout Eclipse Rich Client (KIELER)*, ETAS Group Presentation, Stuttgart, Germany, 22.06.2012
- C. Schneider, M. Spönemann, R. von Hanxleden, *Transient View Generation in Eclipse*, First Workshop on Academics Modeling with Eclipse, Kgs. Lyngby, Denmark, 02.07.2012
- L. K. Klauske, C. D. Schulze, M. Spönemann, R. von Hanxleden, *Improved Layout for Data Flow Diagrams with Port Constraints*, 7th International Conference on Diagrammatic Representation and Inference (DIAGRAMS'12), Cambridge, UK, 02.-06.07.2012
- C. Motika, C. D. Schulze, *Plans for Improving Automatic Layout in Ptolemy*, Ptolemy Lunch, EECS Department, UC Berkeley, Berkeley, CA, USA, 05.09.2012
- I. Fuhrmann, C. Motika, C. D. Schulze, *A Short Introduction to New Layout Features*, Ptolemy Lunch, EECS Department, UC Berkeley, Berkeley, CA, USA, 12.09.2012
- I. Fuhrmann, C. Motika, C. D. Schulze, *Ptolemy Modal Models enhanced by SyncCharts Immediate Transitions*, Ptolemy Lunch, EECS Department, UC Berkeley, Berkeley, CA, USA, 19.09.2012
- R. von Hanxleden, *Pragmatics-Aware Modelling*, Seminar at National ICT Australia (NICTA), Sydney, Australia, 10.10.2012
- R. von Hanxleden, *Synchronous C: A Proposal for Light-Weight, Deterministic Concurrency*, Pretzel Weekly Forum at the Department of Electrical and Computer Engineering, University of Auckland, Auckland, New Zealand, 08.11.2012
- R. von Hanxleden, *Pragmatics-Aware Modelling*, Seminar at the Department of Computer Science, University of Auckland, Auckland, New Zealand, 28.11.2012

Further Activities and Events

R. von Hanxleden:

Chair of the Department of Computer Science (until 30.06.2012).

Member of the *ArtistDesign European Network of Excellence on Embedded System Design*.

Programme Committee member for the *International Conference on Embedded Software (EMSOFT'12)*, the *Embedded System Design (ESD) Track at the International Symposium on Electronic System Design (ISED) 2012*, the *17th International Monterey Workshop on Development, Operation and Management of Large-Scale Complex IT Systems* and the *Methodische Entwicklung von Modellierungswerkzeugen (MEMWe2011) Workshop at the GI-Jahrestagung INFORMATIK 2012*.

Reviewer for the *ACM Transactions on Embedded Computing Systems (ACM TECS)* and the *IEEE Transactions on Software Engineering (IEEE TSE)*.

Reviewer of the EU-FP7 Project DESTTECS (*Design Support and Tooling for Embedded Control Software*).

Research visit to the University of Auckland, to NICTA, Sydney, and to Swinburne and Monash Universities, Melbourne (10.2012-03.2013).

I. Fuhrmann, C. Motika, C. D. Schulze:

Research stay at UC Berkeley, visiting Prof. E. Lee and his group (03.-22.09.2012).

C. Motika, C. Schneider:

Demonstration of the Model-Railway, Girls' Day 2012 (26.04.2012) and the *Schnupperstudium* (16./17.10.2012)

C. Motika, R. von Hanxleden:

Reviewers for "*Enterprise Modelling and Information Systems Architectures (EMISA)*" (Journal).

J. Carstens, I. Fuhrmann, T. Grebien, R. von Hanxleden, P. Klose, C. Motika, C. Schneider, C. D. Schulze, M. Spönemann:

Reviewers for the *International Conference on Embedded Software (EMSOFT'12)*.

T. Grebien, R. von Hanxleden, C. Krüger, C. Motika, C. Schneider, C. D. Schulze, M. Spönemann:

Reviewers for *GI SICHERHEIT 2012 Sicherheit - Schutz und Zuverlässigkeit*.

I. Fuhrmann, R. von Hanxleden, C. Motika, C. Schneider, C. D. Schulze, M. Spönemann:

Reviewers for *International Symposium on Electronic System Design (ISED) 2012*.

B. Duderstadt, T. Grebien, R. von Hanxleden, C. Motika, C. Schneider, C. D. Schulze, M. Spönemann:

Reviewers for *ACM SIGPLAN/SIGBED Conference on Languages, Compilers, Tools and Theory for Embedded Systems (LCTES) 2012*.

R. von Hanxleden, C. Motika, C. D. Schulze, M. Spönemann:

Reviewers for *Proceedings of the 17th International Monterey Workshop on Development, Operation and Management of Large-Scale Complex IT Systems* (LNCS volume 7539).

Further Activities

PRETSY-Workshop (23.-25.05.2012)

Visit from Alexei Zhukov, Irkutsk State University (02.-28.04.2012)

Visit from Subarno Banerjee, IAESTE Internship from National Institute of Technology, Durgapur, India (19.05.-21.09.2012)

Visit from Indrajit Malatesh Nadgir, ETAS India (23.04.-04.05.2012)

Visit from Matthew Viele, National Instruments (14.05.2012)

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