This is the fifth Biennial report of the Department of Informatics (IFI) at Technische Universität Clausthal, covering the years 2012 and 2013. It provides an overview of all major research and educational activities of the department members. In the reporting period, we were able to further increase the level of external research funding despite four professor vacancies. Furthermore, we successfully completed the re-accreditation of our Bachelor-/Master programs in Computer Science and Business Information Systems (German: Wirtschaftsinformatik), and reached top marks in the CHE university rankings in Computer Science and Wirtschaftsinformatik. Last but not least, we were happy to celebrate the Department’s 30th anniversary with an open Day with more than 400 visitors.

The success of the department could not have been achieved without the high and persistent efforts of each individual person in our department, in teaching, research, administration, and infrastructure support. It is my strong wish to express my appreciation and gratitude to them. Due to their spirit and dedication, the Department is well set up for the future challenges.

Composing a report like this involves long hours of tedious effort. Although all research groups did provide us with material for Chapter 3, it still was a lot of work to compile the overall report, especially if the “content owners” are busy professors. I would like to thank Sven Hartmann for contributing Chapter 2. Andrea Behfeld, Stefanie Cronjäger, Christine Kammann, Sandra Karpenstein, and Anita Seiz-Uhlig have helped putting together finance and personnel data. Last but not least, Adina Aniculăeșei and Federico Schlesinger have collected contributions (sometimes with gentle force) and put them together into a coherent and homogeneous booklet: Thank you very much indeed.

While we did our best to make sure that all data are sound and correct, we do not claim that this report is flawless. It goes without saying that I am solely responsible for any remaining faults.

As the world keeps on progressing rapidly, for more recent information we refer to our webpage, http://www.in.tu-clausthal.de/, which is continually updated.

July 2014

Prof. Dr. Jörg Müller
Head of Department
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1 The Department of Informatics

1.1 Overview

Like no other research discipline, computer science has been profoundly and irreversibly changing our society and our daily lives over the past fifty years. The pace of this change is continually increasing (with recent trends like social software or cloud computing), and computer systems are getting more complex and more difficult to understand, to design, and to control. In order to be able to master the complexity of tomorrow’s IT ecosystems, and to maintain Germany’s competitiveness in a global race for innovation and market shares, young computer scientists need to learn about the techniques of professional computer science in order to understand, analyze, design, and build complex computer-based applications. To make an important contribution to this endeavor is the educational mission of the Department of Informatics at Technische Universität Clausthal. We offer young people high-quality courses in the core disciplines of computer science, such as computer engineering, communication and distributed systems, computer graphics, computer supported collaborative work, database systems, software engineering, theoretical computer science, business information technology, and computational intelligence.

The development of the department over the years 2012 and 2013 was characterized by: (i) a process of stabilization after previous fast growth; (ii) successful re-accreditation of the Bachelor/Master programs in Computer Science and Business Information Systems (German: Wirtschaftsinformatik); (iii) further increased external research funding which was mainly fueled by the Institute for Applied Software Systems Engineering (IPSSE), an industrial Research Institute funded by Volkswagen AG, founded in 2011.

At the same time, two esteemed colleagues left the department in the reporting period; there are currently four professor vacancies in our department, and three appointment procedures ongoing.

As mentioned above, the national and international visibility of our research continues to be at a high level: publication output, citation indices, and international networking activities are strong; at the same time, acquired research funding has grown considerably compared to the previous reporting period, while the number of completed dissertations/habilitations remains at a stable level.
In the NTH context, the NTH School of IT Ecosystems, which was launched in 2009 as a 3.5 million € research project by the computer science departments of TU Braunschweig, LU Hannover and TU Clausthal, was finished in 2012, leading to promising successor projects such as the DFG-funded SocialCars Research Training Group, the DFG Priority Program Design For Future - Managed Software Evolution, and the NTH Bottom-Up project Robotic Firefighters. Currently, NTH is undergoing an evaluation process, and we are all curious about the results and future directions of this institution.

1.2 History

In 2012, the Department of Informatics at TU Clausthal celebrated its 30th anniversary with an established tradition in education and research. From 1984 to 2006 the department ran a five-year degree (Diplom) program in computer science. Since the mid-nineties, this was supplemented by a Diploma program in Business Information Systems. In 2006, the Diploma program was replaced by Bachelor/Master programs in Computer Science and Wirtschaftsinformatik.

The department went through a challenging period during the late nineties and early two-thousands: It was understaffed and had to serve a large number of students. Finally, a strategic decision was made in 2002/03 by the federal state of Lower Saxony and the executive management of our university to establish computer science as one of the core technological backbones of Technische Universität Clausthal. This resulted in plans to increase the academic headcount to the size recommended by the German Association of Computer Science (German: Gesellschaft für Informatik).

As a consequence, between 2003 and 2009, the department went through a period of fundamental change, characterized by the retirement of four colleagues, and the successful appointment of nine new professors. From 2009 to 2011, three colleagues of our department were offered chairs at highly reputed international universities: in 2009, Kai Hormann accepted an offer for a chair at the University of Lugano; in 2010, Barbara Hammer left for the Center of Excellence on Cognitive Interaction Technology at the University of Bielefeld; in 2011, Andreas Rausch declined an offer for a Chair at University of Hamburg.
1.3 Research

While the years 2004–2010 were characterized by an almost complete re-staffing of the department’s faculty, the focus in the reporting period was on establishing and stabilizing the new structures, on improving the research funding, and on positioning the department in the new context of the NTH. An important indicator of the successful scientific development in the department are the number and quality of scientific publications as well as memberships of researchers of the department in international program committees. Figure 1-1 illustrates the development of the scientific publication activities of members of the department between 2004 and 2013, categorized by type of publication (peer-reviewed publications only). It reflects a lively and high-quality publication activity, even though the absolute numbers compared to the two years before have slightly decreased. The visibility of our faculty is also reflected in an average h-index of 18 (according to Google Scholar Citations and Harzing PoP).

![Figure 1-1 Scientific publications of the department.](image)

In the current climate of industrializing universities and focusing resources to “elites”, the acquisition of external funds is gaining importance as a key performance indicator for research. Figure 1-2 shows the development of funding income, broken down into two types of funds:

- Funding from national, e.g., BMBF, DFG, and international agencies, e.g., European Commission, as well as industry funding (German: “Drittmittel”),
Additional funding acquired from the federal government of Lower Saxony, e.g., for e-Learning activities and innovation projects (German: “**Sondermittel**”).

The chart shows that the very positive development witnessed in the previous reporting period is continuing. With a total acquired funding of over 4.5 million €, the performance in this reporting period has increased by 17% compared to the 2010/2011 period, which is mainly due to the new IPPSE project and the large IT Ecosystems NTH project, the latter running until the end of 2012.

![Figure 1-2 Funding acquisition of the department.](image)

Another important indicator of scientific activity is the number of completed dissertations. In this respect, as shown in figure Figure 1-3, the performance of the department is roughly at the same level as in the previous reporting period — the slight stagnation is mainly due to the fact that four professorships are currently vacant.
1.4 Education

The Department of Informatics

Figure 1-3 Completed dissertations in the department.

Figure 1-4 illustrates the development of the number of students who graduated with a Diploma, Bachelor’s, or Master’s degree from our department. After the introduction of Bachelor/Master and the gradual termination of the Diploma program, the number of Diploma students has naturally kept on decreasing. While the number of graduates from the new Bachelor/Master program is increasing, it is still below the level of the former Diploma program.

Finally, it should be mentioned that the department has been active in numerous national and international cooperations in education and research, which have led and will lead to new scientific results and funding prospects. In the area of scientific education, the collaboration with other universities within Lower Saxony in the ELAN and ATLANTIS programs as well as the International Master course on Internet Technologies and Information Systems are worth mentioning (see also Chapter 2), as well as our comprehensive involvement in the ERASMUS mobility program.
Education activities in the past two years were focused on preparing the re-accreditation of the Bachelor and Master programs in the areas of computer science and business information technology (see Chapter 2 for details) in 2013, and on extending our offering in the areas of computer engineering (with a Bachelor-Master Program). The Early Studies program in Computer Science has been extended, and a new Master Course in Systems Engineering has been started, targeting professional education.

In the reporting period, the courses offered by our Department achieved three excellent valuations in the prestigious university ranking led by the Centrum für Hochschulentwicklung (CHE) (http://ranking.zeit.de):

1. In the ranking published in May 2012, the Bachelor Course in Computer Science at TU Clausthal was listed as the best out of 78 universities in the German-speaking area, regarding the quality of student mentoring and supervision; we were attested the third-best quality in IT infrastructure, and were among the top 6 on the criterion of overall student satisfaction. Figure 1-5 shows an excerpt from the official CHE ranking available at http://ranking.zeit.de, illustrating the excellent performance of TU Clausthal in comparison with some other German top universities and neighboring universities in Lower Saxony.
1.4 Education

The Department of Informatics

Figure 1-5 Excerpt of CHE Hochschulranking 2012/2013 Informatik (Bachelor) (Source: http://ranking.zeit.de). Criteria: (1) Overall assessment; (2) Support and supervision by lecturing staff; (3) IT infrastructure; (4) Research funding by scientist; (5) Research reputation.

2. In the corresponding ranking of Master Programs, published in January 2013, the Master Program in Computer Science at our Department reached top scores in all five main criteria. Out of 33 participating universities, TU Clausthal is the only non-private university that achieved such a result. Figure 1-6 shows the top universities ranked by the five default ranking criteria provided by the CHE, see http://ranking.zeit.de.

3. In early 2014, an update to the CHE Ranking in Business Information Technology (German: Wirtschaftsinformatik) was published, covering the Bachelor Programs. We are glad to report that also in this ranking, TU Clausthal achieved an excellent result, as shown in Figure 1-7: Out of 45 universities, we came second in the ranking (following the CHE default ranking criteria).

For a detailed overview of our study programs, we refer to Chapter 2 of this report.
Mentoring Program

The department provides a mentoring program for first-year students in computer science designed to help them to get accustomed to the new environment. In small groups, students meet regularly in order to discuss work issues, but also problems of daily university life.

Since the winter term 2013/14, the Mentoring Program has been integrated into a new introductory course, the Computer Science Workshop (German: Informatik-werkstatt). The aim of this new offering is to support students in the initial phase of their studies by offering them a practical perspective on their future field of work. This aim is achieved by a range of offerings, including:

Figure 1-6 Excerpt of CHE Hochschulranking 2013/2014 Informatik (Master) (Source: http://ranking.zeit.de). Criteria: (1) Overall assessment; (2) IT infrastructure; (3) Course offering; (4) Curriculum; (5) Ease of transition to Master program.
1.5 Staff and Organization

Figure 1-7 Excerpt of CHE Hochschulranking 2013/2014 Wirtschaftsinformatik (Bachelor) (Source: http://ranking.zeit.de). Criteria: (1) Overall assessment; (2) Curriculum; (3) International orientation; (4) Course offering; (5) Publications per year.

- practical work in small groups under guidance from experienced personnel. Here students learn a variety of things, e.g. how to program Lego Mindstorms robots, about processes and features of the SAP ERP application system, how to create their first mobile phone app, or how to build a little vehicle on their own. In the Informatics Workshop, we follow a problem-based learning method which, in our experience, helps motivate students.

- regular opportunities to learn about elementary soft skills, such as organizing / moderating meetings, dealing with conflicts in groups, documenting results of teamwork, and presenting them using different media.

- meetings with alumni who provide information about their occupational profiles, about their everyday work, and who are happy to answer questions which the students may have.

- a technology fair at the end of the term where student groups proudly demonstrate the practical results of their work.
1.5 Staff and Organization

Staff

Nine professors, and two adjunct professors have been members of the Department of Informatics by December 31, 2013.

With a mixture of sadness and pride, we report that in the reporting period, two esteemed colleagues left our Department following offers of professorships at German “Elite Universities”: In 2012, Gabriel Zachmann was offered a full professorship in Computer Graphics at the Universität Bremen. In 2013, Niels Pinkwart was offered a Full Professorship in Computer Science Education / Computer Science and Society at Humboldt Universität Berlin. We thank Gabriel and Niels for their dedicated and fruitful work in our department; our best wishes for the future accompany them, and with research collaborations going on, they will continue to be very welcome guests at our department. Their example has shown that the department offers young scientists an inspiring and fruitful work environment in which they can develop their skills and personalities and create research results at an internationally competitive level.

During the reporting period, the number of research staff (without professors) grew from 50 to 59 (2009: 40), reflecting in particular the increase in research funding. Last but not least, the department also enjoys the dedicated support by three technicians, as well as nine members of the administration team. For more detailed and recent information, please visit http://www.in.tu-clausthal.de/personen/.
1.5 Staff and Organization

- **Professors**
  - Prof. Dr. Jürgen Dix  
    *Computational Intelligence*
  - Dr. Stefan Guthe (since October 2012)  
    *Computer Graphics and Multimedia*
  - Dr. Andreas Harrer (since September 2013)  
    *Business Information Technology: Human-Centered Information Systems*
  - Prof. Dr. Sven Hartmann  
    *Databases and Information Systems*
  - Prof. Dr. Michaela Huhn  
    *Theoretical Foundations of Computer Science*
  - apl. Prof. Dr. Günter Kemnitz  
    *Hardware-Design and Robotics*
  - Prof. Dr. Jörg P. Müller  
    *Business Information Technology: Mobile and Enterprise Computing*
  - Prof. Dr. Niels Pinkwart (until May 2013)  
    *Business Information Technology: Human-Centered Information Systems*
  - Prof. Dr. Andreas Rausch  
    *Software Systems Engineering & Institute for Applied Software Systems Engineering*
  - apl. Prof. Dr. Matthias Reuter (CUTEC)  
    *Modeling and Simulation*
  - Prof. Dr. Harald Richter  
    *Technical Informatics and Computer Systems*
  - Prof. Dr. Christian Siemers (50%)  
    *Distributed Systems and Communication*
  - Prof. Dr. Gabriel Zachmann (until September 2012)  
    *Computer Graphics and Multimedia*

- **Former Professors**
  - Prof. Dr. Gerhard Joubert (until 2003)  
    *Practical Computer Science*
  - Prof. Dr. Ingbert Kupka (until 2004)  
    *Theoretical Computer Science*
  - Prof. Dr. Wilfried Lex (until 2004)  
    *Mathematical Foundations of Computer Science*
  - Prof. Dr. Klaus Ecker (until 2005)  
    *Applied Computer Science*
• Prof. Dr. Torsten Grust (until 2005)
  Databases
• Prof. Dr. Kai Hormann (until 2009)
  Computer Graphics and Multimedia
• Prof. Dr. Barbara Hammer (until 2010)
  Theoretical Foundations of Computer Science
• Prof. Dr. Niels Pinkwart (until 2013)
  Business Information Technology: Human-Centered Information Systems
• Prof. Dr. Gabriel Zachmann (until 2012)
  Computer Graphics and Multimedia

Department Organization


☐ Head of department (German: Institutsdirektor)
  • Prof. Dr. Jörg P. Müller (since 2008)

☐ Board (German: Direktorium)
  • Prof. Dr. Jürgen Dix, Prof. Dr. Sven Hartmann, Prof. Dr. Jörg P. Müller

☐ Infrastructure team
  • Dipl.-Ing. (FH) Thomas Bravin
  • Jörn Körner
  • Peter Platzdasch

☐ Administration team
  • Andrea Behfeld
  • Stefanie Cronjäger
  • Daniela Görtz
  • Arne Heine
  • Nadine Heinrich
  • Christine Kammann
  • Sandra Karpenstein
1.6 Major events and activities

30th Anniversary Celebration

In Summer 2012, the Department of Informatics celebrated the 30th anniversary of its foundation in 1982. On July 7, 2012, the Department welcomed 400 guests. University staff, students, alumni, and many citizens from Clausthal-Zellerfeld spend a great day with many demos and expositions presented by members of the Department, a special scientific program for children, games, food and entertainment. Figure 1-8 shows some impressions of the program.

Figure 1-8 Impressions from the 30th Anniversary Celebration of our Department. Clockwise from top left: (i) Waiting for the crowd (in dry weather!); (ii) kids enjoy exploring the Lego Mindstorms simulator; (iii) testing out the real thing; (iv) director’s speech; (v) ubiquitous computing.
Colloquium Series

The department’s colloquium series serves as a communication platform for interchanging ideas between the different fields of computer science and related areas. It is a forum for our graduate and postgraduate students to get into contact with internationally renowned scientists and to initiate short term stays abroad, e.g. within the scope of a Master’s or Ph.D. thesis. Therefore, we invite speakers from all over the world to present their recent scientific advances and to discuss possible cooperations on future joint projects. In the reporting period, 30 guest researchers visited our department and presented their work in the colloquium series.

2012

- Dr. Dirk Werth (18.01.2012) 
  *Enterprise Software-as-a-Service*

- Jun.-Prof. Dr. Erika Ábrahám (13.02.2012) 
  *SAT-Modulo-Theories Solving for Real Algebra*

- Ph.D. Achim D. Bruckner (13.02.2012) 
  *Theorem Prover-based Testing*

- Dr. Micahela Huhn (13.02.2012) 
  *Formale Verifikation in der modellbasierten Entwicklung software-intensiver Systeme*

- Prof. Dr. Martin Lange (13.02.2012) 
  *SMT-Based Analysis of Real-Time Systems*

- Prof. Andreas Harrer (14.02.2012) 
  *Software architecture and intelligent support of self-organised group learning processes in Metafora*

- PD Dr. Sebastian Rudolph (14.02.2012) 
  *Entscheidbarkeit der Beantwortung konjunktiver Anfragen in Beschreibungslogiken mit Nominalen, Inversen und Kardinalitätsbeschränkungen*

- Prof. Dr. Marc Toussaint (14.02.2012) 
  *Probabilistic inference approaches to planning and reinforcement learning in structured domains*

- PD Dr. Rob von Stee (14.02.2012) 
  *Eigenmütziges Routing auf einem Ring*

- Dipl.-Ing. Christian Senf (06.03.2012) 
  *Standards für den elektronischen Datenaustausch in der öffentlichen Verwaltung*

- Dipl.-Ing. Nils Cordes (06.03.2012) 
  *E-Business Systeme auf der Basis offener Standards und freier Software*
1.6 Major events and activities

- Dr.-Ing. Dipl. Inf. Christian Allmann (14.03.2012)
  Forschungsprojekt e-performance

- Prof. Dr. Kevin D. Ashley (24.04.2012)
  Toward Teaching Writing and Argumentation with AI-Supported Peer Review

- Prof. Dr. Peter Dürr (07.05.2012)
  Einsatz von Softwaretools für den politischen Meinungsbildungsprozess

- Prof. Dr. Violeta Bozhikova (30.05.2012)
  Some approaches in the field of software engineering

- Dr. Gerhard Pews (16.04.2012)
  Ein Architekturstandard im öffentlichen Bereich: die Blaupausen der Register Factory

- Claus Jungmann and Marco Grunert (28.06.2012)
  Softwarearchitektur im Projekteinsatz

- Prof. Dr. Erik Jansen (06.07.2012)
  30 years computer graphics - towards realtime realistic rendering

- Prof. Dr. Jacek Blazewicz (07.07.2012)
  From scheduling to DNA sequencing and backward

- Prof. Dr. Franziska Klügl (16.07.2012)
  Multiagentensimulation - Methodik und Anwendung

- Prof. Dr.-Ing. Peter Liggesmeyer (30.11.2012)
  Von der Sicherheitsanalyse zum Safety Engineering: Multi-Core und Co.

- Prof. Dr. H. Dieter Rombach (06.12.2012)
  Improving Patient Safety and Risk Management through Software Engineering & Ambient Technology

☐ 2013

- Dr. Dirk Werth (16.01.2013)
  Software as a Service (Enrichment Lecture)

- Prof. Dr. Urs Andelfinger (31.01.2013)
  Die wirksame Nutzung von CMMI & Co. in der industriellen Praxis; Von Sackgassen und Erfolgsfaktoren

- Dr. Matei Popovici (12.02.2013)
  A logical method for temporal knowledge representation and reasoning

- Dr. Qing Wang (28.05.2013)
  Capturing Knowledge Patterns in Entity Resolution

- Prof. Jørgen Villadsen (12.06.2013)
  On Programming Multi-Agent Systems

- Dr. Lena Wiese (04.07.2013)
  Methods for logical database security
- Dr. Gerald Weber (21.10.2013)  
  *Document Orientation: A semantically rich way to describe user interfaces*

- Prof. Dr. Dirk Linowski (06.12.2013)  
  *Industrienahe Forschung an tunesischen Universitäten? Beobachtungen als EU Experte vor Ort*

For more information, see  
http://www.in.tu-clausthal.de/studium/informatik-kolloquium/.

### Awards and Nominations

☐ Andreas Rausch, together with Frank Nehuis, Marcel Ibe, Carsten Stechert and Thomas Vietor, received a Best Paper Award at the CIRP Design Conference 2012, held in Bangalore, India, March 28 - 30, 2012, for the contribution *Clustering Regional-Specific Requirements as a Methodology to Define the Modules of a Car Concept*.

☐ Andreas Rausch received a Sustainable Production Award in the Category “Automation & IT” at Hanover Fair 2013 for the BMBF-funded project *SOWEMA: Vollautomatisierte Prozesskette zur Fertigung lastoptimierter CFK-Bauteile*.

☐ Harald Richter received the Best Paper Award at the 10th IEEE East-West Design & Test Symposium (EWDTS 2012), held in Kharkov, Ukraine, September 14–17, 2012, with the contribution titled *Real-time Interconnection Network for Single-Chip Many-Core Computers*.

☐ Malte Aschermann and Jörg P. Müller were nominated for the Best Paper award at the 11th German Conference on Multiagent System Technologies, held in Koblenz, Germany, September 18–20, 2013, with a contribution titled *Similarity-Based Resource Retrieval in Multi-Agent Systems by Using Locality-Sensitive Hash Functions*.

### Graduate and Postgraduate Seminar

In the Graduate and Postgraduate Seminar, our graduate and postgraduate students report on their recent scientific achievements. In the reporting period, we have had the following 34 talks:

☐ **Summer 2012**

  - Stefan Warwas (08.05.2012)  
    *The Bochica Framework for Model-driven Agent-Oriented Software Engineering*
1.6 Major events and activities

- Wilfried Ramaker (28.06.2012)
  Multiagentensysteme für das dezentrale Management sensibler Daten: Architekturen und Methoden

- Malte Aschermann (19.07.2012)
  Effiziente Lokalisierung von Produktmodellen in dezentralen Umgebungen durch inhaltsbasierte Verteilungsstrategien

- David Drexler (28.08.2012)
  Methoden zur Exploration von großen zusammenhängenden Datenmengen und deren Evaluation am Beispiel von LASAD

- René Weller (07.09.2012)
  New Geometric Data Structures for Collision Detection

- Daniel Arifin Siemarga Sim (10.09.2012)
  Technologieanalyse und prototypische Implementierung eines Online-Portals auf Basis einer Business Process Engine

Winter 2012/2013

- Sascha Kattelmann (16.10.2012)
  Model Checking mit LTL und CTL

- Christian Eichhorn (06.11.2012)
  Vergleich agentenorientierter Simulationsplattformen und Evaluation ihrer Verwendbarkeit für Anwendungen des kooperativen Verkehrsmanagement

- Leila Majidi (06.11.2012)
  Logfilebasierte Usability-Analyse am Beispiel einer Online-Eltern-Community

- Jens Dehnert (06.11.2012)
  Game representations and their complexity

- Tarek Oueslati (06.11.2012)
  Modellbasierte Absicherung der funktionalen Sicherheit von zustandsabhängigen Fahrerassistenzfunktionen nach ISO 26262

- Stefan Rühl (31.01.2013)
  Introduction of Deployment Variability to Multi-Tenancy Applications

- Oliver Müller (11.02.2013)
  Ein constraintbasiertes Modell zur Beschreibung und Validierung von Schnittstellen in der Produktentwicklung

Summer 2013

- Xin Cai (02.04.2013)
  Instanzierung und Transformation von Modellen für die Diagnose von Bahnautomatisierungsanlagen
• Stefan Wittek (10.04.2013)
  Prototypische Implementierung und empirische Evaluation eines auf Bewe-
gungssteuerung basierenden Kommunikationskanals für Gesten in einer Kol-
laborativen Virtuellen 3D Welt
• Fechal Batakpale (18.04.2013)
  Entwicklung eines domänenspezifischen graphischen Editors für modulare
Werkzeugmaschinenmodelle
• Jürgen Lorenz (05.06.2013)
  Database Access Monitoring for Secure Database Communication
• Zhenyu Geng (14.06.2013)
  Hybride Parallisierung von Lattice Boltzmann Simulationen mit MPI und
CUDA
• Jörn Teuber (28.06.2013)
  Fast Sphere Packing with Adaptive Grids
• Sebastian Hanschke (01.07.2013)
  Skill-Systeme in Computerspielen am Beispiel von Porta Aenigma
• Sascha Lorenz (01.07.2013)
  Konzeption und prototypische Implementierung eines Systems zum Austausch
von Daten zwischen Tablets und interaktiven Tischen in Computerspielen
• Tobias Ahlbrecht (08.07.2013)
  A Tool for Computing Stable Topologies in Mobile Ad-Hoc Networks
• Javad Ghofrani (12.07.2013)
  An Improved Link Integrity Algorithm using Link Recycling and Real-Time Ac-
cess to the Status of RDF Resources
• Leif Körner (07.08.2013)
  Entwicklung eines verbesserten Paketverwaltungssystems mit Kohana und
Live Framework
• Philip Schlender (08.08.2013)
  Entwicklung eines einheitlichen Datenformats für die Verarbeitung handschri-
tlicher Modelle in einem GMF-Editor
• Yuri Jon (02.09.2013)
  Development of a Cabin Crew Application for a Smartphone

Winter 2013/2014

• Joachim Schramm (07.10.2013)
  Organisationsspezifische Anpassung von Vorgehensmodellen - Nutzen und
Herausforderungen
• Daniel Fischer (28.10.2013)
  Sichere Datenkommunikation mit ressourcenbeschränkten eingebetteten Sys-
temen über schmalbandige funkbasierte IPv6-Netzwerke
1.6 Major events and activities

- Zhivko Bogdanov (18.11.2013)
  Visualisierung von Datenbäumen mit GPU
- Karina Rehfeldt (25.11.2013)
  Konzeption und prototypische Implementierung eines Scheduling-Mechanismus für verteilte Simulationskomponenten
- Nhu Phuong Nguyen (02.12.2013)
  Question Generation In Argumentation Systems
- Dennis Reichardt (16.01.2014)
  Entwicklung und Evaluation eines Lernverfahrens zur Parametrisierung von Spectral Clustering
- Ahmad Obeid (21.01.2014)
  Higher ISO layers of the CarRing II project with emphasis on layer 3 and the transparent mode
- Tim Warnecke (24.03.2014)
  Konfiguration und Integration von Teilsystemen zu System-of-Systems mit Regelüberwachung und -sicherung

For more information, see http://www.in.tu-clausthal.de/studium/diplomanden-und-doktorandenseminar/.

Technical Report Series

The department’s Technical Report Series (ISSN: 1860-8477) was started in 2005 and publishes recent scientific results, either as preliminary version of articles under submission or in print, or as extended versions of workshop proceedings papers. The papers are expected to be written in English and undergo an internal review process. The review board consists of the current and the retired professors of the department. The Editor-in-Chief of the series is Prof. Dr. J. Dix.

For more information, see http://www.in.tu-clausthal.de/forschung/technical-reports/.

Technical reports in 2012/2013:


2 Academic Programs

2.1 Overview

Choosing to study at the Department of Informatics of TU Clausthal means choosing to study off the beaten tracks offered by most of the major German universities. Overcrowded lecture halls and anonymous mass education are unknown to our students who benefit from an outstanding student-professor-ratio of 30:1.

Our department has an international flair due to the high percentage of international students, but also international collaborations in student exchange and world-wide research links. About one third of our students come from abroad to study with us. Our students enjoy the beautiful landscape of the Harz mountains as a perfect setting for recreational and sports activities, or simply to counterbalance their intensive studies. All of these benefits make Clausthal in general and the Department of Informatics in particular a distinguished place.

We offer our students attractive degree programs in Computer Science, Business Information Systems, and Computer Engineering at Bachelor, Master, and Doctoral level. Moreover, we also engage in life long learning, and offer professional degrees. Figure 2-1 gives an outline of our degree programs available for students.

Our department has currently 330 students. That is, about 8 percent of all students at TU Clausthal are majoring in the IT disciplines. The vast majority of them is studying towards a Bachelor’s or Master’s degree. About 16 percent of our students are female. While this is already considerably high for the IT disciplines, we are actively seeking to attract more female students.

In addition to our programs in the IT disciplines, our department significantly contributes to other degree programs at TU Clausthal, especially for students in engineering, business, and science. We teach introductory and programming courses for undergraduates as well as advanced computing lectures for graduates.

For all our degree programs, students can choose to start in the winter semester as well as in the summer semester.
2.1.1 Outline of Degree Programs

<table>
<thead>
<tr>
<th>Year</th>
<th>Business Information Systems (Bachelor)</th>
<th>Business Information Systems (Master)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Internet Technologies and Information Systems (International Master)</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Computer Science (Bachelor)</td>
<td>Computer Science (Master)</td>
</tr>
<tr>
<td>3</td>
<td>Computer Engineering (Bachelor)</td>
<td>Automation (Master)</td>
</tr>
<tr>
<td>4</td>
<td>Systems Engineering (Professional Master)</td>
<td></td>
</tr>
</tbody>
</table>

Figure 2-1 Degree Programs offered at the Department of Informatics.

2.1.2 Contacts

- Faculty Dean: Prof. Dr. Jürgen Dix
- Associate Dean Academic: Prof. Dr. Sven Hartmann
- Program Directors and Study Advisers:
  - Business Information Systems: Prof. Dr. Jörg Müller
  - Computer Engineering: Prof. Dr. Christian Siemers
  - Computer Science: Prof. Dr. Sven Hartmann
2.2 Bachelor Degree Programs

2.2.1 B.Sc. in Computer Science

This degree program is a 6-semester full-time degree that provides students a broad university-level education in Computer Science. Our graduates have excellent job opportunities in industry and administration. Computer Science is an enthralling subject and indispensable for the invention of novel technologies that help to advance society. Our students experience a mixture of lectures, tutorials, seminars, lab classes, and practical courses. An outline of the current curriculum is shown in Figure 2-2.

<table>
<thead>
<tr>
<th>Semester 1</th>
<th>Semester 2</th>
<th>Semester 3</th>
<th>Semester 4</th>
<th>Semester 5</th>
<th>Semester 6</th>
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<tr>
<td>Introduction to Computer Science 9 CP</td>
<td>Algorithms and Data Structures 9 CP</td>
<td>Automata Theory and Formal Languages 6 CP</td>
<td>Logic and Verification 6 CP</td>
<td>Embedded Systems 6 CP</td>
<td>Human Computer Interaction 6 CP</td>
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<tr>
<td>Computing Tools and Computer Architecture 6 CP</td>
<td>Object-Oriented Programming 6 CP</td>
<td>Database Systems 6 CP</td>
<td>Operating Systems and Distributed Systems 6 CP</td>
<td>Optional Course in Computer Science or Business Informatics 6 CP</td>
<td>Optional Course in Computer Science or Business Informatics 6 CP</td>
</tr>
<tr>
<td>Computer Science Workshop 6 CP</td>
<td>Design of Digital Circuits 6 CP</td>
<td>Software Engineering 6 CP</td>
<td>Advanced Programming Lab 6 CP</td>
<td>Seminar II 3 CP</td>
<td>Bachelor Thesis 12 CP</td>
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<td>Calculus and Linear Algebra I 9 CP</td>
<td>Calculus and Linear Algebra II 9 CP</td>
<td>Computer Networks 6 CP</td>
<td>Seminar I 3 CP</td>
<td>Group Project 9 CP</td>
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<td></td>
<td>Soft Skills 3 CP</td>
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<td>Mathematics 6 CP</td>
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<td></td>
<td>Numerical Mathematics 6 CP</td>
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<td>Combinatorial Optimization 6 CP</td>
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<td>Optional Course in Applications, Maths or Stats 6 CP</td>
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<td></td>
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<td></td>
<td></td>
<td></td>
<td>Thesis 12 CP</td>
</tr>
</tbody>
</table>

**Figure 2-2 Curriculum of TU Clausthal’s B.Sc. in Computer Science.**

In the first year, students attend introductory courses, e.g. Programming, Algorithms and Data Structures, Computer Architecture, and Introductory Maths. Our weekly Computer Science Workshop provides hands-on experience with small team-based projects and discusses future career options for computer scientists. In the second year, students will learn about core areas, such as Software Engineering, Databases, Operating Systems, Distributed Systems, Computer Networks, or Logic and Verification. In the final year, our students deepen their skills and study selected topics from a range of optional courses. Our students demonstrate their competencies in a group project, and write a Bachelor thesis under the direction of a faculty member.
For more information, please see http://www.studium.tu-clausthal.de/studienangebot/mathematik-und-informatik/informatik-bachelor.

2.2.2 B.Sc. in Business Information Systems

This degree program is a 6-semester full-time degree that offers students an extensive education in contemporary topics in Business Informatics. Our graduates often pursue a career in information systems development, information management, business and systems analysis, business requirements and business process analysis, IT planning, IT consultancy, or project management. Business information systems address how people, information, computers, networks and processes come together to create cohesive business solutions. Modern organizations are driven by information systems, and industry is demanding graduates who are well versed in Business Informatics topics. An outline of the current curriculum is shown in Figure 2-3.

![Curriculum of TU Clausthal’s B.Sc. in Business Information Systems.](image-url)
To begin with, our students attend introductory courses, like Business Processes and Information Systems, Technologies and Applications of Information Systems, Business Programming, and Introductory Maths. Our weekly Business Informatics Workshop provides hands-on experience with small team-based projects. During their studies, a distinctive range of courses from Business Informatics, Computing, and Business Studies helps our students to develop technical skills as well as skills in business analysis and problem-solving, systems analysis, project management, and the management of information systems in organizations. During their studies, our students experience lectures, tutorials, seminars and practical classes. All students conclude their studies with a Bachelor thesis under the supervision of a faculty member.

For further details, please refer to http://www.studium.tu-clausthal.de/studienangebot/mathematik-und-informatik/wirtschaftsinformatik-bachelor.

2.2.3 B.Sc. in Computer Engineering

This program is an 8-semester full-time degree that offers students a thorough education. Students acquire knowledge in the fields of basic sciences (mathematics, physics), engineering (mechanical, electrical) as well as in computer science and engineering. This distinctive combination of engineering and computer science accounts for the fact that computer engineers working in the design and development of complex technological processes need both an engineering background (to understand the technological processes) and a computing background (to understand the software systems that are required to operate these processes).

In this degree, two fields of specialization are offered: a more engineering-oriented focus on automation systems and a more computing-oriented focus on embedded systems. Basics of engineering and computer science are taught in the first two years (mathematics, physics, computer science, programming, electronics and circuitry, signals and systems). In the final two years students focus on more specialized subjects from engineering (mechanics, feedback control, mechatronics) and computing (embedded systems, distributed systems, computer networks, databases). Depending on the chosen specialization, the compulsory courses vary slightly, and students can choose various optional courses. The specialization in automation systems includes a 12-week internship with a company to gain work experience. The curriculum concludes with a Bachelor thesis. For students wanting to continue their studies for a Master degree, this program is complemented by the 2-semester Master in Automation, or by a transfer into the final year of the Master in Computer Science.

More information can be found at http://www.studium.tu-clausthal.de/studienangebot/mathematik-und-informatik/technische-informatik-bachelor.
2.3 Master Degree Programs

2.3.1 M.Sc. in Computer Science

This program is a 4-semester full-time degree which offers broad fundamental and specialized knowledge in Computer Science. It qualifies students for a future professional career in industry, administration, and academia. Our students learn about theories, methods, architectures, and technologies which allow them to use, develop, analyze, and optimize computer and information systems. We offer a wide range of elective courses that permit interested students to choose a specialization of their own interest, including:

- Information and Knowledge Engineering
- Embedded Systems
- Games Engineering
- Software Engineering

Students are encouraged to take courses on interdisciplinary subjects such as Geo Informatics, Sports Informatics, Business Informatics, Simulation and Scientific Computing, Automation and Electrical Engineering, and Operations Research, too. Our students undergo training in research methods, project management, and soft skills. They engage in seminars and team-based system development projects. Students with a particular interest in research can select the research track of our program in which they conduct a larger self-directed research project in one of the department’s research groups to acquire an advanced level of research experience.

All students write a research thesis under the guidance of a professor. Our graduates are qualified to master emerging technology trends, to understand research challenges, and to pursue doctoral studies.

For more information, please see [http://www.in.tu-clausthal.de/en/studium/studiengaenge/mscinformatik](http://www.in.tu-clausthal.de/en/studium/studiengaenge/mscinformatik).

2.3.2 M.Sc. in Business Information Systems

This program is a 4-semester full-time degree that teaches theoretical, methodological, empirical and product-related competences in Computer Science, Business Studies and the core of Business Information Systems. The program addresses graduates from Bachelor degree programs in Informatics, Business Information Technology, or similar fields. Students have the option to take a research track in this program, conducting a one-semester research project as preparation for a career in academia.

Interested students can specialize in the following areas:

- Information Systems Engineering
- Operations Research
- Serious Games

More information can be found at [http://www.in.tu-clausthal.de/en/studium/studiengaenge/mscwinf](http://www.in.tu-clausthal.de/en/studium/studiengaenge/mscwinf).

### 2.3.3 M.Sc. in Internet Technologies and Information Systems

Our International Master in Internet Technologies and Information Systems (ITIS) is a 4-semester degree. This program is jointly offered by the universities in Braunschweig, Clausthal, Göttingen, and Hannover.

During the first two semesters, students choose from a wide range of courses, seminars, and practical courses offered by the four universities using modern e-learning facilities. In the third semester, students undertake a major research project sponsored by one of the research groups contributing to the degree. The major research areas are Distributed Systems and Algorithms, Databases and Information Systems, and Networking and Communication. Interested students can also specialize in IT-related subjects in Business and Law.

In the final semester, students write a research thesis under the supervision of a professor. Students will learn to perform up-to-date research on their own responsibility while still benefiting from the professional guidance by experienced researchers. The close integration into ongoing research projects aims to prepare graduates for future Ph.D. studies.

The ITIS Master is a program of excellence: Applicants for the ITIS Master must have graduated with a Bachelor’s degree in computer science (or similar) with a GPA of 2.3 or better. The intake is limited to 25 students per year across all four participating universities. Students experience individual study plans, the personal atmosphere of small classes, and intensive supervision.

For more information, please refer to [http://www.itis-graduateschool.de](http://www.itis-graduateschool.de).
2.3.4 M.Sc. in Systems Engineering

Our Professional Master in Systems Engineering is geared towards people already working in industry who wish to further their professional development and training. This program is a 4-semester degree, though ambitious students can complete their studies within 3 semesters.

The program was developed in close cooperation with industry, in particular with Siemens. Typically, engineers working on industry projects face the problem that they must combine knowledge from mechanical and electrical engineering with methods of computer science, specifically software development. Therefore the program consists mainly of compulsory classes teaching advances of information technology, mechanical engineering, and software engineering. The program concludes with a Master’s thesis, in which the student works on a scientific or engineering topic under the guidance of an academic advisor.

About 10 students are enrolled in this professional development and training program. More information can be found at http://www.studium.tu-clausthal.de/studienangebot/mathematik-und-informatik/systems-engineering-weiterbildungsstudiengang-master.
2.4 Ph.D. Programs

At our department it is possible to study for a Ph.D. in Computer Science or Business Information Systems. Currently we have about 60 young academics enrolled as Ph.D. students. Under the supervision of a professor, they work in one of the department’s research groups and perform innovative research on an own research project. Ph.D. studies usually take three to five years. To begin with, Ph.D. students are asked to prepare a Ph.D. proposal that defines the objectives, methodology and timeline of their research project. At the end, Ph.D. candidates submit their Ph.D. thesis for review by the examiners, and defend it in a public colloquium. Our Ph.D. students have the opportunity to exchange their ideas and present their work in regular doctoral colloquiums held at the department or within their research groups. Most Ph.D. students present results of their research in international conferences and workshops, and publish them in reputable journals or proceedings. Many of them also assist the teaching staff by organizing tutorials and seminars or helping with Bachelor and Master projects.

2.4.1 Doctoral Colloquium in Business Informatics

In 2006, a local network DoKoSon\(^1\) has been established initiated by Profs. Michael Breitner (Hannover), Dirk Mattfeld (Braunschweig) and Jörg P. Müller (TU Clausthal). In the frame of this colloquium series, Ph.D. students in the area of business information systems are provided a forum to meet, to exchange and discuss ideas in the context of their Ph.D. thesis, and to train and develop methodical skills. DoKoSon offers an interesting program consisting of doctoral presentations and workshops, e.g. on topics such as presenting, writing scientific papers, scientific reviewing, or creativity techniques. By 2011, the DoKoSon community has grown to comprise seven professors in Business Informatics, including all colleagues from the universities of Braunschweig, Clausthal, Göttingen, and Hannover.

\(^1\) Doktorandenkolloquium Wirtschaftsinformatik Südost-Niedersachsen
2.4.2 Doctoral School in Electromobility

The cooperative doctoral program in Electromobility offers interdisciplinary doctoral studies in cooperation with University of Hannover, Ostafalia University of Applied Sciences, Energy Research Center Lower Saxony (EFZN) and Research Center for Automotive Engineering Lower Saxony (NFF). The Ph.D. students may choose a university professor as supervisor, with whom they want to write their Ph.D. thesis. The young academics are given the chance to perform groundbreaking research at the interface between science, engineering and economics. In addition to the research and qualifications performed on site at the chosen university, the students have the possibility to expand their skills by taking part at the joint workshops and colloquiums organized by the participating institutes. The topics on which the Ph.D. students are encouraged to work are embedded in a coordinated research program to investigate the fundamentals of the following five research areas:

- Charging infrastructure and Smart E-Grid
- Integration of Smart E-Car in the Smart E-Grid
- Electric traction in the Smart E-Car
- Energy Management in the Smart E-Car
- Business Models for the Smart E-Car in the Smart E-Grid

The doctoral program offers doctoral students the possibility of interdisciplinary research in a key area of science and technology. At the same time, doctoral students will be prepared for positions in industry and research institutions.

The participating institutes and universities offer the following infrastructure:

- NFF offers facilities for the development and testing of new engines and propulsion systems,
- University of Hannover has a Center for Information Technology and Management,
- Ostfalia University of Applied Sciences has a renewable energy park with various energy generators and storage technologies,
- EFZN provides an energy storage and network lab.

Further information can be found at https://www.tu-braunschweig.de/forschung/zentren/nff/kpe.
2.5 Teaching Activities

Figure 2-4 shows the Bachelor-level lecture courses offered by our department in 2012 and 2013, while Figure 2-5 shows the Master-level lecture courses offered in 2012 and 2013.

Figure 2-6 shows the practical courses and project courses offered by our department in 2012 and 2013, including supervised team projects for Bachelor-level and Master-level students.

Figure 2-7 shows the Bachelor-level, Master-level and Ph.D.-level seminar courses offered by our department in 2012 and 2013.

For more detailed information about all courses, we refer the reader to the online university course catalogue at https://qis.tu-clausthal.de.
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<tr>
<th>Courses</th>
<th>Format</th>
<th>Course Coordinators</th>
<th>Co-Teachers</th>
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<tr>
<td>ATLANTIS: Business Intelligence</td>
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*Format: WS = Wintersemester, SS = Sommersemester*
### Courses Offered by the Department of Informatics

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### 2.5 Teaching Activities

#### Academic Programs

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**Figure 2.7 Seminar courses offered by the Department of Informatics.**
2.6  Studying at our Department

2.6.1  E-Learning

Our department cooperates with the universities in Göttingen, Hannover, and Braunschweig within the framework of the ELAN-funded project “E-Learning in South Lower Saxony”. TU Clausthal has a long experience on exporting and importing lectures between universities, and using sophisticated multimedia-based technology: it not only allows the students to watch and listen to the remote lecturer and see the slides, but also allows them to interactively ask questions. In addition, recordings of lectures are available through the university’s video server that allows students to follow the lectures at any time on demand.

Our department participates in the ELAN-funded project ATLANTIS, a collaboration of the chairs for business information systems of the universities of Braunschweig, Clausthal, Göttingen, Hannover, Oldenburg, and Osnabrück. The objective of this project is to set common principles for the curricula of the introductory courses in business information technology and to exchange courses on the Bachelor level based on internet technology.

For more information, please see http://www.elan-niedersachsen.de/index.php?id=582.

2.6.2  Students Sport Activities

On Campus Tannenhöhe our department is located in close proximity to TU Clausthal's Sports Institute with its gym and sports grounds. Sports Institute provides a diverse range of recreational and competitive sports opportunities. As of 2013, there are more than 60 different types of outdoor and indoor activities suitable for every athletic level. This broad selection ensures that there is something for every student. Incoming students are inspired to try something new or encouraged to improve their current athletic abilities. During any season, the landscape offers a beautiful, natural background for various outdoor activities, from cross-country skiing to mountain biking and walking. Indoor courses include, among others, volleyball, aerobics and strength training. Competitive sports are also very popular and many athletic events take place in the Harz Mountains. Popular activities include swimming and triathlon training. In addition, the Sports Institute offers regular modules in exercise and sports science every semester. For more information, we refer the reader to http://www.sport.tu-clausthal.de/.

As of 2013, Computer Science students can choose a minor in sports engineering. With the increased focus on health and active lifestyles, there is a growing demand for experts in this field.
2.6.3 International Collaborations and Study Abroad

Internationality has always been very important at TU Clausthal. We are presently working in cooperation with around 150 universities and research institutions worldwide. Our students enjoy a unique and culturally-rich atmosphere. More than 30 percent of the students are international students. Therefore, students (German and international alike) have numerous opportunities not only to learn foreign languages and practice speaking and writing them with native speakers, but also to broaden their horizons by discovering more about different cultures from the international students in Clausthal. The majority of the degree programs are currently taught in German. Some of the lectures, however, are already being taught in English. At the moment, two Master degree programs are conducted in English. Nevertheless, more programs are still being developed and will begin in 2014.

The Erasmus scheme enables our students to study or work in Europe for a semester or full year as part of their degree. Most participating students are eligible for an Erasmus mobility grant. The scheme is funded by the European Commission as part of the Lifelong Learning program. It exists to promote student mobility in higher education, mainly within the EU, but also with various non-EU countries.

A semester or year abroad is a fantastic opportunity for personal, social and academic development. Our students get to know university life in a different country, forming friendships and gaining new perspectives on world culture. With these opportunities to develop, it is no surprise that many students describe their study abroad as a worthwhile experience which they would not want to miss.

Our department encourages its students to experience the international nature of informatics by spending a semester abroad.
2.7 Outreach Activities

Besides the academic activities for our current students we also regularly organize events for our prospective students and our former students.

2.7.1 Summer Seminar

Every year during a summer weekend, our department invites high school students in their last or second-to-last year from all over the country to Clausthal to participate in an informative two-day, hands-on seminar.

In collaboration with the Office for Public Relations at TU Clausthal (many thanks to Jochen Brinkmann for organizing this event) we offer an interesting program to inform about and advertise our study programs. First, students receive a general introduction that features the key benefits and facts of studying in Clausthal in general and at our department in particular. After that, our professors give down-to-earth overviews of some of their special fields, and the high school students get some insight into the work of IT professionals through presentations and hands-on experiments. Finally, invited alumni as well as advanced graduate students give the students’ a perspective of studying in Clausthal. The seminar is rounded off by a barbecue party in the evening.

For more information, we refer the reader to http://www.in.tu-clausthal.de/en/fuer-schueler/schuelerseminar/.

2.7.2 School Information Days

Once every year in springtime, we address the even younger prospective students from nearby high schools. Since 1981, the annual university-wide school information days are an inherent part of the outreach efforts at TU Clausthal. On two days, more than 1000 students from about 30 high schools in Lower Saxony and Saxony-Anhalt visit the university and its departments. It is a good chance for prospective students to familiarize themselves with the city of Clausthal, the university, study programs, and future job prospects. The students visit the different departments in small groups of 20 to 25 students, each guided by a student of TU Clausthal.

As part of the school information days, the Department of Informatics welcomes more than 10 groups on both days. Within one and a half hours, we provide general information about computer science in Clausthal and life at the university, and we answer questions regarding the university and our study programs. After the general introduction we offer interesting talks, spectacular presentations, and hands-on experiments, e.g.,

- Robotics
- 3D LED cube
2.7 Outreach Activities

- Programming with Lego Mindstorms
- Databases on the Internet
- Computer Graphics and Virtual Reality
- Development of a peer-to-peer chat.

Among our first-year students at TU Clausthal there are often former participants of the school information days, demonstrating the success of this activity. For more information, we refer the reader to [http://www.wissenschaft-erleben.de/schuelerinfotage/](http://www.wissenschaft-erleben.de/schuelerinfotage/).

2.7.3 Girls’ Day

Our department participates in an annual event organized by the Equal Opportunities Office since 1995 which addresses female pupils in particular and aims at getting them interested in studying engineering or sciences at TU Clausthal. During one week, about 20 to 25 pupils from all over Germany attend regular university lectures, take part in 2-hour practical exercises, get into contact with both students and professors, and visit a number of institutes. Moreover, they participate in several leisure activities.

For more information, we refer the reader to [http://www.gb.tu-clausthal.de/schnupperstudium/](http://www.gb.tu-clausthal.de/schnupperstudium/).

2.7.4 School Visits

In order to demonstrate pupils that IT is a fascinating subject, we regularly visit schools and give talks in classes. We explain what the IT disciplines are about, show research projects, and answer all kinds of questions. By these talks, the pupils get an overview of what we are doing at our department and how our degree programs look like.

2.7.5 Alumni Management

Every year, our department invites former and current students as well as members of the department to an informal meeting. One of the main benefits for current students is that they can get an overview of how life and work can look like with a degree in computer science. Former students, on the other hand, get the opportunity to learn what has changed since they left Clausthal; in addition, they can refresh their contacts with other former students and their former professors. All students get an overview of the current research and projects during a tour of the department.
2.7.6 Early Studies Program for High School Students

With our department, excellent pupils get the opportunity to regularly visit selected courses in computer science at TU Clausthal (including programming classes and introductory classes about computer science, algorithms and data structures). This allows them to experience computer science and how this subject is approached at the university level at a very early age. There are several advantages for the high school students: first, they can better assess whether the subject matches their inclinations; second, they can acquire credit points for classes before they actually start their official computer science program. That way, they can spend more time on other courses in the first year of their Bachelor degree. Or, they can finish their studies earlier, giving them an advantage when applying for a job.

Since 2008, this activity attracts between 10 and 20 participants every semester. Many of them return to our department later on to pursue studies in one of our Bachelor degrees. Even those participants who do not decide for a career in the IT disciplines frequently give very positive feedback on the early study program, since it allowed them to experience university life.

While the program is open for students from all high schools, our department is currently cooperating with four local schools in this matter. This includes organized bus transfers and a close cooperation with the schools to avoid overlaps between university class hours and school classes.
2.8 Highlights in 2012 and 2013

☐ In 2013:

- In July 2013, our International Master degree in Internet Technologies and Information Systems (ITIS) received accreditation from ASIIN. In addition, the degree program was awarded the Eur-Inf Quality label granted by EQANIE.

- In April 2013, our Bachelor and Master degrees in Computer Science and in Business Information Systems received accreditation from ASIIN. In addition, the degree program was awarded the Eur-Inf Quality label granted by EQANIE.


☐ In 2012:

- In December 2012, our department achieved a first place in the CHE subject ranking for Master programs in Computer Science at universities in Germany, Austria, Switzerland and the Netherlands.

- In April 2012, our department achieved a top-10 position in the CHE subject ranking for Bachelor programs in Computer Science at universities in Germany, Austria, Switzerland and the Netherlands.

For details, please see www.che.de.
3 Research Groups

3.1 Business Information Technology Unit

3.1.1 Overview

**Leaders**
- Prof. Dr. Jörg P. Müller
- Prof. Dr. Niels Pinkwart (until 05/2013), Prof. Dr. Andreas Harrer (since 09/2013)

**Secretary**
- Stefanie Cronjäger

**Scientific Employees**
- M.Phil. Madiha Ahmad (until 09/2013)
- Dipl.-Wirt.-Inf. Malte Aschermann
- Dr. sc. Jelena Fiosina
- Dr. sc. Maksims Fiosins
- Dipl.-Wirt.-Inf. Jana Görmer
- Dipl.-Wirt.-Inf. Sebastian Groß (until 05/2013)
- Dipl.-Wirt.-Inf. Stefan Kehl
- Dipl.-Inf. Philipp Kraus
- Dr. rer. nat. Nguyen-Thinh Le (until 09/2013)
- Dipl.-Wirt.-Inf. Christopher Mumme (until 03/2012)
- Dipl.-Inf. Hannes Olivier, M.Sc. (until 02/2013)
- Dipl.-Inf (FH) Kerstin Pfahler (from 09/2013)
- M.Sc. Sven Strickroth (until 05/2013)
- B.Sc. Sabrina Wittek (from 05/2013)
- B.Sc. Stefan Wittek (until 07/2013)

**External Ph.D. students**
- Dr. rer. nat. Matthias Born, SAP AG Research, Karlsruhe (until 01/2012)
- Dr. rer. nat. Sebastian Mechs, Siemens Corporate Technology, München (until 09/2013)
- Dipl.-Ing. Marc Glauche, Siemens AG, Berlin

**Stipendium holders**
- M.Ed. Haitao Li (until 03/2013)
- M.Sc. Roman Pavlov (until 10/2013)

3.1.2 Research Agenda

The business information technology unit consists of two research groups.

The research group *Human Centered Information Systems (HCIS)*, led by Niels Pinkwart (since September 2013: by Andreas Harrer), focuses on the design of digital media and technologies to support human co-operation, communication, and social interaction.
We investigate collaborative systems from a variety of perspectives, including their conceptual design, software architectures, user interfaces, and last but not least, usage by humans in their work, learning or leisure context. In our research, we adopt an interdisciplinary approach which is rooted in Computer Science and Information Technology, but also includes methods from Cognitive and Social Sciences. A specific focus of our research is set on applications in the domain of educational technology, particularly on distributed and collaborative software systems which provide intelligent support to students in order to help them learning.

The main research focus of the Mobile and Enterprise Computing (MEC) research group, led by Jörg P. Müller, is on decentralized information technologies, in particular, multi-agent and peer-to-peer (P2P) systems, methods, architecture, models, tools for decentralized and adaptive management, engineering, and coordination in information systems.

We are interested in the development, validation, and application of decentralized, self-organizing techniques in various networked domains, such as Transport and Traffic, Industrial automation and Logistics, and Product Life-cycle Management. The systems we are investigating are composed of autonomous nodes that are required to cooperate or coordinate their activities, because they co-exist in a shared environment, depend on shared resources, or pursue common goals. Core technology competences at MEC are multi-agent systems and intelligent agents, P2P computing, protocols, architectures, and middle-ware for decentralized information management and coordination including cloud and virtualization technologies, model-driven development of business IT systems, and organic / autonomic computing. MEC teaching activities cover introductory and advanced courses on (distributed) business information systems and technology.

The homepage of the business information technology unit is http://winf.in.tu-clausthal.de

The homepage of the Human Centered Information Systems research group is http://hcis.in.tu-clausthal.de/

The homepage of the Mobile and Enterprise Computing research group is http://meclab.in.tu-clausthal.de

### 3.1.3 Supervised Theses

**Ph.D. Theses:**


Diploma and Master’s Theses:


**Bachelor’s Theses:**


3.1.4 Projects

Project 1: IT-Ecosystems – Adaptive Interaction Mechanisms (AIM)

Project Members
- Prof. Dr. Jörg P. Müller (Leader)
- Jana Görmer (Project Staff)
- Christopher Mumme (Project Staff)

Partners
- Prof. Dr. Jörg P. Müller, Department of Informatics, Research Group of Mobile and Enterprise Computing, TU Clausthal, Germany (Main Leader)
- Prof. Dr. Bernardo Wagner, Institute for Systems Engineering, Research Group of Real-Time Systems, LU Hannover, Germany
- Prof. Dr. Niels Pinkwart, Department of Informatics, Research Group of Human-Computer Interaction, TU Clausthal, Germany
- Prof. Dr. Michaela Huhn, Department of Informatics, Research Group of Fundamentals of Computer Science, TU Clausthal, Germany

Funding
State Government of Lower Saxony
232,400€ (of 2,500,000€ total)

Duration
03/2009 – 08/2012
Project Description

Classical approaches of computer science do not scale well for today's large and complex software-intensive systems. Software systems cannot be considered in isolation, since they are connected among each other and interact massively. Instead they are to be designed as parts of a larger IT Ecosystem. In analogy to biological ecosystems, IT Ecosystems are based on the balance between individuals (autonomy) and sets of rules (control) defining equilibria within an IT Ecosystem. Maintaining and continuously evolving IT Ecosystems requires deep understanding of this balance.

The new research topic IT Ecosystems cuts across several research areas, including: emergence of system functions, extending classical engineering approaches, adaptive infrastructures, control of semantic diversity, and enhanced human-environment-machine interaction. These core areas are addressed by the newly established NTH focused Research School for IT Ecosystems, a cooperation of Technische Universität Braunschweig, Technische Universität Clausthal, and Leibniz Universität Hannover. A joint demonstrator will present innovative research results in the context of a smart city application.

The goal of AIM is to investigate methods for decentralized, bottom-up organization of complex software systems, with special focus on the emergence and adaptation of interaction mechanisms among automated actors in dynamic environments. AIM is a subproject of the IT ecosystems project funded by the Federal government of Lower Saxony.

References

[Fiosins et al., 2013] (Page 189), [Rausch et al., 2012a] (Page 205), [Görmer and Mumme, 2012] (Page 198)

Contact E-Mail
joerg.mueller@tu-clausthal.de

Project Homepage
http://www.it-oekosysteme.org
Project 2: **SoKoo: SocialCars – Kooperatives (de)zentrales Verkehrsmanagement**

**Project Members**
- Prof. Dr. Jörg P. Müller (Leader)
- Dr. Maksims Fiosins (Project Staff)
- Jana Görmer (Project Staff)

**Partners**
- Prof. Dr. Bernhard Friedrich, Institute for Transportation and Urban Engineering, TU Braunschweig, Germany
- Prof. Dr. Dirk Mattfeld, Institute for Business Information Systems, Decision Support Group, TU Braunschweig, Germany
- Prof. Dr. Markus Fidler, Institute for Communication Technology, LU Hannover, Germany
- Prof. Dr. Monika Sester, Institute for Geoinformatics, LU Hannover, Germany
- Prof. Dr. Mark Vollrath, Institute for Psychology, Engineering and Traffic Psychology Group, TU Braunschweig, Germany

**Funding**
- Niedersächsische Technische Hochschule
- 40,000€ (of 115,000€ total)

**Duration**
- 01/2012 – 09/2013

**Project Description**
SoKoo is the successor project of PLANETS (Planning and Decision-making in Networks of Autonomous Actors in Traffic). It is funded by Niedersächsische Technische Hochschule (NTH). The goal is to build on the results of PLANETS, developing and evaluating innovative approaches for dynamic traffic management based on state-of-the-art technologies in information and communication technology.

The main research focus of the project is the integration of traffic and communication simulation, taking into account multiagent-based models and methods for modeling and simulation. The main outcome of SoKoo was an application proposal for a DFG Research Training Group (SocialCars). This proposal was submitted in early 2013 and we were notified about its acceptance in November 2013.
The complexity of the broad field of technology is managed by interdisciplinary cooperation of expertise in the areas of traffic, business information systems and communication technology. Next to the Department of Computer Science at the Technische Universität Clausthal, partners from TU Braunschweig (Institute for Traffic and Urban Engineering, Institute of Traffic Psychology, Institute of Decision Support) and the LU Hannover (Institute for Communication Technology and Institute for Geo-Informatics) are involved in the project.

References
[Fiosina et al., 2013b] (Page 189),
[Fiosins, 2013] (Page 189),
[Fiosins et al., 2012] (Page 189)

Contact E-Mail
joerg.mueller@tu-clausthal.de

Project Homepage
http://www.socialcars.org/

Project 3: ADMIT: Agent-oriented Distributed Data Mining using Computational Statistics

Project Members
Dr. sc. Jelena Fiosina (Leader)
Prof. Dr. Jörg P. Müller (Leader)

Funding
EU FP7 Marie Curie Intra-European Fellowships (IEF)
170.000€ (of 170.000€ total)

Duration
06/2010 – 07/2014
**Project Description**

Today’s systems for managing critical infrastructure such as traffic, energy, or industry automation systems are highly complex, distributed, and increasingly decentralized. Multi-agent systems (MAS) provide an intuitive metaphor and configurable, robust and scalable methods for problem-solving and control in distributed, decentrally organized systems.

The purpose of Distributed Data Mining (DDM) is to provide algorithmic solutions for data analysis in a distributed manner to detect hidden patterns in data and extract knowledge necessary for decentralized decision making. A new promising area of research studies possibilities for coupling MAS and DDM by exploiting DDM methods for improving agents’ intelligence and MAS systems performance.

In the ADMIT project we focus on methods for distributed estimation of parameters for the individual agents, agent groups, and system-level information models. Our approach is based on Computational statistics (CST), which includes a set of methods for approximate solutions of statistical problems without complex statistical procedures. The goal of the ADMIT project is to develop an agent-oriented DDM framework, which includes a set of computationally effective, robust and easy to apply methods for model parameter estimation and allows easy incorporation into MAS applications to analyze models at different levels of MAS. The scientific research objectives of ADMIT are:

- To develop a conceptual architecture of agent-oriented DDM framework as well as a methodology of its usage in multi-agent programming frameworks;
- To develop a set of computationally effective and reliable to bad data quality CST-based DDM methods, for efficient estimation of model parameters on the basis of distributed data as well as estimate the methods performance;
- To assess the impact of incorporation of the DDM framework to MAS-based applications (with the main focus on traffic and logistics domains).
References
[Fiosina and Fiosins, 2013c] (Page 188),
[Fiosina and Fiosins, 2013b] (Page 188),
[Fiosina, 2012] (Page 197),
[Fiosina and Fiosins, 2012] (Page 197)

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Project Homepage
http://meclab.in.tu-clausthal.de/research/

Project 4: Manufacturing Execution Systems for the Steel Industry

Project Members
Prof. Dr. Jörg P. Müller (Leader)
Christopher Mumme (Project Staff)
Stefan Wittek (Project Staff)
Jens Dehnert (Project Staff)

Partners
Prof. Dr. Jürgen Kletti, MPDV Mikrolab GmbH, Mosbach, Germany
Hans-Josef Kay, Deutsche Edelstahlwerke GmbH, Witten, Germany
Prof. Dr. Christoph Schwindt, Insitute for Economic Sciences, TU Clausthal, Germany

Funding
MPDV Mikrolab GmbH
16,000€ (of 32,000€ total)

Duration
05/2010 – 10/2012

Project Description
The goal of this project was to analyze production processes in the steel industry with specific view to the requirements to Manufacturing Execution Systems. In the first phase of the project, we identified and analyzed production processes and analyzed the IT landscape of a steel-producing company; the value stream analysis method was used for the former, and component and function map diagrams for the latter. In the second phase, we created a reference process model for steel production based on the information recorded in the first phase, containing both the process view and the IT view. In the third phase, we performed an analysis of the HYDRA MES system with respect to its ability to match the functions of the reference model developed in phase 2. The project was done in co-operation with the research group of Prof. Christoph Schwindt at Technische Universität Clausthal.
Project 5: eCult: eCompetence and Utilities for Learners and Teachers

Project Members
Prof. Dr. Jörg P. Müller (Leader)
Oliver Müller (Project Staff)

Partners
Prof. Dr. Niels Pinkwart, Department of Informatics, Computer Science Education Group, Humboldt Universität Berlin, Germany
Dr. Hans-Ulrich Kiel, Computing Center, TU Clausthal, Germany (Leader)

Funding
Lower Saxony Ministry of Science and Culture (MWK)
149,000€ (of 298,000€ total)

Duration

Project Description
eCult is a collaborative project in Lower Saxony, funded by the Federal Ministry of Education and Research. Eleven universities and two other institutions are taking part in this project. The goal is to improve the quality of teaching and learning at universities. Therefore the project participants exchange local experiences to enhance existing eLearning approaches and to develop new eLearning approaches together. The project focuses on eAssessment, teaching and learning organisation, and video-based teaching and learning. The MEC research group is active in the area of eAssessment. In this area we focus on decentralised systems to support programming and modeling exercises at universities.
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Project Homepage
http://www.ecult-niedersachsen.de/

Project 6: CONNECT: An agent-based approach to change management in global product development

Project Members
Prof. Dr. Jörg P. Müller (Leader)
Stefan Kehl (Project Staff)

Partner
Dr. Patrick Stiefel, Volkswagen AG, Abt. K-EP/F, Wolfsburg, Germany (Main Leader)

Funding
Volkswagen AG
189,000€ (of 189,000€ total)

Duration
01/2013 – 12/2015

Project Description
Product Data Management (PDM) is an essential subarea within Product Life-cycle Management (PLM) and therefore of significant importance for industry. The increasing global collaboration in the field of product development along with the rising global competition requires new concepts and technologies to support the processes of the Product Data Management appropriately. Besides the safe, efficient and scalable management of product data, the seamless integration of trustworthy collaboration partners is one of the main focuses. In CONNECT, our MEC lab cooperates with Volkswagen AG in the development and evaluation of innovative concepts to realize and optimize processes and technologies for the implementation of Product Data and Change Management Systems in a decentralized setting of a global enterprise.
Project 7: Robotic FireFighters: Self-Organizing Robot Teams for Disaster Management

Project Members
Prof. Dr. Jörg P. Müller (Leader)
Dr. Maksims Fiosins (Leader)
Ramin Safar Manesh (Project Staff)

Partners
Prof. Dr. Bernardo Wagner, Institute for Systems Engineering, Real Time Systems Group, LU Hannover, Germany (Main Leader)
Prof. Dr. Lars Wolf, Research Group of Communication and Multimedia, TU Braunschweig, Germany

Funding
Niedersächsische Technische Hochschule
80,000€ (of 240,000€ total)

Duration
04/2013 – 12/2014

Project Description
Recent disasters, such as the Fukushima catastrophe, the attack on the WTC, the oil spill in the Gulf of Mexico, or the Mont Blanc Tunnel fire, have shown that post disaster management tasks still require considerable human intervention, even though the humans entering affected areas risk their health and lives, causing human tragedy and immense cost for national economies.
With view to keeping these dangers and costs at bay, and to increasing effectiveness of disaster management operations, our long-term vision is that teams of autonomous robots equipped with sensors, manipulators, and communication capabilities will be able to enter dangerous, polluted or contaminated areas and to manage all the necessary tasks (e.g. search for survivors, evacuate injured persons, remove safety critical materials, clean up) without the need for explicit human assistance.

This inspires the notion of Robotic FireFighters (RFF), in analogy to human fire brigades, where firemen (and firewomen) work together towards the common goal of getting a disaster under control. In this project, we develop and evaluate models and method for multi-agent task allocation and negotiation in multi-robot scenarios, and work with our project partners on deploying the resulting distributed algorithms on a robotic platform (KUKA youbots running the ROS operating system).

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Project Homepage
http://www.rts.uni-hannover.de/index.php/Robotic_FireFighters

Project 8: DESIM: Decentralized Architecture and Concepts for SoS Simulation

Project Members
Prof. Dr. Jörg P. Müller (Leader)
Philipp Kraus (Project Staff)

Partner
Prof. Dr. Jürgen Dix, TU Clausthal, Germany (Main Leader)
Funding
Simulationswissenschaftliches Zentrum Clausthal/Göttingen
102,500€ (of 205,000€ total)

Duration
06/2013 – 05/2016

Project Description
The aim of the DeSIM project is to design and develop a distributed and high-scaling multi-agent-simulation (MAS). The presentation of the problem is focused on a detailed (micro)simulation view of each agent, where the agent-based modeling and communication structure are analyzed too. When using detail views, there are different issues in performance scaling where decentralized simulation architecture can be useful.

The research objective is to compare different simulation environments e.g. agent-based, grid-based or high-performance-computing and to create or enhance a framework with design and scaling structures. In order to validate our results, we use the domain of cooperative traffic simulation, including use cases such as decentralized routing, grouping and platooning, and information dissemination. There are tools simplifying the requirements of abstract design, visualization, progression or rather improvement of the current systems. The project combines different points of perception of distinct fields of research.

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Project Homepage
http://www.simzentrum.de/de/forschungsprojekte/desim/
Project 9: Methods for developing efficient product structures

Project Member
Dipl. Wirt.-Inform. Marc Glauche (Leader)

Partner
Prof. Dr. Jörg P. Müller, TU Clausthal, Germany (Main Leader)

Duration
10/2010 – 09/2014

Project Description
The product structure with its cross-company and cross-lifecycle functions forms the binding data basis for all processes and process partners. Therefore central points for implementing an efficient product structure are influencing factors. Through expert consultation concerning relevant influencing factors a systematization and identification of dependencies was created, which serves as the foundation for design measures of an efficient product structure.

The outcome was embedded in a method consisting of the development model and the meta-model. Components of the development model are the individual phases of analysis and synthesis to enable the development of an efficient product structure. In contrast, the meta-model describes the dependency network of product structuring. For the evaluation of the method a case study was performed as an internal validation by the project leader. Basis was the process of developing a wind turbine with eight use cases converted into the Siemens Teamcenter software.

References
[Dietrich et al., 2012] (Page 196), [Glauche et al., 2013] (Page 191)

Contact E-Mail
marc.glauche@tu-clausthal.de
**Project 10: Vehicle Group Formation in Cooperative Traffic**

**Project Members**
- Dipl. Wirt.-Inform. Jana Görmer (Leader)
- Thomas Hornoff (Project Staff)
- Thomas Plathe (Project Staff)
- Tobias Wessels (Project Staff)

**Partner**
- Prof. Dr. Jörg P. Müller, TU Clausthal, Germany (Main Leader)

**Duration**
10/2009 – 09/2014

**Project Description**
In the context of urban traffic management we investigate new models, methods and tools for evaluating and using the concept of agent-based systems for autonomous vehicle groups. With growing on-board intelligence in vehicles and vehicle-to-x communication capabilities, it is expected that future traffic systems will have more dynamic control and decentralized architecture.

Thus, traffic entities such as signals or vehicles need to be coordinated respecting individual and global interests of urban traffic. We argue that vehicle groups can improve urban traffic due to its nature created by individuals, while performing tasks relevant to their missions. These vehicle groups are defined as social entities, each group being a performing unit embedded in the urban network.

Our work, while driven by traffic management issues, i.e. supporting the emergence of complex urban networks with new technologies, focuses on aspects of decentralized decision support for coordination of vehicles on different levels such as goals, plans, and actions. A tool to simulate the autonomous vehicle groups is investigated for traffic including microscopic social agent behavior. Autonomous coordination models for groups and centralized versus decentralized methods are evaluated in simulation. It aims at enabling coordinated behavior between autonomous vehicles to improve dynamic traffic flows in the network of a decentralized environment, where traditional static control may not manage dynamic changes.
Project 11: Model-based Engineering for Energy-Efficient Operation of Factory Automation Systems within Unproductive Phases

Project Member
Dipl. Wirt.-Ing. Sebastian Mechs (Leader)

Partner
Prof. Dr. Jörg P. Müller, TU Clausthal, Germany (Main Leader)

Duration
08/2010 – 08/2013

Project Description
In the face of a future rise in energy prices, energy-efficient operation of industrial automation systems has strategic impact for manufacturing companies. The reduction of energy demand during unproductive phases helps to contribute to the overall energy efficiency of automated production systems.
This dissertation project addresses energy-efficient operation of factory automation systems within unproductive phases technically and (to some degree) economically on a multi-subsystem level. We propose an automaton-based system model enabling the analytical description of structural and behavioral aspects of industrial automation systems. This model serves as basis for identifying optimal strategies analytically, relying on a structure-exploiting procedure which enables efficient computation of strategies quantifying the energy savings potentials supporting technical realization.

A novel approach is developed to calculate those strategies efficiently incorporating the problem structure provided by the model. Using models of real-world automation systems, the approach of this thesis is evaluated. Our experiments show that using the general concepts and methods of this thesis, there is potential for a substantial reduction of the energy demand of industrial automation systems.

References
[Mechs, 2013] (Page 208),
[Mechs et al., 2013b] (Page 203),
[Mechs et al., 2012c] (Page 203)

Contact E-Mail
joerg.mueller@tu-clausthal.de
Project 12: Metafora – Learning to learn together: A visual language for social orchestration of educational activities

Project Members
Dr. Andreas Harrer (Leader)
Kerstin Pfahler (Project Staff)

Partners
Hebrew University of Jerusalem, Israel (Main Leader)
University of Exeter, United Kingdom
National and Kapodistrian University of Athens, Greece
London Knowledge Lab, United Kingdom
Deutsches Forschungszentrum für Künstliche Intelligenz, Saarbrücken, Germany
Testaluna Serious Playing, Genoa, Italy

Funding
European Commision ICT/TEL
360,000€ (of 2,400,000€ total)

Duration
07/2010 – 08/2013

Project Description
Launched in July 2010, by the end of its 3-year duration the Metafora project resulted in the creation of a CSCL system to enable 12 to 16-years-old students to learn science, mathematics and environmental issues in an effective and enjoyable way. These students will, first and foremost, learn to learn, collaboratively addressing an assignment – the "challenge" – posed by the teacher involving a relatively complex problem. Working in groups of 3 to 6 students during a period of 2 to 3 weeks, they will plan the work to do and tackle the challenge – all by themselves.

The Metafora platform offers an argumentation and discussion workspace where the students will gather and discuss their findings and arrive at an agreed solution, using also other available tools, such as microworlds. The use of a visual language permits the students to reflect on and be precise in their planning and then later in enacting the planned activities, while also allowing the system to intelligently track those activities and produce useful information and feedback for both students and teachers.
References
[Harrer et al., 2013a] (Page 199),
[Harrer et al., 2013c] (Page 199),
[Harrer et al., 2013d] (Page 199),
[Irgang et al., 2013] (Page 200),
[Herbst and Harrer, 2013] (Page 200)

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Project Homepage
http://www.metafora-project.eu/

Project 13: Analysis and Visualisation of Complex Social Networks

Project Member
Dr. Andreas Harrer (Leader)

Partners
Prof. Ulrich Hoppe, Collide Research Group, Universität Duisburg-Essen, Germany (Leader)
Tilman Göhnert, Collide Research Group, Universität Duisburg-Essen, Germany
Alona Schmidt, Katholische Universität Eichstätt–Ingolstadt, Germany

Duration
since 01/2012
**Project Description**

Community research and scientometry are growing fields to channel research funding, create performance measures, and identify trends and future directions in a more and more competitive landscape of research communities. Social networks are a subject for research in social sciences since the 1930s, mostly associated with the work of Moreno. Later in the 1960s social networks became popular in the field of scientometrics by the citation networks of Solla Price. Social network structures nowadays are increasingly large, consist of heterogeneous relations and also different stakeholders, such as persons, organizations or groups. These complex networks require advanced methods of analysis and also new visualization approaches to make relevant parts visible in usually cluttered network diagrams. Our project cooperation develops both analysis methods and visualizations that are conceptually and technically integrated into a joint research framework.

**References**

[Harrer and Schmidt, 2013] (Page 192),
[Harrer et al., 2013b] (Page 199)

**Contact E-Mail**

andreas.harrer@tu-clausthal.de

3.1.5 Scientific Activities

**Person**  Prof. Dr. Jörg P. Müller

**Editorial Board Memberships**

  See [http://www.springerlink.com/content/1573-7454/](http://www.springerlink.com/content/1573-7454/).
• International Journal of Agent-Oriented Software Engineering, Publishers Inderscience, Associate Editor (2004–present).

• Electronic Commerce Research, Member in Editorial Board, Springer (Since 2008).

☐ Organization of Conferences and Workshops

• Co-Chair (with Yves Demazeau) PAAMS ’12: 10th International Conference on Practical Applications of Agents and Multiagent Systems, Salamanca, Spain, March, 2012.

• Co-Chair (with Massimo Cossentino) AOSE ’12: 13th International Workshop on Agent-Oriented Software Engineering at AAMAS 2012, Valencia, Spain, June, 2012.
  See http://winf.in.tu-clausthal.de/events/aose12/.

☐ PC-Member of Conferences and Workshops


  See http://admi12.agentmining.org/.

  See http://www.ia.urjc.es/att2012/.

  See http://www.uninova.pt/doceis/doceis12/.

  See http://www.fst.umac.mo/wic2012/IAT/.


  See http://www.aidima.es/iesa2012/.


• AATMO 2013: International Workshop on Agent-based Approaches for Transportation Modelling and Optimisation, Salamanca, Spain, May, 2013.


Steering Committees

• ADMI: Agents and Data Mining Integration and Interaction SIG (2009-present). See http://www.agentmining.org


Person Dr. Andreas Harrer

Organization of Conferences and Workshops


3.1.6 Highlights

In 2012

• March 2012: Jörg P. Müller is co-chairing (with Yves Demazeau, CNR Italy) the 10th International Conference on Practical Applications of Agents and Multi-Agent Systems (PAAMS2012). University of Salamanca (Spain).

• May 2012: Jörg P. Müller celebrates his 47th birthday in good health.

• June 2012: The paper Feedback Provision Strategies in Intelligent Tutoring Systems Based on Clustered Solution Spaces, authored by Sebastian Gross, Bassam Mokbel, Barbara Hammer and Niels Pinkwart, is shortlisted for the best paper award at DeLFI, the eLearning conference of the German Computer Science Association (German: Gessellschaft für Informatik).
• June 2012: Jörg P. Müller is co-chairing (with Massimo Cossentino, CNR-ICAR, Italy) the 13th International Workshop on Agent-Oriented Software Engineering (AOSE2012), Valencia, Spain.

• November 2012: The NTH supports a project "research and collaboration infrastructure for the NTH" with approximately 171,000 €. The project is conducted with partners from Clausthal, Braunschweig and Hannover. From the side of TU Clausthal, the research group of Niels Pinkwart and the computing center (German: Rechenzentrum) contribute to the project.

☐ In 2013

• September 2013: The paper *Similarity-Based Resource Retrieval in Multi-Agent Systems by Using Locality-Sensitive Hash Functions* by Malte Aschermann and Jörg P. Müller is shortlisted for the Best Paper Award of the 11th German Conference of Multiagent Systems Technologies (MATES 2013), Koblenz, Germany.

• September 2013: Andreas Harrer co-chaired at the European Conference on Technology-Enhanced Learning and organized, together with Davinia Hernandez-Leo, the Demo Sprint Contest at the conference in Paphos, Cyprus (http://ectel2013.cs.ucy.ac.cy/index.php/conference/papers-and-demos-awards).

• October 2013: Jörg P. Müller is keynote speaker at the 10 years anniversary celebration of the chair of Software Methodologies for Distributed Systems, Prof. Dr. Bernhard Bauer, University of Augsburg.

• November 2013: The DFG announces the funding of the Research Training Group *SocialCars: Kooperatives (de-)zentrales Verkehrsmanagement* (DFG GRK 1931, http://www.socialcars.org) with 5 Mio € from April 2014 until September 2018. Jörg P. Müller is Vice-Speaker of the GRK.

☐ Visitors

• January 2013:
  Dr. Dirk Werth, German Research Center for Artificial Intelligence (DFKI GmbH), Saarbrücken, Germany.

• June/July 2013:
  Aditya Raj, Vellore Institute of Technology, India.

• September 2013:
  Prof. Dr. Peter Göhner, Universität Stuttgart, Germany.
3.2 Computational Intelligence

3.2.1 Overview

**Leader** Prof. Dr. Jürgen Dix

**Secretary** Anita Seiz-Uhlig

**Scientific Employees**
- Dr. Nils Bulling
- PD Dr. habil. Wojciech Jamroga
- Dipl.-Inf. Michael Köster
- Lic. Federico Schlesinger
- Dr. Tristan Behrens (until 10/2012)
- Dr. Pietro Galliani (since 09/2013)
- B.Sc. Tobias Ahlbrecht (since 09/2013)
- Dr. Matei Popovici (from 03/2013 until 08/2013)

3.2.2 Research Agenda

Our scientific research focuses mainly on the following areas of artificial intelligence:

1. programming multi-agent systems,
2. theories of agencies (logics and rational agents),
3. evaluating and simulating multi-agent systems,
4. game theory and relations to multi-agent systems,
5. model checking ATL-like logics and
6. coordination and control of multi-agent systems.

In addition we are also interested in knowledge representation, in particular in computational logic (deductive databases, answer set programming, non-monotonic reasoning).

For further information, please see the group’s homepage at: [http://cig.in.tu-clausthal.de/]().

3.2.3 Supervised Theses

**Ph.D. Theses:**


**Diploma and Master’s Theses:**
3.2 Computational Intelligence


Bachelor’s Theses:


3.2.4 Projects

**Project 14: DeSIM - Decentralised Simulation**

**Project Members**

Prof. Dr. Jürgen Dix (Leader)  
Prof. Dr. Jörg Müller (Leader)  
Dipl.-Inf. Michael Köster (Project Staff)  
B.Sc. Tobias Ahlbrecht (Project Staff)  
Dipl.-Inf. Philipp Kraus (Project Staff)

**Duration**

since 09/2013

**Project Description**

The aim of the DeSIM project is to design and develop a distributed and high-scaling multi-agent-simulation (MAS). The presentation of the problem is focused on a detailed (micro)simulation view of each agent, where the agent-based modeling and communication structure are analysed too. When using detail views, there are different issues in performance scaling where decentralized simulation architecture can be useful.

The research’s objective is to compare different simulation environments e.g. P2P, grid-based or high-performance-computing and to create or enhance a framework with design and scaling structures. In order to validate our results, we use the domain of cooperative traffic simulation, including use cases such as decentralized routing, grouping and platooning, and information dissemination.

There are tools simplifying the requirements of abstract design, visualization, progression or rather improvement of the current systems. The project combines different points of perception of distinct fields of research.

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Project Homepage

http://www.in.tu-clausthal.de/abteilungen/cig/cigroot/research/projects/desim-decentralised-simulation/

Project 15: GaLOT - Game Logics for Open IT Environments

Project Members
Prof. Jürgen Dix (Leader)
Dr. Nils Bulling (Coordinating researcher)
Dr. Wojtek Jamroga (Coordinating researcher)
Dr. Matei Popovici (from 03/2013 until 08/2013) (Project Staff)
Dr. Pietro Galliani (since 09/2013) (Project Staff)

Partners
Prof. Dr. Leon van der Torre, University of Luxembourg (Leader)
Prof. Dr. Sjouke Mauw, University of Luxembourg
Prof. Dr. Valentin Goranko, Technical University of Denmark, Kongens Lyngby, Denmark

Duration
since 03/2013

Project Description

Game theory provides basic conceptual tools to assess abilities of players in scenarios involving interaction. On the other hand, mathematical logic has proved useful when addressing qualitative properties of systems. A number of strategic logics (or game logics) have been studied intensively in the last 15 years, that allow to specify properties of games in an abstract way. Unfortunately, most of them are based on models of perfect information. Such an assumption is unrealistic when it comes for distributed IT environments. Moreover, it makes the study of information security impossible because the notions of information and knowledge are not properly defined.

A multitude of semantic variants were proposed in the recent years to combine knowledge and strategies in a single logical framework, but many questions remain open. In this project, we address some of these questions. Firstly, there are many different semantics for ability under uncertainty, but their exact relationship is still unclear. Secondly, there is no unifying framework. Furthermore, verification of abilities under uncertainty is known to be computationally hard, but little work has been done on tractable fragments of the logics. Moreover, combining knowledge and strategies for stochastic models is an almost untouched research area. We are going to investigate these basic threads by rigorous theoretical analysis. On a more practical level, we plan to provide a preliminary toolbox that allows for verification of information-related properties in open IT environments of relatively small scale.
It is important to emphasize that the focus of this project is theoretical rather than applied. However, study of strategic logics should be driven by practical context. This purpose will be served by scenarios from *IT Ecosystems*, a big project which is currently being finished in Clausthal, Braunschweig and Hannover.

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```
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```

**Project Homepage**
```
http://www.in.tu-clausthal.de/abteilungen/cig/cigroot/research/projects/
galot-game-logics-for-open-it-environments/
```

**Project 16: Normative Multi-Agent Systems**

**Project Member**
Dr. Nils Bulling (Leader)

**Partner**
Dr. Mehdi Dastani, Utrecht University, The Netherlands

**Duration**
since 2010
**Project Description**

The environment is an essential component of multi-agent systems and is often used to coordinate the behaviour of individual agents. Recently many languages have been proposed to specify and implement multi-agent environments in terms of social and normative concepts.

In this project, we work on a formal setting of multi-agent environment which abstracts from concrete specification languages. This setting is based on norms and sanctions and we would like to show how concepts from mechanism design can be used to formally analyze and verify whether specific normative behaviors can be enforced (or implemented) if agents follow their subjective preferences. Complexity issues of associated problems are considered as well. We also investigate how norm violations can be monitored.

**References**

[Bulling et al., 2013a] (Page 196)

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**Project Homepage**

http://www.in.tu-clausthal.de/index.php?id=cigproject_Bulling10Norms

**Project 17: Variants of Strategic Reasoning**

**Project Members**

Dr. Nils Bulling (Leader)

Dr. Wojtek Jamroga (Leader)

Dr. Matei Popovici (Project Staff)

**Duration**

2010 – 2013
Project Description

Alternating-time temporal logic (ATL) is a modal logic that allows to reason about agents' abilities in game-like scenarios. Semantic variants of ATL are usually built upon different assumptions about the kind of game that is played, including capabilities of agents (perfect vs. imperfect information, perfect vs. imperfect memory, etc.).

ATL has been studied extensively in previous years; however, most of the research focused on model checking. Studies of other decision problems (e.g., satisfiability) and formal meta-properties of the logic (like axiomatization or expressivity) have been relatively scarce, and mostly limited to the basic variant of ATL where agents possess perfect information and perfect memory. In particular, comparison between different semantic variants of the logic is largely left untouched. In this project, we consider various semantics of ATL and show how they affect the set of valid formulae.

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Project Homepage
http://www.in.tu-clausthal.de/index.php?id=cigproject_Bulling10SemanticVariants

Project 18: Stability in Mobile Ad-hoc Networks

Project Members
Dr. Nils Bulling (Leader)
Dr. Matei Popovici (Project Staff)
Michael Köster (Project Staff)

Duration
since 2012
Project Description

Mobile ad-hoc networks are networks that allow (mobile) users to communicate in heterogeneous environments without relying on a fixed infrastructure, examples of which are mobile communication in large urban spaces or in public transportation. Due to their many advantages, such as decentralization, independence of communication infrastructure, flexibility, etc., their field of use steadily increases. However, networks of this kind also raise new problems related to, for example, routing and data delivery, security and privacy, trust and usability.

In this project we investigate formal models of mobile ad-hoc networks and address questions regarding optimal and stable network topologies. In particular, stability is important in order to ensure that communication is reliable and that applications designed for such networks are accepted by the users.

References

[Bulling et al., 2012a] (Page 195),
[Bulling et al., 2012] (Page 207),
[Ahlbrecht, 2013] (Page 210)

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Project 19: An Environment Interface Standard for Agent-Oriented Programming

Project Members
Prof. Dr. Jürgen Dix (Leader)
Dipl.-Inf. Tristan Behrens (Leader)

Partner
Dr. Koen Hindriks, TU Delft, The Netherlands (Leader)
3.2 Computational Intelligence

**Duration**
05/2009 – 09/2012

**Project Description**

Our objective is to design and develop a generic environment interface standard (EIS) that facilitates connecting agents programmed in various agent programming languages (APL) to environments. We aim at a de facto standard that possibly can become a real standard in the future. Our motivation is based on the following considerations:

- implementing an EIS makes already working environments widely available (short-term goal),
- an EIS allows for the easy distribution of future environments (Multi-Agent Contest, Unreal, ORTS, etc.),
- an EIS allows the direct comparison of APL platforms, and
- an EIS enables the development of a truly heterogeneous MAS, consisting of agents from APL platforms that adhere to the standard of the EIS (long-term goal).

Our approach takes the following goals into account: to design an interface that is as generic as possible, and to reuse as much as possible from existing interfaces. Obviously, there is a trade-off between these two goals. Our basic strategy for designing a generic environment interface is to start with what is currently “out there” in existing platforms, and to try to merge this into a generic interface which is sufficiently close to these existing approaches.

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**Project Homepage**
http://cig.in.tu-clausthal.de/eis
Project 20: IT Ecosystems – Local Communities in Information Cities (LocCom)

Project Members

- Prof. Dr. Jürgen Dix (Leader)
- Dipl.-Inf. Michael Köster (Project Staff)
- Prof. Dr. Christian Siemers

Partners

- Prof. Dr. Heribert Vollmer, Leibniz Universität Hannover, Germany
- Prof. Dr.-Ing. Michael Beigl, Technische Universität Braunschweig, Germany
- Prof. Dr.-Ing. Lars Wolf, Technische Universität Braunschweig, Germany
- Prof. Dr. techn. Dipl.-Ing. Wolfgang Nejdl, Leibniz Universität Hannover, Germany
- Prof. Dr. Mark Vollrath, Technische Universität Braunschweig, Germany

Duration

03/2009 – 09/2012

Project Description

In this project we develop methods, concepts, and tools for decentralized IT Ecosystems. Important outcomes will be the development of new services and techniques to guarantee certain quality characteristics. In order to do so, we investigate adaptive techniques on all layers ranging from reconfigurable hardware via protocols up to modeling and inference methods.

An important aspect will be the application of context in generalized form. In particular, a principal objective is the modeling and implementation of generalized social networks based on mobile devices. Using services and information offered by these devices on one hand, and the needs and duties of users on the other hand, peers will be brought together. Further, recommendations concerning activities and usages will be generated automatically and tailored for the users, by taking into account the autonomy of users and devices. To achieve these goals, techniques and methods of several heterogenous research areas must be combined. The work to be carried out includes:

- Extending temporal logics (LTL, CTL, CTL*) to model local communities and social networks.
- Mechanisms to detect, describe, and use context.
- Scalable networking and communication of mobile devices considering availability of devices and network services.
- Provable characteristics of social networks (privacy and availability).
- Recommender Systems, User-centric Media, Integration with heterogeneous mobile devices.
3.2 Computational Intelligence

- Adaptive hardware architectures designed for network scalability, optimization of energy consumption vs. computing power.

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Project Homepage
http://www.it-ecosystems.org/

Project 21: A Simulation Platform for Multi-Agent Systems

Project Members
- Prof. Dr. Jürgen Dix (Leader)
- Dipl.-Inf. Tristan Behrens (Leader)
- Dipl.-Inf. Michael Köster (Leader)
- Lic. Federico Schlesinger (Project Staff)
- B.Sc. Tobias Ahlbrecht (Project Staff)

Partners
- Dr. Peter Novák, TU Delft, The Netherlands
- Dr. Mehdi Dastani, Utrecht University, The Netherlands

Duration
since 01/2005

Project Description
Since 2005, we are organising a yearly agent contest. This competition is an attempt to stimulate research in the area of multi-agent programming by (1) identifying key problems, and (2) collecting suitable benchmarks. These can serve as milestones for testing agent-oriented programming languages, platforms and tools. The simulation platform we have developed and which is constantly improved makes it possible to test agent systems in a fair manner.
References

[Behrens et al., 2012b] (Page 190),
[Ahlbrecht et al., 2013] (Page 193),
[Ahlbrecht et al., 2013a] (Page 193),
[Behrens et al., 2012e] (Page 194),
[Dix et al., 2012b] (Page 196)

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Project Homepage
http://www.multiagentcontest.org

3.2.5 Scientific Activities

Person
Prof. Dr. Jürgen Dix

☐ Editorial Board Memberships

  See http://www.elsevier.com/wps/product/cws_home/672712
- IfI Technical Report Series, Department of Informatics, TU Clausthal (since 2005).
  See http://www.in.tu-clausthal.de/forschung/technical-reports/.


Organization of Conferences and Workshops


PC-Member of Conferences and Workshops


• DATALOG 2.0 2012: 2nd Workshop on the Resurgence of Datalog in Academia and Industry, Vienna, Austria, September, 2012. See http://www.dbai.tuwien.ac.at/datalog2.0/.


• SUM 2012: Sixth International Conference on Scalable Uncertainty Management, Marburg, Germany, September, 2012. See http://www.mathematik.uni-marburg.de/~sum2012/.


• CLIMA XIV: 14th International Workshop on Computational Logic in Multi-Agent Systems, Corunna, Spain, August, 2013. See http://centria.di.fct.unl.pt/events/climaXIV.


☐ **Steering Committees**


☐ **Invited Talks**


☐ **Visits**
• Prof. Dr. Cees Witteveen, Department of Computer Science, TU Delft, The Netherlands, 2013.
  See http://www.tudelft.nl.

☐ Member

• Institut für Informationssysteme, TU Wien, Favoritenstrasse, 1040 Vienna, Austria (since 1996).
  See http://www.tuwien.ac.at.
• ACM, USA (since 2004).
  See http://www.acm.org.
• IEEE, 2001 L Street, NW. Suite 700, Washington, DC 20036-4910, USA (since 2004).
  See http://www.ieee.org/
• Senate of NTH (2011-2014).
  See http://en.nth-online.org/.
• Senate of TU Clausthal (2011-2014).
  See http://www.tu-clausthal.de.

☐ Evaluator

• DICODE, EU-ICT-FP7, Expert Evaluator, Luxembourg City, Luxembourg, October, 2012.

☐ External Evaluator (Habilitation)

  See http://www.uni-hamburg.de/.

☐ External Evaluator (PhD)

• Chetan Yadati Narashima: Coordinating Autonomous Planning and Scheduling, PhD External Examiner, TU Delft, January, 2013.

Person Dr. Nils Bulling

☐ PC-Member of Conferences and Workshops


• CLIMA XIV: 14th International Workshop on Computational Logic in Multi-Agent Systems, Corunna, Spain, September, 2013. See http://centria.di.fct.unl.pt/events/climaXIV/.


3.2 Computational Intelligence


Steering Committees

- LAMAS: Logical Aspects of Multi-Agent Systems (since 2013). See http://logic-mas.org

Invited Talks


- A Game-Theoretic Approach to Optimal Topologies in Opportunistic Networks at DTU, Denmark, September, 2012.

- A Game-Theoretic Approach to Optimal Topologies in Opportunistic Networks at Utrecht University, The Netherlands, August, 2012.

- Alternating Epistemic Mu-Calculus: Fixed-point Abilities under Incomplete Information at Dagstuhl Seminar VaToMAS, Germany, April, 2013.

- Combining quantitative and qualitative strategic reasoning-Part II: QATL*, some comparisons and preliminary results at Dagstuhl Seminar VaToMAS, Germany, April, 2013.

- Comparing Semantics of Strategic ability at University of Toulouse/IRIT, France, May, 2013.


Person  Dipl.-Inf. Michael Köster

Organization of Conferences and Workshops

• Co-Organizer (with Jürgen Dix and Federico Schlesinger) Agent Con-
test: Multi-Agent Programming Contest, Clausthal, Germany, Septem-
ber, 2013.
See http://www.multiagentcontest.org/.

☐ Visit
• PD Dr. habil. Wojciech Jamroga, Individual and Collective Reasoning
Group, Campus Kirchberg, L-1359 Luxembourg, 2012.
See http://icr.uni.lu/wjamroga/.

Person Lic. Federico Schlesinger

☐ Editorial Board Memberships
• IfI Technical Report Series, Department of Informatics, TU Clausthal
(2012).
See http://www.in.tu-clausthal.de/forschung/technical-reports/.
• IfI Technical Report Series, Department of Informatics, TU Clausthal
(2013).
See http://www.in.tu-clausthal.de/forschung/technical-reports/.

☐ Organization of Conferences and Workshops
• Co-Organizer (with Tristan Behrens, Jürgen Dix and Michael Köster))
Agent Contest: Multi-Agent Programming Contest, Clausthal-
Zellerfeld, Germany, September, 2012.
See http://www.multiagentcontest.org/.
• Co-Organizer (with Jürgen Dix and Michael Köster)) Agent Contest:
Multi-Agent Programming Contest, Clausthal-Zellerfeld, Germany,
September, 2013.
See http://www.multiagentcontest.org/.

3.2.6 Highlights

☐ In 2012
• Jürgen Dix (jointly with Koen Hindriks, Brian Logan and Wayne
Wobcke) organized the Dagstuhl seminar "Engineering Multi-Agent Sys-
tems". During the seminar, a new workshop series, Engineering Mul-
tiagent systems (EMAS), has been founded. It is a merger of the three
workshop series ProMas, DALT and AOSE.
• Jürgen Dix, Tristan Behrens, Michael Köster and Federico Schlesinger
organized the Multi-Agent Programming Contest.
• The IT Ecosystems project (in which Jürgen Dix and Michael Köster
were involved) was finished successfully.
• The new project GaLOT (a DFG-Luxembourg cooperation with Wojtek Jamroga) was accepted.

☐ In 2013

• Nils Bulling (and his co-authors Sujata Ghosh and Rineke Verbrugge) received the Best Paper Award at PRIMA 2013 for their paper Reaching your Goals without Spilling the Beans: Boolean Secrecy Games.

• Jürgen Dix, Michael Köster, Federico Schlesinger and Tobias Ahlbrecht organized the Multi-Agent Programming Contest.

• Jürgen Dix was one of the organizers of the Dagstuhl seminar Belief Change and Argumentation in Multi-Agent Scenarios.

☐ Visitors:

• 10 June – 21 June 2013:
  Dr. Jørgen Villadsen, Technical University of Denmark (DTU), Denmark.
3.3 Theoretical Foundations of Computer Science

3.3.1 Overview

Leaders Dr. Michaela Huhn

Secretary Christine Kammann
Sandra Karpenstein

Scientific Employees
Dipl.-Wirt.-Inf. Sara Bessling (since 07/10)
M.Sc. Wuzhu Chen (07/10 - 08/12)
Dipl.-Inform. Dennis Klar (since 11/12)

External Ph.D. Students
Dipl.-Inform. Dennis Klar (04/10 - 10/12)

3.3.2 Research Agenda

In research and teaching we address mathematically founded methods for the model-based analysis of software-intensive systems, notably formal verification. We work on bridging the gap between graphical system and software design languages for behavioral descriptions and model checking techniques that are capable of formally proving dependability properties on large states spaces. Formal verification is employed not only for safety assurance, but already in safety analysis and in system diagnosis. Currently, we focus on synchronous languages and real-time behavior. But we also consider event-driven and causal models.

In order to use formal verification results in safety assessment and certification, safety arguments have to be structured and associated with design models in a norm compliant way.

In early design stages, the integration between the physical processes and computational control is often analyzed by multi-domain simulation. We contribute as a partner in the OPENPROD project to MODELICA, an open source multi-domain modeling language.

Application areas are the railway and automotive domain, robotics and medical devices and the energy sector.

Taken as a whole, our research contributes to the thorough design and analysis of dependable cyber-physical systems, i.e. the tight integration of physical components with networked computational processes.

For further information, please see the group's homepage at:
http://www.in.tu-clausthal.de/abteilungen/gi
and the research home page at:
http://www.in.tu-clausthal.de/divisions/gi/research/.
3.3.3 Supervised Theses


3.3.4 Projects

Project 22: OPENPROD - Open Model-Driven Whole-Product Development and Simulation Environment

Project Members
- Dr. Michaela Huhn (Leader)
- M.Sc. Wuzhu Chen

Partners
- Linköping University, Sweden
- Fraunhofer FIRST, Berlin, Germany
- Bosch-Rexroth, Lohr am Main, Germany
- Siemens Energy, Erlangen, Germany

Duration
- 2009 – 2012

Project Description
OPENPROD is an ITEA2 European project that provides an open, whole-product model-driven rapid systems development, modeling, and simulation environment integrating into the leading open industrial software development platform (Eclipse) with open-source (OpenModelica, etc.), as well as industrial modeling and simulation tools and applications. The main research topics are: integrated hardware software modeling by Modelica - UML - SysML integration, model compiler enhancements, compilation of Modelica to parallel multi-core platforms, tool interoperability and application demonstrators.
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Project Homepage
http://www.in.tu-clausthal.de/de/abteilungen/gi/forschung/openprod/

Project 23: Model-based Diagnosis of Railway Control and Safety System

Project Members
Dr. Michaela Huhn (Leader)
Dipl.-Inform. Dennis Klar

Partner
Siemens AG Mobility Division, Braunschweig, Germany

Duration
2009 – 2013

Project Description
The purpose of automated monitoring and fault diagnosis of railway systems is to detected failures as early as possible and to support the subsequent restoration measures. This contributes to a minimisation of failure-related down-times and the fulfilment of high quality expectations by customers. The execution of any diagnostic procedure requires a broad knowledge of the functional and structural dependencies within the target system. This task is influenced by several factors: (1) the ever-increasing complexity and diversity of target systems and (2) the high ratio of third-party and legacy components to be diagnosed. The concept of model-based diagnosis poses a promising approach to the systematic capture and analysis of diagnostic knowledge. The use of explicit models of a system’s structure and behavior allows us to trace deviant system observations directly to the causing components.
In cooperation with Siemens Mobility Division in Braunschweig, we apply model-based diagnostic methods to different application areas, such as: interlockings, rail automation and safety systems, and on-board systems of railway vehicles. The manifold of application areas demands a very powerful yet flexible approach, which can be adapted to different requirements and conditions. Besides technical complexities, the effort required for the creation and management of model libraries is considered a key factor.

The goal of this project is to devise a practical diagnostic procedure, to define a systematic and component-oriented approach to modeling, to clarify the constraints of an adaption to existing techniques, and to evaluate the results based on a conceptual prototype and case studies. Further, the estimation and optimisation of efforts and an early assessment of diagnostic system properties are of particular interest.

References
[Klar and Huhn, 2012b] (Page 192),
[Klar and Huhn, 2012c] (Page 201),
[Klar and Huhn, 2012d] (Page 201)

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Project Homepage
http://www.in.tu-clausthal.de/de/abteilungen/gi/forschung/modellbasierte-diagnose/

Project 24: IT Ecosystems – Adaptive Interaction Mechanisms (AIM)

Project Members
Dr. Michaela Huhn (Leader)
Dipl.-Inform. Gianina Homoceanu
Dipl.-Inform. Dennis Klar
Partners

Prof. Dr. Jörg P. Müller, Business Information Technology Group, TU Clausthal, Germany (Main Leader)
Prof. Dr. Bernardo Wagner, Institute for Systems Engineering, Real Time Systems Group, LU Hannover, Germany
Prof. Dr. Niels Pinkwart, Institute for Computer Science, Human-Computer Interaction Group, TU Clausthal, Germany

Duration
2009 – 2012

Project Description

IT Ecosystems: Classical approaches of computer science do not scale well for today’s large and complex software-intensive systems. Software systems cannot be considered in isolation, since they are connected among each other and interact massively. Instead they are to be designed as parts of a larger IT Ecosystem. In analogy to biological ecosystems, IT Ecosystems are based on the balance between individuals (autonomy) and sets of rules (control) defining equilibria within an IT Ecosystem. Maintaining and continuously evolving IT Ecosystems requires deep understanding of this balance.

The new research topic IT Ecosystems cuts across several research areas, including: emergence of system functions, extending classical engineering approaches, adaptive infrastructures, control of semantic diversity, and enhanced human-environment-machine interaction. These core areas are addressed by the newly established NTH focused Research School for IT Ecosystems, a cooperation of the TU Braunschweig, TU Clausthal, and LU Hannover funded by the Federal government of Lower Saxony.

The goal of AIM is to investigate methods for decentralized, bottom-up organization of complex software systems, with special focus on the emergence and adaptation of interaction mechanisms among automated actors in dynamic environments. AIM is a subproject of the IT ecosystems project. The focus of our working group is formal verification for safety aspects.
3.3 Theoretical Foundations of Computer Science

3.3.5 Scientific Activities

Person Dr. Michaela Huhn

Organization of Conferences and Workshops

- Co-Chair Zertifizierung und modellgetriebene Entwicklung sicherer Software - Workshop (ZeMoSS 2012), Berlin, Germany, February, 2012.
- Co-Chair Model-Based Development of Embedded Systems - Workshop (MBEES 2013), Dagstuhl, Germany, April, 2013. See [http://www.in.tu-clausthal.de/divisions/gi/research/mbees2013/](http://www.in.tu-clausthal.de/divisions/gi/research/mbees2013/).

PC-Member of Conferences and Workshops

References

[Klar and Huhn, 2012a] (Page 201)

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Project Homepage
http://www.in.tu-clausthal.de/de/abteilungen/gi/forschung/it-ecosystems/


3.3.6 Highlights

☐ In 2012

- Michaela Huhn co-organizes the ZeMoSS workshop on Zertifizierung und modellgetriebene Entwicklung sicherer Software in Berlin (ZeMoSS 2012).

☐ In 2013

- Michaela Huhn co-organizes the Dagstuhl seminar on Software Certification: Methods and Tools - Seminar (Dagstuhl 13051).
- Michaela Huhn co-organizes the Dagstuhl workshop on Model-Based Development of Embedded Systems - Workshop (MBEES 2013).
- Michaela Huhn co-organizes the ZeMoSS workshop on Zertifizierung und modellgetriebene Entwicklung sicherer Software in Aachen (ZeMoSS 2013).
- Michaela Huhn is named program chair of the FHIES/SEHC 2014 workshop in Washington, D.C., USA.
3.4 Computer Graphics

3.4.1 Overview

**Leaders**  Prof. Dr. Gabriel Zachmann (until 06/2012)
Dr. Stefan Guthe (interim, since 10/2012)

**Secretary**  Christine Kammann

**Scientific Employees**  Dipl.-Inf. David Mainzer
Dipl.-Inf. Daniel Mohr (until 10/2012)
Dipl.-Inf. René Weller (until 10/2012)

3.4.2 Research Agenda

The Computer Graphics Group focuses on few areas within the field of visual computing. The first area is computer graphics, which deals with all aspects of three-dimensional graphical objects. Graphical objects can represent anything from real-world objects, hypothetical objects, simulation data, etc. Computer Graphics is the science of modeling, simulating, visualizing, and interacting with these objects and complete virtual environments built from them.

Our group focuses in particular on *acceleration data structures*, e.g., bounding volume hierarchies, for geometric queries among graphical objects such as collision detection, natural interaction in virtual environments, real-time rendering of complex scenes, and immersive scientific visualization.

The additional areas are video compression and post-processing, global illumination and general-purpose computing on graphics processing units (GPGPU).

For more information, please visit the group’s homepage at: [http://cg.in.tu-clausthal.de](http://cg.in.tu-clausthal.de).

3.4.3 Supervised Theses

*Bachelor’s Theses:*


3.4 Computer Graphics


3.4.4 Projects

**Project 25: Collaborative Multi-User Haptic Workspace**

**Project Members**
- Prof. Dr. Gabriel Zachmann (Leader)
- Dipl.-Inf. René Weller (Project Staff)

**Funding**
- Federal Ministry of Education and Research (BMBF)
- 30,000€ (of 184,000€ total)

**Duration**
- 03/2010 – 03/2012

**Project Description**

Haptic feedback is an essential and emerging technology for many applications, ranging from virtual assembly simulation to mobile computing. It can help to improve human-computer interaction as well as, in multi-user scenarios, human-human interactions in many fields like industrial applications, entertainment, education, medicine and arts.

In this project, we have developed a haptic workspace that allows high fidelity, two-handed multi-user interactions in scenarios containing a large number of dynamically simulated rigid objects and a polygon count that is only limited by the capabilities of the graphics card.

The main challenge when doing haptic rendering is the extremely high frequency that is required: While the temporal resolution of the human eye is limited to approximately 30 Hz, the bandwidth of the human tactile system is about 1000 Hz. In most haptic scenarios, the computational bottleneck remains the collision detection, whereas the force computations, i.e. the collision response, can be done relatively fast.

Thus, the heart of our haptic workspace is our new geometric data structure, called Inner Sphere Trees (ISTs), that not only allows us to detect collisions between pairs of massive objects at haptic rates, but also enables us to define a novel type of contact information that guarantees stable forces and torques.
Project 26:  **Real-time camera-based 3D hand tracking**

**Project Members**
Prof. Dr. Gabriel Zachmann (Leader)
Dipl.-Inf. Daniel Mohr (Project Staff)

**Duration**
07/2006 – 07/2012

**Project Description**
Hand tracking is a powerful technique for interaction in many applications, for example for navigation in virtual environments, virtual assembly simulation, gesture recognition, and motion capture.

The goal of this project is the markerless tracking of the global position and all finger joint angles of a human hand in real-time. Due to measurement noise, occlusion, cluttered background, inappropriate illumination, high dimensionality (about 27 Degrees of freedom), and real-time constraints, hand-tracking is a very important and interesting scientific challenge.

Our approach is model-based, utilizing multiple cameras and multiple features, e.g. edge gradients and skin color to reduce uncertainty. In order to achieve real-time hand-tracking, we use a hierarchical matching approach and dimension reduction techniques. We combine both and additionally exploit time coherence to achieve reliable prediction of the hand state in each frame.
Contact E-Mail
zach@tu-clausthal.de

Project 27: Highly Parallel Collision Detection Algorithm for Deformable Objects

Project Members
Prof. Dr. Gabriel Zachmann (Leader)
Dipl.-Inf. David Mainzer (Project Staff)

Project Description
Fast and exact collision detection between rigid, and/or soft bodies is important for many fields of computer science. The underlying collision detection needs to check if collisions occur between a pair of objects as well as self-collisions among deformable objects. This procedure is the core of many simulation and planning algorithms in computer graphics and related areas, such as automatic path finding, or virtual surgery.

Our approach is designed for interactive and exact collision detection in complex environments and can handle objects movement and deformation at the same time. To achieve these features, our algorithm subdivides the whole scene into independent, overlapping parts in the first step. For the segmentation process, we use a GPU-based clustering algorithm called fuzzy C-means. For all clusters, we can execute the collision detection steps independently, and this offers the possibility to distribute the collision detection computation for the clusters to different GPUs.
3.4.5 Highlights

☐ In 2012

- David Mainzer reads the lecture “Introduction to Computer Graphics” during the summer term at Hochschule Nordhausen.
- Dr. Stefan Guthe joined the Computer Graphics Group at the Department of Informatics of TU Clausthal.

☐ In 2013

- David Mainzer reads the lecture “Introduction to Computer Graphics” during the summer term at Hochschule Nordhausen.

References

[Mainzer and Zachmann, 2013] (Page 203),
[Mainzer and Zachmann, 2014] (Page 203)

Contact E-Mail

dm@tu-clausthal.de
3.5 Model-based System Analysis and Simulation

3.5.1 Overview

**Leader**  Apl. Prof. Dr.-Ing. Matthias Reuter

**Secretary**  Christine Kammann
Sandra Karpenstein

**Scientific Employees**  Dipl.-Inf. Sven Birkenfeld
Dipl.-Päd. Sabine Bohlmann
B.Sc. Stela Mocka

**External Ph.D. Students**  Dipl.-Inf. Kerstin Lenk (FH), Brandenburgischen Technischen Universität Cottbus-Senftenberg,
Cottbus, Germany

3.5.2 Research Agenda

In the past two years, the research focus of the group Model-based System Analysis and Simulation lied on the realization of several applications based on the principle of *Computing with Activities* and hybrid neural network structures. To ensure their on-line capability, most of these structures have been realized using the CUDA techniques. As the data sets used and analyzed were of large and very large multi-sensor data set arrays, most of them have been handled in the context of data warehouse.

A different challenge, respectively a general task was to combine different data sets and formats in integrative situation reports and visualize them in an client specific way. The data were provided mainly through scientific marine research activities (data formats were: SEG-Y, XTF, HSX, R2S, SDF, GPX, GeoTIFF, ESRI Shapefile, YAML and MAGLOG), from ground radar equipment (data formats of different antenna manufacturing, as well as GPS, GeoTIFF and others) and medical technology (data formats: text and image data of different formats).

This research has been employed in various projects, in order to optimize the data analysis of in-use sonar equipment for probing the ocean floor after hazardous materials or to develop hybrid, modular neural networks for the classification and modeling of the combustion process for different grate incinerators.

For further information, please see the group’s homepage at: [http://www.in.tu-clausthal.de/abteilungen/modellbasierte-systemanalyse-und-simulation/](http://www.in.tu-clausthal.de/abteilungen/modellbasierte-systemanalyse-und-simulation/).
3.5.3 Projects

Project 28: TIMM-SOAM

Project Members
Apl. Prof. Dr-Ing. Matthias Reuter (Leader)
Dipl.-Inf. Sven Birkenfeld (Project Staff)
Dipl.-Päd. Sabine Bohlmann (Project Staff)
B.Sc. Stella Mocka (Project Staff)
Bernd Nawothnig (Project Staff)

Partners
Technical Center for Ships and Naval Weapons, Maritime Technology and Research (WTD 71), Eckernförde, Germany
Heinrich Hirdes EOD Services GmbH, Hamburg, Germany
Atlas Elektronik GmbH, Bremen, Germany

Funding
Federal Ministry for Economic Affairs and Energy (BMWi)
678,000€ (of 678,000€ total)

Duration
1.09.2012 – 31.08.2015

Project Description
This project is aimed at the careful preliminary exploration of waters substrates as a prerequisite for a low-risk economic exploitation of North Sea and Baltic Sea.

The first goal of our research is to optimize the data analysis of in-use sonar equipment for probing the ocean floor after hazardous materials by means of neuro-based image interpretation algorithms, to get a significant growth of relevant information by an automatic analysis. Further, in order to increase the surface search performance and detection reliability of hazardous materials, we intent to build an AUV with various sensors, i.e. sonar, metal detector, camera, Raman spectrometer, in different configurations for an improved data collection. The data collected from the different sensors are combined into an overall "image", which is then analyzed with the help of neural networks.

To achieve the first objective, specific neuronal filter chains are designed for the analysis of the sonar data to obtain an optimum reduced data basis for the data analysis. In order to evaluate the pre-filtered images, a hybrid neural classifier is used, consisting of a self-organizing map (SOM) and a multi-layer feed-forward network with integrated receptive field structure. The respectively resulting activity pattern serves then as the input pattern for the back propagation network to assess the signatures of the found material.
3.5.4 Scientific Activities

Person  Matthias Reuter

- Editorial Board Memberships
    See http://www.ieeesystemsjournal.org/editorial-board/.

- PC-Member of Conferences and Workshops
    See http://thesai.org/.
  - ICAT 2013, Sarajevo, Bosnia-Herzegovina, October-November, 2013.
    See http://icat.etf.unsa.ba/icat-2013/cms/.
    See http://www.smc2013.org/.

References
[Jans et al., 2012] (Page 201)

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matthias.reuter@tu-clausthal.de
3.6 Databases and Information Systems

3.6.1 Overview

Leader Prof. Dr. rer. nat. habil. Sven Hartmann

Secretary Andrea Behfeld

Members Dr. Thu Trinh
Dipl.-Math. Sven Arnhold
M.Sc. Leif Körner
M.Sc. Jing Wang
M.Sc. Waqas Ahmed

Associated Members Dipl.-Inf. Sigrun May, Helmholtz Centre for Infection Research

Members MBA Wolfgang Scherer, Chartis

3.6.2 Research Agenda

The research of our group focuses on challenges in data, information systems and algorithm engineering. In the field of data engineering we work on topics like data semantics, database integrity and security, database evolution, special-purpose and graph databases, XML, NoSQL, big data processing and data-driven simulation. Further, in the field of information systems engineering we focus on research issues like conceptual modeling, quality models, model transformation, and automated application testing. The area of algorithm engineering poses challenging topics like data mining, graph algorithms, clustering and inference. Our research has led to various applications in the industry, and we are active in interdisciplinary research on emerging applications of databases and information systems in engineering and science.

For more information, please see the web site of our group at http://dbis.in.tu-clausthal.de.

3.6.3 Supervised Theses

Ph.D. Theses:


Diploma and Master’s Theses:


**Bachelor’s Theses:**


### 3.6.4 Projects

**Project 29: Databases and Information Systems**

*Project Members*
- Prof. Dr. Sven Hartmann (Leader)
- Dr. Thu Trinh
- Dipl.-Math. Sven Arnhold
- M.Sc. Leif Körner

*Partners*
- Prof. Dr. Sebastian Link, University of Auckland, New Zealand
- Prof. Dr. Dirk Linowski, Steinbeis Universität Berlin, Germany
- Dr. Hui Ma, Victoria University of Wellington, New Zealand
- Prof. Dr. Millest Vincent, University of South Australia
- BTC Business Technology Consulting, Oldenburg, Germany
- Fraunhofer Institut für Solar Energiesysteme, Freiburg, Germany
- IBM SmartCloud Content Management, Stuttgart, Germany

*Funding*
- Alfried Krupp von Bohlen und Halbach Foundation, administered by the German Scholars Organisation
- 100,000€ (of 100,000€ total)

*Duration*
- 01/2008 – 12/2014

*Project Description*
- We are investigating distributed data- and knowledge-intensive systems from a variety of perspectives, with a focus on models, architectures and methods for describing and developing them, but also on their mathematical, logical, computational and managerial foundations. Our work further includes the implementation of prototype systems that demonstrate the feasibility of our research for developing up-to-date systems for applications in science, engineering, business, and education.

*References*
- [Ferrarotti et al., 2012a] (Page 197),
- [Hartmann and Link, 2012] (Page 192),
- [Hartmann and Link, 2013] (Page 200)

*Contact E-Mail*
- sven.hartmann@tu-clausthal.de
Project 30: Cardinality Constraints for XML

Project Members
Prof. Dr. Sven Hartmann (Leader)
Dr. Thu Trinh

Partners
Prof. Dr. Sebastian Link, University of Auckland, New Zealand (Leader)
Dr. Flavio Ferrarotti, Victoria University of Wellington, New Zealand

Funding
Marsden Fund, administered by the Royal Society of New Zealand
100,000€ (of 200,000€ total)

Duration
03/2009 – 08/2012

Project Description
The Extensible Markup Language (XML) has evolved to be the lingua franca for data integration and data exchange on the Internet and elsewhere. This development has led to a dramatic increase of XML data that must be stored, managed and processed in its native format. The syntactic expressibility of XML together with the tree-like nested structure of its data impose new challenges for database researchers. It is particularly difficult to develop data management tools that are both efficient and cater for a large class of properties that are naturally exhibited by XML data.

Our project is based on the somewhat surprising observation that cardinality constraints have not been exploited in the context of XML. Cardinality constraints can express many properties of XML data that cannot be captured by other classes of XML constraints. They have a direct impact on many XML recommendations such as schema specification languages, query languages or data manipulation and transformation languages. We aim at developing a well-founded theory that gives original insight into the characteristics of XML data, enhances the semantic capabilities of XML, allows designers to make an informed choice about which classes of cardinality constraints to incorporate into XML recommendations, and provides efficient algorithms to advance XML data processing.

References
[Ferrarotti et al., 2013a] (Page 190)

Contact E-Mail
sven.hartmann@tu-clausthal.de

Project 31: Scalable and Real-Time Dependency Mining

Project Member
Prof. Dr. Sven Hartmann (Leader)
Partners

Dr. Flavio Ferrarotti, Victoria University of Wellington, New Zealand
Prof. Dr. Sebastian Link, University of Auckland, New Zealand
Prof. Dr. Mauricio Marín, Yahoo! Research Latin America, Santiago, Chile
Emir Muñoz, National University of Ireland

Duration
01/2012 – 12/2013

Project Description
Semi-structured data formats like XML or JSON have gained widespread acceptance for publishing, sharing and manipulating data in distributed web-scale applications. While these formats provide a high degree of syntactic flexibility, there are significant shortcomings when it comes to specifying, revealing and validating the semantics of data. We develop and investigate high-performance methods for analysing large streaming data volumes and discovering dependencies among data.

References
[Ferrarotti et al., 2012b] (Page 197),
[Ferrarotti et al., 2013c] (Page 191),
[Ferrarotti et al., 2013d] (Page 197)

Contact E-Mail
sven.hartmann@tu-clausthal.de

Project 32: Interactive Constraint Acquisition

Project Members
Prof. Dr. Sven Hartmann (Leader)
Dr. Thu Trinh
M.Sc. Jing Wang

Partners
Prof. Dr. Sebastian Link, University of Auckland, New Zealand (Leader)
Prof. Dr. Markus Kircherg, HP Labs Singapore and National University of Singapore
Dr. Henning Köhler, Massey University, New Zealand
Prof. Dr. Uwe Leck, University of Wisconsin, USA
Prof. Dr. Bernhard Thalheim, Christian-Albrechts Universität zu Kiel, Germany

Duration
01/2008 – 12/2013
Project Description

Integrity constraints model business rules that every legal database instance is compelled to obey. They restrict databases to those considered meaningful for the application at hand. In practice, the gathering and formalisation of integrity constraints is far from trivial. This task does not only demand high abstraction abilities but also tends to be rather complex. Human factors such as the experience and skills of the data architect play a major role in the acquisition process. In view of the problems encountered in database design practice and the importance of the sound and complete gathering of semantic information, it is highly desirable to support the acquisition of semantic constraints.

We investigate the efficient construction and effective use of example and counter-example databases that can guide the process of constraint acquisition. Such databases serve as a valuable design aid for data architects, e.g., to communicate with domain experts, to study consequences of particular design decisions, and to foresee potential anomalies during database operation. Eventually the generation, analysis and evolution of good example databases at design time may help data architects to specify a constraint set that best reflects the business rules for the application under development, thus preventing expensive corrections at run time.

References

[Hartmann et al., 2013] (Page 192),
[Hartmann et al., 2012a] (Page 192),
[Hartmann et al., 2012b] (Page 199)

Contact E-Mail
sven.hartmann@tu-clausthal.de

Project 33: Inference Control for Secure Probabilistic Databases
Project Members

Prof. Dr. Sven Hartmann (Leader)
M.Sc. Leif Körner

Partners

Prof. Dr. Joachim Biskup, Technische Universität Dortmund, Germany
Prof. Dr. Sebastian Link, University of Auckland, New Zealand
Dr. Lena Wiese, Georg-August-Universität Göttingen, Germany

Project Description

Information is a fundamental asset in our society. For many web applications, information owners want to discretionarily share pieces of private information, while keeping other pieces secret. Inference control is a security mechanism aiming to keep information confidential according to a privacy policy declared by the information owner. Inference control is known to be costly in practice: the users’ access to information must be restricted and query answers must be monitored in context of the privacy policy, while taking into account the users’ ability to draw conclusions from the information accessed in the past and application-specific background knowledge. Our objective is to investigate inference control methods for uncertain and probabilistic databases.

References

[Biskup et al., 2012b] (Page 195),
[Biskup et al., 2012a] (Page 195)

Contact E-Mail

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Project 34: Data Management for Metagenomic Analysis

Project Members

M.Sc. Jing Wang (Leader)
Prof. Dr. Sven Hartmann
3.6 Databases and Information Systems

**Partners**

- Prof. Dr. Peter Lockhart, Massey University, New Zealand
- Richard Hall, Institute of Environmental Science and Research, New Zealand
- Prof. Dr. Mike Hendy, University of Otago, New Zealand

**Duration**

1/2012 – 12/2013

**Project Description**

Nowadays, huge amounts of data are generated in biological research laboratories. Lab automation is essential for the knowledge discovery process. The goal is to develop a framework for assessing the effectiveness of lab automation solutions for data-intensive applications. Our research addresses various aspects of effectiveness, such as throughput, cost-efficiency and quality, that are relevant for analytical research laboratories. We investigate which internal and external factors impact effectiveness, and to which extent. We will evaluate our approach in a range of metagenomic projects. The focus of our research is on a smart combination of high-throughput sequencing and analysis, scalable database technology, lab information systems, and XML-based data exchange.

**References**

- [Hall et al., 2013b] (Page 191),
- [Hall et al., 2013a] (Page 191),
- [Peacey et al., 2013] (Page 192),
- [Todd et al., 2013] (Page 193),
- [Wang et al., 2013] (Page 193)

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**Project 35: Automated Reasoning on Conceptual Schemas**

**Project Members**

- Prof. Dr. Sven Hartmann (Leader)
- M.Sc. Waqas Ahmed (Project Staff)
**Partners**

Prof. Dr. Diego Calvanese, Free University of Bozen-Bolzano, Bozen, Italy (Leader)
Prof. Dr. Ernest Teniente, Universitat Politècnica de Catalunya, Barcelona, Spain (Leader)
Dr. Qing Wang, Australian National University

**Duration**

10/2011 – 12/2013

**Project Description**

To ensure the quality of an information system one must guarantee that the conceptual schema representing the relevant knowledge about the domain of interest satisfies some important properties. The most important one is correctness, i.e. the schema specifies what the designer intended, but other crucial properties are lack of redundancy, simplicity, etc.

The high expressivity of conceptual schemas requires to adopt automating reasoning techniques to support the designer in assessing its properties. This is a very important problem in software development since assessing the quality of the conceptual schemas built helps to detect and fix errors introduced during requirements specification, which are usually much more expensive to correct than errors made during design or implementation.

We seek to exploit synergies between diverse specification languages (ER, UML, ORM) and reasoning methods (static, dynamic, under constraints).

**References**

[Calvanese et al., 2013] (Page 190),
[Ferrarotti et al., 2013b] (Page 191)

**Contact E-Mail**

sven.hartmann@tu-clausthal.de
3.6.5 Scientific Activities

Person  Prof. Dr. Sven Hartmann

Awards


- CUDA Research Center award for the CUDA research team at Technische Universität Clausthal led by Professors Sven Hartmann (Department of Informatics), Stefan Guthe (Department of Informatics), Gunther Brenner (Institute of Applied Mechanics), and Leonhard Ganzer (Institute of Petroleum Engineering) in July 2013.

Invited Talks

- May 2013: Sven Hartmann gave a presentation on *Armstrong Instances as a Reasoning Aid* in Dagstuhl, Germany.

- July 2013: Plenary speaker for the 2013 IEEE CIS Summer School on Computational Intelligence for Automation, organized by the Institute of Automation, Chinese Academy of Sciences in Beijing.

Evaluator

- Expert Reviewer for the MSI science grants of the New Zealand government, administered by the Ministry of Science and Innovation. Approximately $52 million per annum are invested in the Value Manufacturing and Services, Hazards and Infrastructure, Energy and Minerals and Biological Industries sectors through this highly disputed science funding.

Organization of Conferences

- Chair, Dagstuhl Seminar on *Automated Reasoning on Conceptual Schemas*, jointly with Professors Diego Calvanese (Free University Bozen-Bolzano, Bozen, Italy) and Ernest Teniente (Universitat Politècnica de Catalunya, Barcelona, Spain), 2013.
  See [http://www.dagstuhl.de/de/programm/kalender/semhp/?semnr=13211](http://www.dagstuhl.de/de/programm/kalender/semhp/?semnr=13211).

Steering Committee Memberships

  See http://www.foiks.org/.

• CMLSA: The International Workshops on Conceptual Modelling for Life Sciences Applications, Chair (2007-present).

☐ Editorial Board Memberships

• Dissertationen zu Datenbanken und Informationssystemen, AKA Verlag (2009-present).

• Journal of System and Management Sciences (2011-present).
  See http://www.aasmr.org/jsms/

☐ Program Committee Memberships


  See http://www.acm.org/conferences/sac/sac2012/.


• SUM 2012: The Sixth International Conference on Scalable Uncertainty Management, Marburg, Germany, September, 2012.


  See http://cs-conferences.acadiau.ca/ant-12/.


3.6.6 Highlights

□ In 2012:

• February 2012: Sven Hartmann visited the University of Auckland on invitation by Professor Sebastian Link for joint research on our Marsden-funded project on XML cardinality constraints.

• March 2012: Sven Hartmann attended the International Symposium on Foundation of Information and Knowledge Systems in Kiel, Germany.

• April 2012: Sven Hartmann attended the Symposium Rückkehr deutscher Wissenschaftler aus dem Ausland on invitation by the German Scholars Organisation (GSO).

• September 2012: Sven Hartmann visited Victoria University for joint work with Dr. Hui Ma on web service privacy, and Dr. Ferrarotti on scalable discovery of soft keys in XML streams.

• October 2012: our group organized the Welcome Day for the ITIS Master students.

□ In 2013:

• March 2013: Sven Hartmann visited Massey University, New Zealand for joint work with Dr. Henning Köhler on possible and certain database keys.
• June 2013: Sven Hartmann visited the Software Technology Institute at Dalian Jiaotong University, China, on invitation by its Dean, Professor Huang Ming.

• July 2013: Sven Hartmann visited the National Laboratory of Pattern Recognition at the Chinese Academy of Sciences on invitation by its Deputy Director, Professor Cheng-Lin Liu.

• July 2013: Sven Hartmann visited the State Key Lab of Management and Control for Complex Systems at the Chinese Academy of Sciences on invitation by its Deputy Director, Professor Zeng-Guang Hou.

• August 2013: Sven Hartmann visited the Department of Computer Science & Technology at Tsinghua University, China, on invitation by Professor Min Zhang.

• September 2013: Sven Hartmann visited the University of Auckland, New Zealand, on invitation by Professor Sebastian Link for joint research on Armstrong tables.

• October 2013: Sven Hartmann attended the 14th International Conference on Web Information System Engineering (WISE 2013) in Nanjing, China.

• October 2013: our group organized the Welcome Day for the ITIS Master students.

 Visitors

• January 2013:
  Professor Heinrich C. Mayr, Alpen-Adria-Universität Klagenfurt, Austria, visited our group for discussions on advances in conceptual modeling.

• May 2013:
  Dr. Qing Wang, Australian National University, visited our group for joint work on context functional dependencies in databases. Dr. Wang gave a colloquium talk on Capturing Knowledge Patterns in Entity Resolution.

• July 2013:
  Dr. Lena Wiese, Georg-August-Universität Göttingen, Germany, visited our group for discussions on inference control for secure databases. Dr. Wiese gave a colloquium presentation on Methods for Logical Database Security.
December 2013:
Professor Dirk Linowski, Steinbeis Universität Berlin, Germany, visited our group for discussions on compliance management software. Prof. Linowski gave a colloquium presentation on *Industrienahe Forschung an tunesischen Universitäten - Beobachtungen als EU Experte vor Ort*. 
3.7 Software Systems Engineering

3.7.1 Overview

**Leaders**  Prof. Dr. Andreas Rausch

**Secretary**  Annett Panterodt
Anna Mill
Daniela Goertz
Nadine Heinrich
Arne Heine

**Scientific Employees**
- Dr. Sebastian Herold
- Dr. Holger Klus
- Dipl.-Inf. Benjamin Fischer (since 01/2009)
- Dipl.-Inf. Mirco Schindler
- Dipl.-Inf. Marcel Ibe (since 06/2011)
- Dipl.-Math. Ingrid Schindler (since 11/2011)
- M.Sc. Joachim Schramm (since 10/2011)
- B.Sc. Tim Warnecke (since 06/2011)
- Dr. Christian Bartelt
- Dipl.-Inf. Constanze Deiters
- Dipl.-Inf. Patrick Dohrmann (since 07/2009)
- Dipl.-Wirt.-Inf. Björn Schindler (since 02/2008)
- Dr. Thomas Ternité
- Dipl.-Inf. Michael Deynet (until 12/2012)
- M. Sc. Adina Aniculaesei (since 11/2011)
- Dipl.-Ing. Jean Paul Tatou (since 11/2011)
- Dipl.-Inf. (FH) Matthias Mair (since 01/2012)
- Dipl.-Wirt.-Inf. Daning Wang (since 06/2012)
- Dipl.-Ing.(FH) Sijia Liu (since 10/2012)
- Dipl.-Ing. Yong Wang
- M.Sc. Stefan Wittek (since 10/2013)

3.7.2 Research Agenda

Led by Prof. Dr. Rausch, the Software Systems Engineering research group has its goals set on improving the dependability of software systems throughout their development, operation, maintenance, support and evolution. Our focus is the development of methods, techniques and tools necessary for the successful engineering of software systems. These methods and tools are further improved with valid and consolidated findings from research, and then transferred into practice.
In the past two years, our research group has been reorganized to match the rapid developments in the scientific community as well as the innovation necessity in the industry. We focus our research in three main domain application areas: web and mobile systems, cyber-physical systems and embedded systems. Within these application areas we built competences and pursue research focused on the following core topics: practicable and applicable process models, model based software development, and sustainable software architectures. The basis of these research competences is formed by fundamental programming techniques, technologies, and methods of software systems engineering.

All research results are demonstrated in seamless tool support realized within demonstrating scenarios. The results are validated together with industrial partners, and in their environment.

For further information, please see the group's homepage at:
http://sse-world.de/

### 3.7.3 Supervised Theses

**Ph.D. Theses:**


**Diploma and Master's Theses:**


**Bachelor’s Theses:**


3.7.4 Projects

Project 36: SOWEMA - Development of Software, Tools and Machines to Generate an Automatic and Closed Light Construction-Manufacturing Chain

Project Members
Prof. Dr. Andreas Rausch (Leader)
Dipl.-Inf. Benjamin Fischer (Project Staff)
Dr. Christian Bartelt (Project Staff)

Partners
Cenit AG, Stuttgart, Germany
CTC GmbH, Stade, Germany
EADS, Ottobrunn, Germany
Manz Automation Tübingen GmbH, Tübingen, Germany
Otto Bock Health Care GmbH, Duderstadt, Germany
Technische Universität München (LCC), Germany
Wethje GmbH, Hengersberg, Germany

Funding
Federal Ministry of Education and Research (BMBF)
225,000€ (of 225,000€ total)

Duration
01.06.2011 – 31.05.2014

Project Description
Design and production of fiber composite components are basically different from known metal constructions. This project developed a standardized production process, to reduce the necessary know-how of the user, which is usually necessary in large production processes. We proposed using style guides in order to ensure the automatic proceeding of the production processes.

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Project Homepage

http://sse-world.de/index.php/forschung/projekte/

Project 37: Global Software Engineering - Distributed Collaborative Software Development

Project Members

Prof. Dr. Andreas Rausch (Leader)
Dipl.-Inf. Martin Vogel (Project Staff)
Dipl.-Inf. Björn Schindler (Project Staff)
Dr. Christian Bartelt (Project Staff)

Partner

Prof. Dr. Kurt Schneider, Software Engineering Group. Leibniz Universität Hannover, Germany

Funding

Federal Ministry of Education and Research (BMBF)
369.657€ (of 712.314€ total)

Duration


Project Description

The project GloSE generated a methodical and technical approach for the project organization, management and support of the implementation of distributed projects. In order to obtain this approach, we took the inter-site processes and information flows, the documents and information artifacts which were used in globally distributed development projects.

References

[Ibe et al., 2013a] (Page 200)

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Project Homepage

http://sse-world.de/index.php/forschung/projekte/

Project 38: ReqBwPilot - Evaluation of the Early Phase Considering Requirements Management

Project Members

Prof. Dr. Andreas Rausch (Leader)
Dipl.-Inf. Michael Deynet (Project Staff)
Dipl.-Inf. Marcel Ibe (Project Staff)
M.Sc. Joachim Schramm (Project Staff)
Dipl.-Inf. Björn Schindler (Project Staff)

Partner

IT-AmtBw A5, Koblenz, Germany
Funding
Federal Ministry of Defense (BMVg)
115,000€ (of 115,000€ total)

Duration

Project Description
Requirements engineering and architecture design are key factors in software development. Both bear the risk of serious faults, since they include decisions with far-reaching consequences, which may appear later during project progression. Therefore, the previous project ReqBw dealt with the development of a software engineering approach for coupling requirements and architecture at an early stage through the intertwining of corresponding activities. The goal of this project is to validate, test and adopt these requirements engineering approach within the scope of this pilot project.

References
[Ibe et al., 2013a] (Page 200),
[Knieke et al., 2012] (Page 207)

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Project Homepage
http://sse-world.de/index.php/forschung/projekte/

Project 39: Improvement and Maintenance of the V-Modell XT Bund

Project Members
Prof. Dr. Andreas Rausch (Leader)
M.Sc. Joachim Schramm (Project Staff)
Dr. Thomas Ternité (Project Staff)
**Partners**

4Soft GmbH, München, Germany  
Federal Office of Administration (BVA), Köln, Germany  
Weit e.V., Potsdam, Germany

**Funding**

Weit e.V.  
7.500€ (of 7.500€ total)

**Duration**

01.04.2012 – 31.05.2013

**Project Description**

The V-Modell XT Bund is an organization-specific adaptation of the V-Modell XT for the convenience of German federal agencies. The goal of this project is to develop and maintain V-Modell XT Bund consistent to the V-Modell XT.

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**Project Homepage**

http://sse-world.de/index.php/forschung/projekte/

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**Project 40: RPLAN E3V2**

**Project Members**

Prof. Dr. Andreas Rausch (Leader)  
Dr. Sebastian Herold (Project Staff)  
Dipl. Inf. (FH) Matthias Mair (Project Staff)

**Partners**

Actano GmbH, München, Germany  
Fraunhofer Institut für Experimentelles Software Engineering (IESE), Kaiser-  
slautern, Germany

**Funding**

Actano GmbH  
40.000€ (of 40.000€ total)

**Duration**

**Project Description**

RPLAN from Actano is a planning software broadly used in the automotive domain. For the future release, Actano plans several improvements regarding the look and feel, the performance, and the support of collaborative planning. Together we investigate the impacts of the new requirements on the existing software architecture of RPLAN and develop core concepts of the future architecture. This includes a technical framework for data models prepared for use in collaborative environments, a new interaction concept as well as technological issues like RPLAN in the cloud and multi-tenancy.

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**Project Homepage**

http://www.actano.de/

**Project 41: NuWi (Nutzen- und Wirkungscontrolling) - Support for Controlling and Reporting in the IT Investment Program of the German Federal Ministry of the Interior**

**Project Members**

- Prof. Dr. Andreas Rausch (Leader)
- Dipl.-Inf. Mirco Schindler (Project Staff)
- Dipl.-Inf. Patrick Dohrmann (Project Staff)

**Partners**

- Federal Ministry of the Interior (BMI), Berlin, Germany
- Federal Office of Administration (BVA), Köln, Germany

**Funding**

Federal Ministry of the Interior (BMI)

249.832€ (of 249.832€ total)

**Duration**


**Project Description**

The IT Investment Program, with a budget of 500.000.000 € was passed by the German Bundestag on 20th February 2009. The available budget was used to fund over 300 projects, each project heading to improve Germany’s IT position in the current crisis. In order to manage that program and validate its outcome, the company PG Invest was founded.
The primary goal of NuWi was to support PG Invest with respect to controlling and reporting. The second goal was to use the current situation at the time as an opportunity for collecting valuable data of how projects develop. This yielded a knowledge database which can be used to improve controlling and management of future projects. For example, a duration ratio such as the one between the analysis phase and the overall project can be used to make more reliable estimations of the actual progress in a given project. Seamless modeling approach for SOA-based information systems was developed by integrating existing approaches.

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**Project Homepage**  
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**Project 42: Portal4BCC**

**Project Members**  
Prof. Dr. Andreas Rausch (Leader)  
Dr. Christian Bartelt (Project Staff)  
Dipl.-Inf. Marcel Ibe (Project Staff)  

**Partner**  
Business Communication Company GmbH, Wolfsburg, Germany  

**Duration**  
01.07.2011 – 30.06.2012  

**Project Description**  
Business process management (BPM) engines can help to adapt software systems to processes that change frequently. In collaboration with our partner, Business Communication Company GmbH (BCC), we developed a new online portal based on the business process management platform Activity and the graphical specification language BPMN 2.0. Thus, changes in processes can be performed or new processes can be added to the portal in a very fast and simple manner. Furthermore, it is possible to connect processes from the portal with in-house processes.

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**Project Homepage**  
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**Project 43: SmartPlug - Mobile Smart Metering Systems**
Project Members

Prof. Dr. Andreas Rausch (Leader)
M.Sc. Adina Aniculaesei (Project Staff)
Dipl.-Inf. Holger Klus (Project Staff)

Partner

Inensus GmbH, Goslar, Germany

Funding

Zentrale Innovationsprogramm Mitellstand AIF Projekt GmbH
174.430, 80€ (of 174.430, 80€ total)

Duration

01.07.2011 – 30.06.2013

Project Description

In 2011, the federal ministry for transportation has required that until 2020 one million electrical cars be used on the german roads. To achieve this goal, an infrastructure of more than ten millions charging stations is necessary. To this moment, in Germany there are approximately 2500 charging stations, and each of them contains a lot of technical equipment which must be protected against vandalism and criminal offenders.

In order to avoid the complexity of the current charging stations, the SmartPlug project proposed to use the already available power sockets installed in the private spaces, i.e. households, and slightly modified power outlets for the public spaces, on which simple RFID-tags have been previously applied. In this way, a financially feasible and comprehensive charging infrastructure for electrical vehicles can be efficiently and cost-effective deployed.

Depending on the energy carrier from which it originates, the electricity in these charging stations is delivered to various prices. These may be energy vectors, such as sun or wind, or fossil energy vectors, such as fuel oil or natural gas. Based on this infrastructure, we have developed a device (hardware & software) for charging electrical cars. We have also designed and developed an application which provides the user with help in finding the nearest cheapest charging station, as well as with information on the current charging status, on the actual user account balance, etc.
3.7 Software Systems Engineering

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Project Homepage
http://sse-world.de/index.php/forschung/projekte/

Project 44: RASII - System for Automatic Detection of Vehicle and Rescue Squads in Emergency Services

Project Members
Prof. Dr. Andreas Rausch (Leader)
Dipl.-Wirt.-Inf. Mirco Schindler (Project Staff)
Dipl.-Inf. Patrick Dohrmann (Project Staff)
Dr. Holger Klus (Project Staff)

Partners
Institute for Electrical Information Engineering, Clausthal, Germany
Sinosys Ltd & Co.KG, Clausthal, Germany
DHM embedded systems GmbH, Clausthal, Germany
Fire Brigade Wolfsburg, Wolfsburg, Germany

Funding
European Fonds for Regional Development
148.280€ (of 385.688, 80€ total)

Duration
01.06.2011 – 31.05.2013
Project Description

In the field of fire and rescue services provided in Germany a large number of fire-fighters are volunteers. Even in cities where a professional fire brigade exists, volunteer fire brigades are used as support forces. This fact leads to the problem that the number of available forces varies in a wide range, and therefore the formation of rescue squads varies too. Because of this variation the squad leader or the emergency coordination center has no information about all qualifications or know-how of each fire-fighter in a concrete operation. The aim of our system is to automatically capture information that are relevant for a fire-fighting operation in a very early stage and forward it to the stakeholder. Thus, critical situations can be detected more quickly.

References

[Deiters et al., 2013] (Page 196)

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Project Homepage

http://sse-world.de/index.php/forschung/projekte/

Project 45: KoMo - Collaborative Modeling with Domain-Specific Languages

Project Members

Prof. Dr. Andreas Rausch (Leader)
Dipl.-Inf. Christian Bartelt (Project Staff)
Dipl.-Inf. Martin Vogel (Project Staff)
B. Sc. Tim Warnecke (Project Staff)

Partners

Quinscape GmbH, Dortmund, Germany
MCR Informationssysteme GmbH, Buch am Buchrain, Germany

Funding

Federal Ministry of Education and Research (BMBF)
220.209€ (of 773.970€ total)

Duration

01.07.2011 – 30.06.2013

Project Description

The very early and creative phases are important for success of a project. In this phase, whiteboards provide an easy option to draw models and diagrams but later on these models need to be transformed in formal models.
The aim of the system is to make use of digital white-boards to recognize the hand drawn models of software developers and architects and transform these into formal models. The transformed models are managed by a repository explicitly developed for diagrams. The repository will also allow merging different versions of the same diagram. Thus, it is important to detect and visualize conflicts which can happen during a merge process. Another goal is to offer the possibility of modeling diagrams with digital white-boards in a collaborative way. That is to say, software developers at different locations are able to work together.

References
[Bartelt et al., 2013c] (Page 194),
[Vogel et al., 2013b] (Page 207)

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Project Homepage
http://www.kooperative-modellierung.de/

Project 46: FlexSimPro - A Flexible Software Architecture for the Integrated Simulation of Manufacturing Processes of Hybrid Machine Tools

Project Members
Prof. Dr. Andreas Rausch (Leader)
Dr. Christian Bartelt (Project Staff)
Dipl.-Ing Jean Paul Tatou (Project Staff)

Partner
Produktionstechnischen Zentrum Hannover, Germany
Funding
State Government of Lower Saxony
64,000€ (of 64,000€ total)

Duration

Project Description
Simulating manufacturing processes today involves many software simulation tools. Each of them covers only a specific view of the manufacturing process. The goal of this project is to design and to implement a flexible and extendable software architecture for the integration of these existing software simulation tools. At the end of this project, it should be possible to carry out a complete plant simulation using our implemented simulation platform.

References
[Bartelt et al., 2013b] (Page 194)

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Project Homepage
http://sse-world.de/index.php/forschung/projekte/

Project 47: IntaCPM1.4 - Integration of the current Customer Product Management 2012 in the V-Modell XT Bw

Project Members
Prof. Dr. Andreas Rausch (Leader)
M.Sc. Joachim Schramm (Project Staff)
Dipl.-Inf. Patrick Dohrmann (Project Staff)
Dr. Thomas Ternité (Project Staff)
Partner
Federal Office of Equipment, Information Technology and In-Service Support for the Federal Armed Forces (BAAINBw), Germany

Funding
BAAINBw
93,576, 92€ (of 93,576, 92€ total)

Duration

Project Description
Our research group has developed a process for the organization-specific adaptation of process models. This method has already been applied during the realization of the V-Modell XT Bw.

Accompanying the further development of the V-Modell XT Bw, we are able to assess whether the model is practical and, at the same time, reliable. In addition, the integration of model-based development methodologies with process models for universities continues to be an interesting area of research that has not yet been exhausted.

The aim of this project was to update the V-Modell XT Bw on the CPM and on the version 1.4 of V-Modell XT, published in 2012. These developments bring an additional benefit gain by integrating NAF (NATO Architecture Framework) models for Enterprise Architect and improved tool support.

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Project Homepage
http://sse-world.de/index.php/forschung/projekte/

Project 48: Vereinfachter Zugang zum V-Modell XT - Konzeption

Project Members
Prof. Dr. Andreas Rausch (Leader)
M.Sc. Joachim Schramm (Project Staff)
Dr. Thomas Ternité (Project Staff)
**Partners**

4Soft GmbH, Germany  
Siemens AG, Germany  
Technische Universität München, Germany  
Weit e.V., Germany

**Funding**

Weit e.V.  
44.086, 00€ (of 44.086, 00€ total)

**Duration**


**Project Description**

Since the end of 2011, there were more and more ideas to simplify access to the V-Modell XT, especially for beginners. Many suggestions and ideas were in the form of Problem and Change messages on the Change Control Board of the V-Modell XT. These problem and change messages were analyzed in a workshop and were summarized into work packages.

The aim of this project was to design specific approaches to improving access to the V-Modell XT. In follow-up projects, these concepts will then be implemented and integrated into the XT V-model.

The results of this project bring the following benefits:

- The user is facilitated a faster and simpler introduction into the V-Modell XT. After reading the revised Part 1, the principles of the V-model and the application reference should be understood.
- A new structure of the V-Modell XT reference model facilitates particularly inexperienced users to get started with the VMXT. A clear and comprehensible structure helps the user thereby quickly navigate to the desired content.
- Once this work package is implemented, the user is relieved of the need to understand the concepts of building block approach (German: Vorgehensbausteine) and product dependency (German: Produktabhängigkeit). Instead, each of the necessary information is to be incorporated in the places usually used by the user.
- During the application of the V-Modell XT, its understanding by the user is improved through reducing to a manageable number the redundantly acting products, i.e. the six different types of test specifications.
- The introduction to the V-Modell XT terminology is facilitated by intuitive terms, i.e. the terms used in the decision points and project initialization are formulated in a less abstract manner.

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Project Homepage
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Project 49: IServeU - Intelligent Modular Service Robots Functioning in a Human Environment on Example of Hospitals

Project Members
Prof. Dr. Andreas Rausch (Leader)
M.Sc. Adina Aniculaesei (Project Staff)
B.Sc. Tim Warnecke (Project Staff)

Partners
Hochschule Ulm, Ulm, Germany
Katherinenhospital Stuttgart, Germany
REC GmbH, Planegg, Germany
Robert Bosch GmbH, Germany
RWTH Aachen, Germany
Friedrich-Alexander-Universität Erlangen-Nürnberg, Germany

Funding
Federal Ministry of Education and Research (BMBF)
2.616.107€ (of 4.242.635€ total)

Duration
01.03.2013 – 01.03.2016

Project Description
Due to decreasing hardware and software costs, the number of service robots in homes and businesses should increase significantly. However, the current situation is far from that. One reason for this is represented by the high costs that are dominated largely by the cost of the sensors. On the other hand, a robot still lacks the intuitive solutions that enable people to deal advantageously with most unforeseen problems. A false image sensor or temporary conflicting goals quickly lead the robot to sub-optimal and irreproducible behavior.

Transport robots that act not only autonomously, but also cooperatively in a human environment - so-called Intelligent Transport Assistants (ITA) - must be able to identify a user, to follow him, or to lead him. The areas of application of such ITAs are wide: from transport tasks in hotels, airports and train stations to transport support while shopping.

This project focuses on transportation tasks in hospitals as key application scenarios. The hospital provides a robot-friendly environment, due to its relative lack of obstacles. However, on a closer look, even this environment is highly dynamic, heterogeneous and characterized by many unpredictable situations.
In this project, our research group focuses on the design and development of the following tools:

- a mechanism which allows the remote management of robots via various mobile devices, i.e. tablet or smart phone, or via desktop computers,
- graphical front-ends for various devices for the remote control of the robots, i.e. smart phone or desktop computer,
- a monitoring and verification method to observe the behavior of the robot during its runtime and to predict any violations of the tasks constraints, and
- a fall-back safety mechanism to intervene whenever the verification system detects a situation in which the robot cannot proceed on its own.

The dynamic character and the heterogeneity of the environment in which the robots are deployed promote the project’s goals to develop a general approach for service robots in the human environment, which will then be applicable to many other application areas.

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Project Homepage
http://sse-world.de/index.php/forschung/projekte/

Project 50: Mobil4e - eMobility for the education and training

Project Members
Prof. Dr. Andreas Rausch (Leader)
M.Sc. Stefan Wittek (Project Staff)
Dipl.-Wirt.-Inf. Daning Wang (Project Staff)
**Partners**

Hochschule für bildende Künste Braunschweig, Germany  
Hochschule Hannover, Germany  
Leibniz Universität Hannover, Germany  
Ostfalia Hochschule für angewandte Wissenschaften, Wolfenbüttel, Germany  
Technische Universität Braunschweig, Germany  
Institute for Electrical Engineering, Clausthal, Germany  
Institute for Economic Sciences, Clausthal, Germany

**Funding**

Federal Ministry of Transport, Building and Urban Development (BMVBS)  
491,514, 18€ (of 702,384€ total)

**Duration**

15.03.2013 – 15.03.2016

**Project Description**

This project aims to develop a new concept for continuous education, in which praxis-oriented, advanced training modules are flexibly combined with a novel virtual learning laboratory and workshops for academic training, in order to qualify engineers, technicians and management personnel.

Another goal of the project is to develop tangible training workshops for building of competences in eMobility at German universities. In addition to advanced training, these university-wide multi-functional workshops are created as meeting places for research and teaching, so that teachers, researchers and industry engineers may learn about innovations in eMobility and also learn from each other.

In addition to the tangible experience received during the workshops, a novel learning software is used to train the students in the deployment, configuration, and the visualization of component interactions, versions and entire systems of eMobility in a virtual environment. Our research group builds the virtual learning laboratory, the training modules and the workshops for academic training. These constitute three elements for the continuous education concept targeted in this project. Using these three academic tools, the students can experience eMobility, try out various scenarios in a virtual environment and learn about it methodically.

The quality of the tree academic methods proposed in this project will then be evaluated through adequate techniques. At the end of the project a list of recommendations will be developed. This analysis will provide information on the effectiveness of sustainable and rapid building of competences in industry through practical training workshops and enable new ways of utilization beyond the traditional training for a large number of academics.
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Project Homepage
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Project 51: PiVo - Tanken im Smart Grid

Project Members
Prof. Dr. Andreas Rausch (Leader)
Dipl. Inf. Benjamin Fischer (Project Staff)
Dipl.-Ing. Yong Wang (Project Staff)

Partners
Bornemann AG, Goslar, Germany
Bundesverband Solare Mobilität e.V., Germany
Forschungsstelle für Energiewirtschaft e.V., München, Germany
Business Communication Company GmbH, Wolfsburg, Germany
Energie-Forschungszentrum Niedersachsen, Goslar, Germany
Institute for Electrical Engineering, Clausthal, Germany
Institute for Process and Production Control, Clausthal, Germany

Funding
Federal Ministry of Transport, Building and Urban Development (BMVBS)
180.941, 06€ (of 934.568€ total)

Duration
01.01.2013 – 31.12.2015
Project Description

This project researches devices and algorithms used for charging electric vehicles, while at the same time, aiming to maintain the system stability of the electrical networks. With the growing number of electric vehicles, the burden on the electrical grid is selectively increased. In order to relieve the networks, various methods for intelligent charging management are being researched. There are two important aspects taken into consideration. Firstly, the current electrical network is analyzed in order to identify risk areas. Secondly, the project focuses also on the corresponding reaction of the electric vehicles to a problematic situation during charging. The task of our research group in this project is to collect the necessary data, and based on a topographical map, to generate the energy map for the analysis of network stability of a given topographical region.

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Project Homepage
http://sse-world.de/index.php/forschung/projekte/

3.7.5 Scientific Activities

Person Prof. Dr. Andreas Rausch

Awards

- Andreas Rausch received a Best Paper Award at the CIRP Design Conference 2012, held in Bangalore, India, March 28 - 30, 2012, for the contribution *Clustering Regional-Specific Requirements as a Methodology to Define the Modules of a Car Concept.*
Andreas Rausch received a Sustainable Production Award in the Category “Automation & IT” at Hanover Fair 2013 for the BMBF-funded project SOWEMA (Vollautomatisierte Prozesskette zur Fertigung lastoptimierter CFK-Bauteile).

Editorial Board Memberships

  See http://www.sigs-datacom.de/sd/publications/os/.

3.7.6 Highlights

In 2013

- March 2012: Marcel Ibe and Andreas Rausch received the Best Paper Award at the CIRP Design Conference 2012, held in Bangalore, India, March 28 - 30, 2012, for the contribution *Clustering Regional-Specific Requirements as a Methodology to Define the Modules of a Car Concept*.

- June 2013: Andreas Rausch visited the Dalian Jiatong University, China and ratified an agreement for exchange of postgraduates between the Dalian Jiatong University and the TU Clausthal.

- June 2013: The NTH Doctoral School on Electromobility enrolls its first two Ph.D. students, Wolfgang Schwedler and Christian Schwinke. The research of Wolfgang Schwedler will take place at the Institute for Applied Software Systems Engineering in Goslar.
3.8 IPSSE

3.8.1 Overview

**Leaders**
- Prof. Dr. Ursula Goltz (TU Braunschweig)
- Dr.-Ing. Stefanie Jauns-Seyfried (Volkswagen AG)
- Prof. Dr. Andreas Rausch (TU Clausthal), Chairman IPSSE
- Prof. Dr. Christian Siemers (TU Clausthal)

**Secretary**
- Daniela Görtz

**Scientific Employees**
- Dipl.-Inf. Benjamin Cool (since 11/2011)
- Dipl.-Ing. Peter Engel (since 08/2012)
- Dipl.-Inf. Christoph Gernert (since 08/2012)
- M.Sc. Axel Grewe (since 09/2012)
- B.Sc. Jörg Grieser (since 10/2013)
- B.Sc. Dirk Herrling (since 06/2011)
- M.Sc. Vignesh Jayaraman (since 04/2013)
- B.Sc. Yuri Jon (since 11/2011)
- Dr. rer. nat. Christoph Knieke (since 12/2010)
- Dipl.-Inf. Marco Körner (since 11/2010)
- M.Sc. Inform. Malte Mauritz (since 04/2011)
- B.Sc. Franz Melchior (since 10/2012)
- Dr. rer. nat. Dirk Niebuhr (since 11/2010)
- Dipl.-Inform. Henrik Peters (since 10/2011)
- M.Sc. Arthur Strasser (since 06/2012)
- Dipl.-Inf. Christian Ristig (since 01/2013)
- Dipl.-Wirt.-Inf. Martin Vogel (since 05/2011)

3.8.2 Research Agenda

The research association *Institute for Applied Software Systems Engineering (IPSSE)* was founded in late 2011 as cooperation between TU Clausthal, TU Braunschweig and Volkswagen AG.

The research goal of IPSSE lies in methods and tools for the development of embedded systems. In this scope, one of the prevailing themes of IPSSE is the application of model-driven approaches to automotive software engineering. Therefore we provide a kit containing methods, techniques and tools for successful engineering of embedded software. Our task is to improve this kit with valid and consolidated findings from research, and to transfer it to practice.

Currently, there are five areas of expertise:

- Reliable reactive systems,
- Adaptive and modular architectures,
Platform and development tools,
Hardware/software co-design and
Continuous education.

IPSSE has a recognized expertise in these fields, on both academic and industrial level.

Concrete approaches in these fields are
Model-based development with support of product variants, reuse and evolution
Design of modular architectures
Measurement and evaluation of architecture erosion and quality with the goal of continuous architecture improvement
Definition and development of platforms, for example in the multi-core environment
Model management and automated consistency and quality assurance of models
Design and implementation of modeling and development tools, e.g. for implementation and testing
Test-driven development and model-based testing
Software quality: Formal methods, validation and verification
Design procedures for real-time systems and distributed real-time systems, also with the aid of co-design
Transcoding for systems with various design and execution paradigms
Safety: Detection of execution errors (during runtime) in programs and hardware (in-situ monitoring)

All research results are demonstrated in demonstrators, prototypes or full-featured tools. Seamless tool support is realized within demonstrating scenarios. The results are validated in the environment of the industrial partners and with their close co-operation.

For further information, please see the group’s homepage at http://www.ipsse.de/.

3.8.3 Supervised Theses

Diploma and Master’s Theses:
3.8 IPSSE


**Bachelor’s Theses:**


### 3.8.4 Projects

**Project 52: Agosense**

**Project Members**

- Dr. rer. nat. Christoph Knieke (Leader)
- Dipl.-Inf. Benjamin Cool (Project Staff)

**Partner**

- Volkswagen AG, Wolfsburg, Germany
**Funding**

Volkswagen AG  
40,000€ (of 40,000€ total)

**Duration**  

**Project Description**  
In this project we helped Volkswagen to establish a middleware platform to interconnect one of their tool chains. The middleware platform to be established was the agosense.symphony platform shown in the project picture below. Based on this platform, we assisted Volkswagen with the implementation of two processes: one to link PTC Integrity and IBM Doors, and the other to link PTC Integrity and ChESS (Change-Management for Embedded Software Systems). This project was led by Volkswagen, while IPSSE provided development support and valuable software engineering know-how.

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**Project 53: Array Interfaces**

**Project Members**
- Dr. rer. nat. Christoph Knieke (Leader)  
- Dipl.-Inf. Benjamin Cool (Project Staff)  
- B.Sc. Dirk Herrling (Project Staff)  
- Dipl.-Inf. Marco Körner (Project Staff)  
- Dr. rer. nat. Dirk Niebuhr (Project Staff)

**Partner**  
Volkswagen AG, Wolfsburg, Germany
Funding
Volkswagen AG
5,000€ (of 5,000€ total)

Duration
since 01.10.2013

Project Description
The software development for the engine control unit is model-driven and component-based. The interfaces are composed of different elements which can be, amongst others, arrays. Arrays open up special challenges as write access is not an atomic operation on the engine control unit. Data consistency has to be ensured for different data hazard scenarios, like read after write, write after read or write after write.

In this project a variety of topics have been investigated:

- Techniques used by control system engineers at Volkswagen to ensure data consistency when accessing interface arrays.
- Development of tools and code-fragments to ensure data consistency with minimal processing and memory overhead.
- Prototyping of safe, concurrent read and write access of interface arrays in engine control modules.
- Development of a best-practices guideline to ensure consistent array access with minimal processing and memory overhead.
- Integration of said guideline into the current software development process for engine control software.

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Project 54:  BKV - Development of a Pressure Control Software for a Brake Servo Unit
Project Members

Prof. Dr. Andreas Rausch (Leader)
Dipl.-Inf. Marco Körner (Project Staff)
Dr. rer. nat. Dirk Niebuhr (Project Staff)

Partner

Volkswagen AG, Wolfsburg, Germany

Funding

Volkswagen AG
65,000€ (of 65,000€ total)

Duration


Project Description

Over time the amount of functional requirements of a software system grows. The change of the software often is done under high time pressure which often leads to an erosion of the software architecture. An aggravating factor is that the software system is embedded in different hardware environments. The major goal of the BKV (short for “Bremskraftverstärker”, English: brake servo unit) project was to redesign the software system to fulfill the needs of functional and non-functional requirements in a software product line context. The new design describes a reference architecture using a different decomposition than the original one and utilizing a new interface concept. The resulting modularity allows the instantiation of efficient software architectures for each product of the BKV product line.

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Project 55: Real-Time Capable and Safety-Aware Multicore Architecture

Project Members

Prof. Dr. Christian Siemers (Leader)
Dipl.-Inf. Christian Ristig (Project Staff)

Partner

EADS, München, Germany

Funding

EADS
37,500€ (of 37,500€ total)

Duration

**Project Description**
Multicore processors are the best choice, if performance issues must be met, and the number of cores will increase significantly in the next years. Nevertheless, until now, multicore architectures have been rarely used within safety critical applications, as they present even more issues to be solved, in order to meet safety requirements. This project addressed the real-time behavior as well as the safety issues of multicore architectures using architectural approaches.

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**Project 56: EBKV - Software Architecture of a Centralized Torque Management System**

**Project Members**
- Prof. Dr. Andreas Rausch (Leader)
- Dipl.-Inf. Marco Körner (Project Staff)
- M.Sc. Axel Grewe (Project Staff)

**Partner**
Volkswagen AG, Wolfsburg, Germany

**Funding**
Volkswagen AG
60,000€ (of 60,000€ total)

**Duration**
since 30.11.2012

**Project Description**
The extension of the torque management system by new software and hardware systems increased the variability of the product line. Although some of the new features introduced crosscutting concerns, the time pressure during development allowed only local changes. That lead to an erosion of the software architecture.

The major goal of the EBKV project was a re-design of the reference software architecture of the torque management system. It was imperatively necessary to take the challenges into account that came with a complex product line. The new design uses newly developed architecture styles to weaken the strength of the coupling between the components. This enabled a modularity that could be used to create efficient architectures for each product of the software product line.

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**Project 57: Energo**
**Project Members**

Prof. Dr. Andreas Rausch (Leader)
Dipl.-Ing. Peter Engel (Project Staff)
B.Sc. Jörg Grieser (Project Staff)

**Partner**

Volkswagen AG, Wolfsburg, Germany

**Funding**

Volkswagen AG
15,000€ (of 15,000€ total)

**Duration**

since 01.01.2012

**Project Description**

Energo is a software application of the engine control unit for Predictive Drive Control, which was developed with the help of a model-based approach. The objectives of the system are to provide hints for the driver to attain more fuel efficiency, e.g. early take off the acceleration pedal in front of a rotary traffic, and strategic operation decisions for freewheeling, e.g. fuel cut-off in the overrun with opened or closed clutch.

Due to the intensive calculations, the software application requires a large amount of computing capacity of the engine control unit. Timing measurements and detailed analysis enable the identification of the most resource hungry parts of the software. Suitable measures should reduce the demand of processing unit power. Furthermore, there is a focus on timing measurements for engine control unit applications. This requires basic research of a measuring concept and appropriate software solutions. Their general adaptability should be evaluated on the basis of the Energo project.

Up to the present moment, several goals have been achieved in this project:

- Research of timing measurement concepts and software
- Functional analysis of the Energo components
- Improvement of runtime performance
- Optimization of memory requirements
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Project 58: Cooperative Doctoral School on Electromobility

Project Members
Prof. Dr. Andreas Rausch (Leader)
Dipl.-Ing. Peter Engel (Project Staff)

Partners
Niedersächsische Technische Hochschule, Germany
Niedersächsische Forschungszentrum Fahrzeugtechnik, Branschweig, Germany
Ostfalia Hochschule für angewandte Wissenschaften, Wolfenbüttel, Germany
Hochschule Hannover, Germany
Technische Universität Braunschweig, Germany
Leibniz Universität Hannover, Germany

Funding
Lower Saxony Ministry for Science and Culture (MWK)
120.000€ (of 1.200.000€ total)

Duration

Project Description
The electrification of driving is an essential lever for sustainable mobility. It offers the opportunity to reduce our dependency on oil, to minimize emissions and to better integrate the vehicles into a multi-modal transport system. However, there is an apparent need to develop not only new materials for energy storage and energy conversion, but also new business models, new control options for smart grids and new simulation tools for assessment and development of new concepts.
The cooperative doctoral program Electromobility (German: *Kooperatives Promotionsprogramm Elektromobilität*) is a multi-site, interdisciplinary doctoral program on the interface between science, engineering and economics, which complements the location-based graduate and postgraduate study through a cross-site interdisciplinary training program. The goal of this PhD program is an interdisciplinary research of selected basic concepts and approaches for the generation of 2020+ electric mobility. The following institutions take part in this program:

- Niedersächsische Technische Hochschule: a merger of Technische Universität Braunschweig, Technische Universität Clausthal, and Leibniz Universität Hannover,
- Hochschule Hanover, and
- Ostfalia Hochschule für angewandte Wissenschaften.

The PhD students are working at one of these universities and are involved in the facilities of the PhD program. IPSSE coordinates the cooperation of all involved facilities and supervises the research projects of two PhD students.

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**Project 59: MBT - Model-based Testing**

**Project Members**

Dr. Christoph Knieke (Leader)

Dipl.-Inform. Henrik Peters (Project Staff)

**Partner**

Volkswagen AG, Wolfsburg, Germany

**Funding**

Volkswagen AG

35,000€ (of 35,000€ total)

**Duration**

since 01.01.2012
**Project Description**

The software of power-train functions is tested at different levels. It should be noted that acceptance testing at the level of modules and functions comes with different challenges. Among other things, so-called legacy software has to be integrated and verified often. In the development process of power-train functions there are project-specific test criteria, so that each project is testing on their own terms.

The aim of the project is to optimize the test quality by means of introducing model-based testing to the development process. On one hand, uniform standards for tests on module and function level should be introduced. On the other hand, the degree of test automation should be increased by a model-based approach.

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**Project 60: Model Quality**

**Project Members**

Prof. Dr. Andreas Rausch (Leader)

Dipl.-Wirt.-Inf. Martin Vogel (Project Staff)

**Partner**

Volkswagen AG, Wolfsburg, Germany

**Funding**

Volkswagen AG

20,000€ (of 20,000€ total)

**Duration**

since 01.01.2013

**Project Description**

Requirements engineering for software development in the automotive domain becomes more pretentious and complex. Functions in this domain are less programmed and more modeled. How good or bad these models are in terms of selected quality factors, e.g. maintainability or extensibility, is often disregarded. Because these models are not used only for one automotive, but on several automotive series, it is necessary to ensure the quality of the models in terms of the selected quality factors. In order to ensure the quality of the models in the long term, it is imperative to check their quality in a durable manner during the development process.
Project 61: Module Development

Project Members
Dr. rer. nat. Christoph Knieke (Leader)
All scientific employees (Project Staff)

Partner
Volkswagen AG, Wolfsburg, Germany

Funding
Volkswagen AG
1.115.000€ (of 1.115.000€ total)

Duration
since 01.01.2012

Project Description
Module development is a term used by Volkswagen to describe software development for the engine control unit. The control system engineers of Volkswagen and its suppliers use a model-driven approach to develop the physical models of the requested functions. The software engineering department takes these models and transforms them into C-code, e.g. by adding quantization formulas and using code generators.

IPSSE is handling a part of the load which the software engineering department of Volkswagen has to manage. More concrete, IPSSE is performing the following tasks:
• Integer quantization: The physical models developed by the control systems engineers are by default calculated in floating point arithmetic. Although code generators can automatically transform floating point into fixed point calculations, the results can be significantly improved if meta information like ranges of values or needed resolutions are added to the model.

• Model to C code transformation: The C code is generated from the given physical model by a code generator, which requires a specific configuration of the involved tools and referenced objects.

• Testing: Currently, model in the loop tests are run by the control system engineers. The results of these tests are compared against those of the software in the loop tests, which are performed by the software engineers.

• Analysis: A static code analysis is performed for the generated C code for all models, in order to ensure safety and non-functional requirements.

The purpose of this project is to gain a better understanding of the underlying principles which support the process of software development for engine control units at Volkswagen. Only with a good knowledge of the involved tools and processes can serious support and consulting in the fields of tool support and processes of software development be provided.

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Project 62: MultiCore

Project Members
Prof. Dr. Andreas Rausch (Leader)
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Dipl.-Ing. Peter Engel (Project Staff)

Partner
Volkswagen AG, Wolfsburg, Germany

Funding
Volkswagen AG
170.000€ (of 170.000€ total)

Duration
since 01.01.2012
**Project Description**

Multicore electronic control units (ECUs) provide additional computational power and the ability for parallel execution, that can be featured by car manufacturers to enable high scale integration of in-vehicle applications, e.g. engine control. Applications, which were initially executed on a single-core, have to be partitioned for integration on multiple cores. Our goal in this project is to provide techniques for migration of control applications. These techniques ensure that approved critical or non-critical single core applications behave in the same way on multiple cores.

In this project, different migration scenarios have been investigated. One of these is the model enrichment scenario, which enables the migration of behavioral models, e.g. models developed in ASCET. The migration is realized by additionally providing requirements specification on the base of a developed architecture specification language. The language is then used to verify behavioral requirements of model-based applications during model-based software integration.

The second part of the project deals with a timing analysis of the models. At first, models are created which contain information of the supplier and the OEM-code. Then, we analyze the timing properties of these models in order to forecast some of the timing problems that may arise due to the parallel execution of the software applications.
Project 63: Poseidon

Project Members
Dr. rer. nat. Christoph Knieke (Leader)
B.Sc. Dirk Herrling (Project Staff)

Partner
Volkswagen AG, Wolfsburg, Germany

Funding
Volkswagen AG
20,000€ (of 20,000€ total)

Duration

Project Description
Software engineering for the engine control unit is performed in diverse, non-standard ways by different software developers. This is worth changing in order to have a more predictable quality of the resulting software artifacts and a better understanding of the software development process in general.

Poseidon was one of many steps taken to improve this situation. The idea behind this project was a mixture of tutorial and interactive manual. It was build as a web application to step through the explanation of a specific process (e.g. module testing) and serve as a manual. The name of the project originates from the Greek god with the same name.

During the execution of the project, several goals have been achieved:

- Documenting the process for different tasks during software development for engine control software, e.g. module testing, quantization, build processes, etc,
- Providing an interactive step-by-step process for the explanation of various software processes,
- Providing every step in the process with texts and graphics,
- Full text search function through the descriptions of the process steps.
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Project 64: Quicar Elektrisch - eMobility Car Sharing

Project Members
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M.Sc. Meng Zhang (Project Staff)

Partners
Volkswagen AG, Wolfsburg, Germany
Niedersächsisches Forschungszentrum Fahrzeugtechnik, Braunschweig, Germany
Ostfalia Hochschule für angewandte Wissenschaften, Wolfenbüttel, Germany
Hochschule Hannover, Germany
Technische Universität Braunschweig, Germany
Leibniz Universität Hannover, Germany

Funding
Federal Ministry for Economic Affairs and Energy (BMWi)
120,000€ (of 2,600,000€ total)

Duration
01.01.2012 – 30.12.2015


Project Description

The successful marketing of e-car-sharing is still pending against a number of unresolved challenges. Heavy investments in vehicles and in their customized software are necessary. At the same time, there is a lack of knowledge with regard to customer expectations and market development. Further problems arise from the dimensioning and operation of the electric vehicles and the necessary infrastructure. These issues include the optimization of vehicle components, such as control and driver assist systems for short-term use. Another issue is the establishment of appropriate charging infrastructures in the (semi-)public space, ensuring correct charging interface and on-demand charging strategy, while dealing with range restrictions.

New (vehicle) technical solutions adapted to the boundary conditions of the car-sharing are therefore required. In this context, the IPSSE team focused on the optimization of vehicle functions and drive efficiency.

In order to determine a usage- and profile-optimized operating strategy of the entire vehicle, it is necessary to determine and display the energy consumption of the engine and power train as well as the single energy consumption of ancillary components, as these contribute significantly to the total energy expenditure.

Thus, the goal of this project is to identify significant improvement potentials. This is targeted by evaluation and further processing of the CAN data through analog measurement technology. For this purpose, basic usage scenarios were defined and a data logger at an E-Golf was put in operation. A first series of measurements was performed for the defined scenarios. In a further step, these data will be evaluated and determined to what extent the incorporation of analog measuring technology is necessary and whether the energy consumption of the ancillary components can be accurately estimated by a suitable simulation model.
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Project 65: Algorithms for Model Optimization with TurboProp

Project Members
Dr. rer. nat. Christoph Knieke (Leader)
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Partner
Volkswagen AG, Wolfsburg, Germany

Funding
Volkswagen AG
100,000€ (of 100,000€ total)

Duration
since 01.01.2012

Project Description
TurboProp is a software application that provides developers with an environment for the unified implementation of software models. It reduces significantly the development time and supports optimization of code, precision and performance. The software helps in analyzing software models via the user interface and indicates possible errors and overflows in the model. Based on this analysis, it corrects the model by automatically choosing suitable data types and quantization, such that 32-bit overflows and precision losses are minimized or, if possible, avoided. The selections are made with the help of an algorithm based on affine arithmetic. The algorithm also suggests changes to the existing model on grounds of precision, performance and also memory usage as required by the user. The project is a collaboration between Volkswagen and IPSSE, in which IPSSE is responsible for the development and implementation of the analysis and optimization algorithm.
Project 66: UseBox - Unified Software Engineering Toolbox

Project Members
- Dr. rer. nat. Dirk Niebuhr (Leader)
- Dipl-Inf. Christian Ristig (Project Staff)
- M.Sc. Inf. Axel Grewe (Project Staff)
- Dipl-Inf. Henrik Peters (Project Staff)
- B.Sc. Dirk Herrling (Project Staff)

Partner
- Volkswagen AG, Wolfsburg, Germany

Funding
- Volkswagen AG
- 75,000€ (of 75,000€ total)

Duration
- since 01.01.2012

Project Description
The Unified Software Engineering Toolbox (UseBox) is a unified, yet flexible platform for plugin-applications, which automatize certain activities of the development process for automotive software in the engine control unit at Volkswagen AG. The UseBox is currently developed and maintained by the Institute for Applied Software Systems Engineering and frequently used by control system engineers and software developers at the engine unit of Volkswagen AG.

The research group at IPSSE has developed a versatile set of plug-ins:
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Project 67: ZEUSS - Centralized Development Environment for Control Unit Software

Project Members
Dr. rer. nat. Christoph Knieke (Leader)
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B.Sc. Dirk Herrling (Project Staff)
M.Sc. Inform. Malte Mauritz (Project Staff)

Partner
Volkswagen AG, Wolfsburg, Germany

Funding
Volkswagen AG
70,000€ (of 70,000€ total)

Duration
since 01.01.2012
Project Description

There are a large number of manual processing steps included in the software development process for engine control units. Many of these steps can be automated, with the help of various tools which provide application programming interfaces (APIs). Over the last years dozens of small scripts and programs have been created independently by software developers to improve their everyday work.

ZEUSS (Zentrale Entwicklungsumgebung für Steuergeräte Software, English: centralized development environment for control unit software) aims at the automation of as many process steps during software creation as possible and making the small scripts of the software developers obsolete. This project is lead by Volkswagen, in which IPSSE is providing development support and valuable know-how in software engineering.

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3.8.5 Highlights

In 2013

- January 2013: Dirk Herrling visited the University of Auckland, New Zealand, and held a talk titled Iterative Development of a Requirements Model with Integrated Feedback Loops. While on site, he laid the basis for supervising a master project with the title Development of a Time Management Software and a seminar paper titled Comparison of PHP Frameworks. The student projects were coordinated from TU Clausthal, whereas the final presentations took place at the University of Auckland.
3.9 Computer Systems

3.9.1 Overview

**Leader** Prof. Dr.-Ing. Dr. rer. nat. habil. Harald Richter

**Secretary** Andrea Behfeld

**Scientific Employees**
- Dr. Stefan Aust (until 2012)
- Dipl.-Wirt.-Inf. Eduard Weber (until 2012)
- M.Eng. Nils Schulte (until 2012)
- M.Sc. Ahmad Obeid (since 2012)
- Dr. Kateryna Umgryumova (since 2012)
- Dr. Mikhail Glukhikh (since 2013)
- Dr. Mikhail Moiseev (2013)
- Matthias Langer (2012-2013)
- M.Sc. Roman Ledayayev (since 2013)

**External Ph.D. Students**
- Dipl.-Inf. Yang Xiang, Rechenzentrum Max-Planck Gesellschaft & IPP (RZG), Garching, Germany (until 2012)
- Dipl.-Inf. Dietmar Sommerfeld, Rechenzentrum Georg-August-Universität Göttingen and Max-Planck Gesellschaft (GWDG), Göttingen, Germany (until 2013)
- M.Sc. Florian Pramme, Ostfalia Hochschule für angewandte Wissenschaften, Wolfenbüttel, Germany (since 2012)
- M.Sc. Michael Kreutzer, University of Applied Science, Middle Hesse, Germany (since 2013)

**External Collaborators**
- Dr. M. Wille, Volkswagen GmbH, Wolfsburg, Germany
- Dr. B. Hayn, IAV GmbH, Berlin, Germany
- Dr. M. Glukhikh, St. Petersburg State Polytechnic University, Russia
- Dr. M. Moiseev, St. Petersburg State Polytechnic University, Russia
- Prof. D.P.F. Möller, Universität Hamburg, Germany
- Prof. F. Mayer-Lindenberg, Technische Universität Hamburg-Harburg, Germany
- Prof. D. Tavangarian, Universität Rostock, Germany
- Prof. O. Haan, GWDG, Rechenzentrum Universität Göttingen and Max-Planck Gesellschaft, Germany
- Prof. J. Grabowski, Georg-August-Universität Göttingen, Germany
- Prof. V. Kharchenko, National Aerospace University KhAI, Kharkiv, Ukraine
- Prof. M. Ugryumov, National Aerospace University KhAI, Kharkiv, Ukraine
- Dr. A. Gorbenco, National Aerospace University KhAI, Kharkiv, Ukraine
- Prof. G. Zholtkevych, V.N. Karazin Kharkiv National University, Kharkiv, Ukraine
- Prof. G. Bikker, Ostfalia Hochschule für angewandte Wissenschaften, Wolfenbüttel, Germany
- Prof. K. Wüst, Technische Hochschule Mittelhessen, Germany
3.9.2 Research Agenda

The chair of Technical Informatics and Computer Systems worked in the period of 2012-2013 on the following hardware and software projects:

- **CarRing II**, which is a real-time computer network for in-car communication (in cooperation with Volkswagen)
- **TUCar**, which is an electric car that serves as a testbed for CarRing II (in cooperation with Volkswagen)
- **Safenet**, which is a highly reliable version of CarRing II (in cooperation with St. Petersburg State Polytechnic University)
- **ConPar**, which is a real-time parallel computer for the re-centralization of electronic controller units in a car
- **TI Online**, which is an E-learning portal with learning content for the subject of Technical Informatics (in cooperation with Universität Hamburg, Technische Universität Hamburg-Harburg and Universität Rostock)
- **D-Grid Scheduler**, which replaced the original scheduler of D-Grid by a novel one that delivers 28% more throughput in computing centers (in cooperation with GWDG)
- **SimCloud (SimPaaS)**, which is a cloud-based software infrastructure for scalable simulation (in cooperation with Georg-August-Universität Göttingen)

For further information, please see the group’s homepage at: [http://www.in.tu-clausthal.de/abteilungen/technische-informatik-und-rechnersysteme/personen/](http://www.in.tu-clausthal.de/abteilungen/technische-informatik-und-rechnersysteme/personen/)

and the research home page at: [http://www.in.tu-clausthal.de/abteilungen/technische-informatik-und-rechnersysteme/forschung/](http://www.in.tu-clausthal.de/abteilungen/technische-informatik-und-rechnersysteme/forschung/).

3.9.3 Supervised Theses

*Ph.D. Theses:*


*Diploma and Master’s Theses:*


### 3.9.4 Projects

**Project 68: CarRing II - A Real-Time Computer Network for Automobiles**

**Project Members**
- **Prof. Dr. Harald Richter** (Leader)
- Dipl.-Wirt.-Inf. Eduard Weber (Project Staff)
- B.Sc. Mathias Langer (Project Staff)
- M.Sc. Ahmad Obeid (Project Staff)
- Dr. Mikhail Glukhikh (Project Staff)

**Partner**
- **Volkswagen GmbH**, Wolfsburg, Germany

**Funding**
- German Research Foundation (DFG)
- 192,000€ (of 192,000€ total)

**Duration**
- 2004 – 2015

**Project Description**
CarRing II is a real-time computer network which can outmatch and replace the field and multimedia busses that are currently used in cars. Other application areas are in real-time data-transfers inside of land, air, and space vehicles and in process and factory automation. CarRing II offers high reliability and scalability from small to large systems, efficient medium access, and a higher level of abstraction for the end user, beside a much higher data rate (3.125/6.25 Gbit/s) than field busses.
Furthermore, the 4–9 km long cable tree in the vehicle is significantly reduced. One reason for this superiority is that a two-wired, shielded twisted-pair cabling in ring topology is used. Another reason is the CarRing II’s application programming interface that implements all ISO layers 1-4 and 7, thus allowing communication functions of higher ISO layers to be realized no longer by individual user programs but by distinct communication controllers.

All protocols are executed by a FPGA in real-time. The FPGA is programmed by our group in SystemC in order to guarantee deterministic latency for data transmission and acts as a CarRing II node. Up to 16 nodes can be coupled in a ring, and up to 255 rings are possible in a car by employing additional routers. The project is funded by the DFG. The current status of the project is that five communication nodes are operational, and ISO layers 1-4 and 7 are synthesized and running.

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Project 69: TUCar - A Test Platform for Communication and Control in Cars

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Dipl.-Ing. (FH) Stefan Aust (Project Staff)

Partners
Volkswagen GmbH, Wolfsburg, Germany
Lenze SE, Aerzen-Groß Berkel, Germany

Duration
2008 – 2018

Project Description
TUCar is a moving test platform for evaluating new concepts in communication and control of electronic controller units (ECUs). The mission of TUCar is testing and exploring the following two features of a future car:

- Improved data transmission between all electronic components
- Re-centralization of ECUs
Therefore, the two sub-projects CarRing II and ConPar have been defined. CarRing II allows for intra-car communication by means of a real-time computer network instead of field busses. ConPar bundles ECUs in one unit via emulating them in a reliable real-time parallel computer.

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Project 70: SafeNet

Project Members

Prof. Dr. Harald Richter (Leader)
M. Glukhikh (Project Staff)
M. Moiseev (Project Staff)

Partners

M. Glukhikh, St. Petersburg State Polytechnic University, Russia
M. Moiseev, St. Petersburg State Polytechnic University, Russia

Duration

2012 – 2013

Project Description

The goal of the SafeNet project is to develop a computer network that fulfills the requirements of future cars which will be based on x-by-wire. This technology allows to control all car functions electronically. However, such vehicles require an in-car communication that has high reliability, time-determinism, good scalability from small to large systems, good flexibility and interoperability, high data rates, low latency and less cable lengths. In order to achieve this, a dedicated computer network called SafeNet will be developed. To meet the above requirements, the design and implementation process of SafeNet must be monitored and supported by special software tools that combine the capabilities of model-based code generation from software engineering with hardware/software co-design from embedded real-time systems.
This is a new and unique feature combination that does not exist yet. However, the AEGIS and RA tools from St. Petersburg State Polytechnic University can be augmented by a comprehensive timing and performance analysis so that they can be used for SafeNet. The SafeNet project has a high commercial potential, due to the innovations in the automotive industry which are expected as soon as it is possible to replace field buses as an outdated technology by a homogeneous, time-deterministic, high-speed computer network that has its emphasis on reliability.

References
[Glukhikh et al., 2013] (Page 191),
[Moiseev et al., 2013] (Page 204)

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Project 71: ConPar

Project Members
Prof. Dr. Harald Richter (Leader)
Dipl.-Ing. (FH) Stefan Aust (Project Staff)

Duration
2010 – 2012

Project Description
In the ConPar project, a parallel computer architecture was developed for the emulation of electronic controller units (ECUs) in cars. This architecture was tested by means of a prototype. The mission of this project is to emulate commercial ECUs in real time and to execute their software without modifications. Prerequisite for this is that the software uses the AUTOSAR standard as middleware. From the point of view of a computer architect, ConPar has to read measurement data from sensors, process multiple tasks in real-time, and generate output command values for feed forward and feedback control. Typical application areas of ConPar are characterized by hard and soft real-time requirements, combined with low or medium computing power and low energy consumption. Computing power should be easily scalable from 2-256 ECUs under the boundary condition of low financial budget.
The aim of ConPar is the re-centralization of ECUs, as their number has already reached a limit of 100, which is on the borderline of feasibility. Especially system reliability and safety is currently only achieved by high production costs and by a lot of manpower in the design phase of the system. This is the state of the art in ECU installation and coupling in the car which is a far way from "Green IT". ConPar will replace up to 256 ECUs in its maximum configuration by one single hardware unit. ConPar’s interconnection network to the periphery will be based on CarRing II and no longer on a classical cable tree. Soft core processors, e.g. Virtex 4 and Virtex 5 FPGAs from Xilinx, will be used as replacements for the ECUs. Thus, several dozens of ECUs can be emulated per FPGA. Virtex 6 will allow the emulation of several hundreds of ECUs by programmable logic.

The basic idea of ConPar is to map the AUTOSAR application programming interface to communication and other system calls onto chip-internal VHDL calls, and to replace process scheduling by so called space sharing. Space sharing instead of time sharing means that each task is allocated to its own soft core processor on the same FPGA chip, together with own memory and I/O accesss. As a consequence, the hardware of the ECU that has executed the car supplier’s software is virtualized, and each process gets the needed hardware resources by means of programmable logic. To achieve this, a non-blocking interconnection network of the Benes type is employed with decentralized routing. This allows for deterministic latency in data frame exchange between tasks. Thus, the task scheduling, i.e. time sharing that is critical in real-time applications, is omitted. Scheduling complexity will otherwise drastically increase in the future in the view of multi-core CPUs.

Totally unsolved is the real-time scheduling problem in many core CPUs. All these obstacles are circumvented by the space sharing method. Furthermore, space sharing improves task isolation in the case of errors. Finally, it is intended in the further future to automatically extract the needed hardware resources of each task out of the given set of tasks and their coupling in a commercial ECU and to synthesize these resources onto a FPGA with appropriate computer aid. However, the very important aspects of operation reliability and safety which are mandatory for applications in a real car will be left out in the ConPar project and preserved for a successor project.

To summarize, ConPar is based on a multi- or many-core architecture with inter-process and inter-ECU communication in real time, together with space sharing instead of time sharing.

References
[Aust and Richter, 2012] (Page 190),
[Richter, 2012] (Page 205)
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Project 72: **TI Online - An Internet-based Bachelor Course for Continuing Education of Professionals**

**Project Members**
- Prof. Dr. Harald Richter (Leader)
- M.Eng. Nils Schulte (Project Staff)
- Dr. Kateryna Umgryumova (Project Staff)

**Partners**
- Prof. Dr. Ing. Dietmar P. F. Möller, Universität Hamburg, Germany
- Prof. Dr. F. Mayer-Lindenberg, Technische Universität Hamburg-Harburg, Germany
- Prof. Dr.-Ing. habil. Djamshid Tavangarian, Universität Rostock, Germany

**Funding**
Lower Saxony Ministry of Science and Culture (MWK)
210,000€ (of 2,400,000€ total)

**Duration**
2010 – 2015

**Project Description**
TI Online is a project spanning across several federal states in Germany in order to create an Internet-based extra-occupational Bachelor course. Participating organizations are: Universität Hamburg, Technische Universität Hamburg-Harburg, Universität Rostock, Universität zu Lübeck, Fachhochschule Lübeck and Technische Universität Clausthal. TI Online will comprise multimedia learning content that is organized in modules. It distinguishes from study courses of 10 pure Informatics and Information Engineering in the selection and weighting of modules from Informatics, Mathematics and Electrical Engineering. TI Online is devised as continuing education for professional workforce. Cost-covering fees will be charged.

**References**
[Sitzmann et al., 2013] (Page 206)
Contact E-Mail
hri@tu-clausthal.de

Project Homepages
http://ti-online.org
http://webadmin.ti-online.org/
http://ilias.ti-online.org
http://docs.ti-online.org/

Project 73: D-Grid Scheduler

Project Members
Prof. Dr. Harald Richter (Leader)
Dipl.-Inf. Dietmar Sommerfeld (Project Staff)

Partner
GWDG (Rechenzentrum Georg-August-Universität Göttingen and Max-
Planck Gesellschaft), Göttingen, Germany

Funding
GWDG
120,000€ (of 120,000€ total)

Duration
2003 – 2012

Project Description
In the first part of the project, we examined the process to enable life science applications for execution on the Grid. Such applications often require the analysis of very large data sets and consist of several successive program runs. As a case study, we described the adaptation of the gene-finding tool AUGUSTUS to Grid computing in the context of the MediGRID virtual organization, which is part of the German D-Grid.

In the second part of the project, we concentrated on scheduling in MediGRID, which is concerned with the mapping of tasks to Grid resources. We started our analysis with measurements of the availability of resources in D-Grid and identified four problems inherent to meta-scheduling that make Grid scheduling nearly always a delicate task. To address these issues, we developed three methods to estimate the queue waiting times of the prevalent cluster resources. Additionally, we proposed three selection algorithms to automatically select the best current estimation method. Evaluation shows that prediction works very well on most resources and recognizes the peaks in waiting times that can last up to hours. We assessed the improved scheduling by measurements and demonstrate a significant acceleration of up to 28% in workflow processing compared to the existing strategies.
Project 74: SimCloud (SimPaaS)

Project Members
Prof. Dr. Harald Richter (Leader)
M.Sc. R. Ledayev (Project Staff)

Partner
Georg-August-Universität Göttingen, Germany

Funding
Lower Saxony Ministry of Science and Culture (MWK)
180,000€ (of 4,000,000€ total)

Duration
2013 – 2015

Project Description
The goal of SimPaaS is to provide for users from natural sciences and engineering disciplines a framework for scalable simulations. The framework is based on cloud technology and is scalable from small to big simulation runs and applications by requesting an arbitrary number of virtual machines (Simulation-as-a-Service, SimaaS). The project has the following sub-goals:

- Development of concepts, methods and tools for the modelling and the implementation of scalable simulation applications in the cloud.
- Development of methods for an optimized resource utilization for scalable simulation applications in the cloud.
- Concept and implementation of simulation-specific monitoring tools and of an interactive execution environment.
- Development of mechanisms to guarantee reliability also in case of long-running simulation applications.
- Evaluation of project results by means of case studies from natural sciences and engineering disciplines.
• Set-up and operation of a prototype cloud as well as transfer of project results into a commercial cloud environment, e.g. as a service in a computing center.

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Project Homepage
http://www.simzentrum.de/projekte/

3.9.5 Scientific Activities

Person Harald Richter

☐ Awards
• Best Paper Award of the 10th IEEE East-West Design & Test Symposium (EWDTS 2012), Kharkov, Ukraine, for the paper Real-time Interconnection Network for Single-Chip Many-Core Computers.

☐ Invited Talks
• April 2012: Presentation on Teaching and Research at the Chair of Technical Informatics and Computer Science of Clausthal University, Germany, on invitation of Prof. G. Zholtkevych, at V.N. Karazin Kharkiv National University, Ukraine.
• September 2012: Presentation on Teaching and Research at the Chair of Technical Informatics and Computer Science of Clausthal University, Germany, on invitation of Prof. V. Kharchenko, at National Aerospace University KhAI, Kharkov, Ukraine.
October 2012: Harald Richter gave a presentation on Forschungsideen und Projekte am Lehrstuhl für Technische Informatik und Rechnersysteme, on invitation of Prof. Appelrath, at Offis Oldenburg.

May 2013: Plenary talk at the 3rd Int. Workshop on Critical Infrastructure, Safety and Security (CrISS-DeSSerT 2103), about On A Reliable Real-Time Computer Network For Safety-Critical Applications, on invitation of Prof. V. Kharchenkov, at Sewastopol Banking Institute, Ukraine.

December 2013: Presentation for the president of the International Federation of Information Processing (IFIP) and the president of the Australian Computer Society (ACS) about Regulations for IT professions in Germany: The German System of Dual Education, on invitation of Leon Strous and Brenda Aynsley, at Intercity Hotel Düsseldorf.

Editor of Journals and Proceedings


Committees

Since 2013: Speaker of the Council of German Computer Society (German: Gessellschaft für Informatik) for IT education and life-long learning.

2012: Member of the committee for nominating the next GI vice president.

Since 2011: Member of the board of governors of the German Computer Society (GI).

3.9.6 Highlights

Visitors

July – August 2012: Dr. Mikhail Moiseev and Dr. Mikhail Glukhikh, Sankt Petersburg State Polytechnic University (SPbSPU), Faculty of Computer Science, Digitek Labs, Russia.

January and July – August 2012: Dr. Kateryna Ugryumova, Kharkov Social-Economy Institute (KhSEI), Ukraine.

July 2013: Prof. Mikhail Ugryumov, National Aerospace University KhAI, Kharkiv, Ukraine.
• February 2013 – January 2014:
  Dr. Mikhail Glukhikh, Sankt Petersburg State Polytechnic University (SPbSPU), Faculty of Computer Science, Digitek Labs, Russia.
3.10  Embedded Systems, Hardware and Robotics

3.10.1  Overview

Leaders  Prof. Dr. Christian Siemers
          apl. Prof. Dr. Günter Kemnitz

Secretary  Andrea Behfeld

Scientific Employees
          of Christian Siemers
          Dipl.-Inf. René Fritzsche
          Dipl.-Inf. Sascha Lützel (until 08.2012)
          Dipl.-Inf. Jens Drieseburg
          Dipl.-Ing. Christian Ristig (since 01.2013)
          B.Sc. Jürgen Lorenz (since 06.2013)

          of Günter Kemnitz
          Dr. Carsten Giesemann

External Students
          of Christian Siemers
          Dipl.-Ing. (FH) M.Sc. Martin Alfranseder, Ostbayerische Technische Hochschule
          Regensburg, Germany
          Dipl.-Ing. Tatiana Djaba Nya, Airbus Group, Ottobrunn, Germany
          M.Sc. Michael Hirsch, Volkswagen AG, Germany
          Dipl.-Inf. Sascha Lützel, Berner & Mattner Systemtechnik GmbH, Wolfsburg, Germany
          Dipl.-Ing. Peter Tabatt, Hochschule Nordhausen, Germany
          of Günter Kemnitz
          Dipl.-Inf. Hossam Ramadan, Syria

3.10.2  Research Agenda

The research goal of the group of Christian Siemers is to improve the dependability of embedded systems concerning their algorithmic and timing behavior. This includes design patterns, design methodologies and tool support as well as approaches for observing runtime behavior to detect runtime failures.

The research in this group mainly deals with various types of technical systems and applications: computer hardware, industrial control systems and mechatronical systems with the focus on embedded systems. Main topics are execution time-based design methodology including hardware/software co-design, system reliability, system observability and in-situ testing. Also included are transcoding algorithms to generate executable programs for non-Von-Neuman architectures.

For further information, please see the group’s homepage at:
http://www.in.tu-clausthal.de/abteilungen/embedded-systems
The group of Günter Kemnitz deals with various types of technical systems and applications: computer hardware, control systems, mechatronical systems and robots. The main focus is on reliability.

For further information, please see the group's homepage at: 
http://techwww.in.tu-clausthal.de/

### 3.10.3 Supervised Theses

**Ph.D. Theses:**


**Diploma and Master’s Theses:**


Bachelor’s Theses:


3.10.4 Projects

Project 75: Fast+Safe+Config - Hardware and Software Development
Project Members
Prof. Dr. Christian Siemers (Leader)
Dipl.-Inf. René Fritzsche (Project Staff)

Partners
Dipl.-Ing. Walter Zander, Zander GmbH&Co KG, Aachen, Germany (Leader)
Dipl.-Ing. Alfons Austerhoff, Zander GmbH&Co KG, Aachen, Germany

Funding
Federal Ministry for Economic Affairs and Energy (BMWi)
136,000€ (of 268,000€ total)

Duration
04/2012 – 03/2014

Project Description
Automation technology for controlling machines and safety technology to prevent persons and machines from accidents - both emerging technologies - are currently joining.

The focus of this project is to integrate both within a hardware platform for distributed automation systems and to configure the PLC (Programmable Logic Control) via network. The last feature is demanding for specific solutions, as the basic technology used for this PLC is based on field-programmable gate arrays (FPGA).

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Project 76: Real Time Capable and Safety Aware Multicore Architecture

Project Members
Prof. Dr. Christian Siemers (Leader)
Dipl.-Inf. Christian Ristig (Project Staff)
3.10 Embedded Systems, Hardware and Robotics

**Partner**
Dr. Stefan Stilkerich, EADS, Germany (Leader)

**Funding**
EADS
37.500€ (of 37.500€ total)

**Duration**
04/2013 – 12/2013

**Project Description**
Multicore processors are the best choice, if performance issues must be met, and the number of cores will increase significantly in the next years. But up to now, multicore architectures are rarely used within safety critical applications, as they present even more issues to be solved for safety reasons. This project addresses the real time behavior as well as the safety issues of multicore architectures by architectural approaches.

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**Project 77: TEC – Time-Enhanced C**

**Project Members**
Prof. Dr. Christian Siemers (Leader)
Dipl.-Inf. René Fritzsche (Project Staff)

**Duration**
since 10/2009

**Project Description**
This project deals with design support (both hard- and software) for small embedded systems and implements approaches for execution in a time-based design methodology. The designer is provided with language constructs to describe the timing behavior, and a pre-compiler is used to partition the application. The pre-compiler also includes the scheduling algorithm used to schedule the threads accordingly. This is done to avoid malfunctions in real time applications at design time. The actual implementation supports C with time extensions written as special comments.
Project 78: Softerror Mitigation inside FPGAs

Project Members
Prof. Dr. Christian Siemers (Leader)
Dipl.-Inf. Sascha Lützel (Project Staff)

Duration
10/2008 – 09/2012

Project Description
Softerror Mitigation inside FPGAs includes the detection and correction of soft errors inside FPGAs caused by cosmic radiation or natural radioactivity. While errors inside data or state memory can be detected directly, e.g. by hamming codes, the detection of such errors inside code memory is more complicated, and in the case of off-the-shelf devices only possible by using indirect methods. The project includes the development and research of methodologies for error detection without using triple-module redundancy to minimise the additional hardware.

References
[Lützel and Siemers, 2012] (Page 202)

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Project 79: Transcoding of imperative programs using global cellular automata

Project Members
Prof. Dr. Christian Siemers (Leader)
Dipl.-Inf. Jens Drieseberg (Project Staff)

Duration
since 01/2012

Project Description
The translation of programs written in imperative languages like C into configurations for FPGA is still a demanding task. The approach of this project is to use global cellular automaton (GCA) as intermediate layer, to automatically partition the application into basic operations mapped on a virtual array of GCAs, and then to generate either partitioned C code for arrays of processors or VHDL code for programmable hardware components like FPGAs.

References
[Drieseberg and Siemers, 2012] (Page 196)

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Project 80: Model-driven Development of Automotive HMI-Product Lines

Project Members
Prof. Dr. Christian Siemers (Leader)
Dipl.-Ing.(FH) Simon Gerlach (Project Staff)

Duration
10/2009 – 12/2012
**Project Description**

Model-driven technologies inside automotive applications are becoming popular. The advantages of this technologies are widespread. Still, mapping this technology into the area of human-machine interaction (HMI) with several languages and country-defined versions means that major modification will come into account. In this case, the model-driven technology has to handle several additional aspects in comparison with classical applications.

**References**


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**Project 81: Software-centric Approach to Enhance Fault-Tolerance of Embedded Systems**

**Project Members**

Prof. Dr. Christian Siemers (Leader)
Dipl.-Ing. Tatiana Djaba Nya (Project Staff)

**Duration**

since 07/2013

**Project Description**

Fault tolerance is a serious demand for embedded systems, specifically inside aerospace and space applications. This project addresses this demand by a software-centric approach, where statistical analysis of runtime behaviour will be used for receiving information of well-behaviour of processes and threads. The main focus is set on receiving statistical parameters for direct or indirect observation of incorrect behavior.
References
[Nya et al., 2013] (Page 204)

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Project 82: Realtime Multicore Scheduling for Embedded Systems

Project Members
Prof. Dr. Christian Siemers (Leader)
Dipl.-Ing.(FH) Martin Alfranseder, M.Sc. (Project Staff)

Duration
since 04/2013

Project Description
As multicore architectures are becoming common to embedded systems, the problem of scheduling realtime applications becomes a serious issue. In comparison with existing approaches, this project focuses on developing scheduling algorithms specifically for multicore architectures under consideration of task-dependencies, changes in task sets and variation of execution times during runtime. The goal is to find an appropriate scheduling for multicore architectures under slightly changing constraints.

References
[Alfranseder et al., 2013b] (Page 194),
[Alfranseder et al., 2013a] (Page 193)

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Project 83: Clustering of Matlab/Simulink-Models for Hardware/Software Co-Design Support

Project Members
Prof. Dr. Christian Siemers (Leader)
M.Sc. Michael Hirsch (Project Staff)

Duration
since 01/2013
**Project Description**

Modeling of applications is state of the art, and tools like MATLAB/Simulink for either microcontroller- or FPGA-based implementation are frequently used for rapid prototyping. Inside this project, the question concerning the simultaneous use of both implementation platforms is discussed. This partitioning problem is addressed using empirical approaches like simulated annealing, and several metrics for supporting automatic choice of proper partitions are researched and developed.

**References**

[Kolassa et al., 2013] (Page 201)

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### 3.10.5 Scientific Activities

**Person** Christian Siemers

- Christian Siemers was involved in the “Exzellenz-Initiative Profil und Kooperation” for small and medium-sized universities (following a call for proposals by the Stifterverband für die Deutsche Wissenschaft and the Heinz-Nixdorf Stiftung), funded from April 2008 until March 2010, since then continued on a bilateral basis. Since April 2008 he coordinates the cooperation, and for this purpose he is with the Hochschule Nordhausen and with the Technische Universität Clausthal, each for 50 percent, to be continued in 2014.

- Inside the Department of Informatics, Christian Siemers was responsible for the accreditation of the M.Sc. Systems Engineering, a continuing study program cooperatively defined by the Department of Informatics, the Institute of Electrical Information Technology, the Institute of Technical Mechanics, the Institute of Process and Production Technology, the Institute of Mechanical Engineering, and the Institute of Electrical Engineering. The study program was successfully accredited in 2012.
3.10 Embedded Systems, Hardware and Robotics

Christian Siemers is a co-founder and a member of the board of directors of the Institute of Applied Software Systems Engineering (IPSSE), founded in 2011 at the Technische Universität Clausthal.

3.10.6 Highlights

Highlight 1: Large-size LED cube

Project Members
Prof. Dr. Christian Siemers (Leader)
Dipl.-Inf. René Fritzsche (Staff)
Dipl.-Inf. Sascha Lützel (Staff)

Duration
since 03/2011

Project Description
Beginning in 2011, we built-up a 16*16*16 cube completely by LEDs to show parallel processing algorithms, visualize timing differences by using sequential and true parallel processing, and - last but not least - for using it as an eye-catcher. The control of the LEDs is performed either by a microcontroller for demonstrating sequential behavior of control, or by an FPGA for true parallel computations.

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Highlight 2: 3D-Scanner

Project Members
Prof. Dr. Christian Siemers (Leader)
Dipl.-Inf. Jens Drieseberg (Staff)

Duration
since 03/2011
Project Description

The project shows that a 3-dimensional scanner can be easily built-up using comparatively cheap components. It mainly consists of a camera, fortunately with a high resolution, a laser, a PC for the self-developed program and two white backplanes, for the background. The camera, configured to low light sensitivity, records only the reflected laser light, which must be widened in one dimension. By slightly moving the laser over the scanned object, all reflected points are recorded. The program then reconstructs the object in a 3-dimensional representation on the screen. This scanner is well-suited for demonstration.

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4 Publications

4.1 Books, Proceedings and Edited Volumes (9)


4.2 Book Chapters (20)


4.3 Journal Articles (32)


4.4 Refereed Conference and Workshop Publications (112)


4.5 Technical Reports (8)


4.6 Ph.D. Theses (11)


4.7 Diploma Theses (20)


4.8 Bachelor’s Theses (22)


4.9 Master’s theses (21)


Supervisor: Dirk Turschner (Institute for Electrical Engineering, Clausthal). 
Co-supervisor: Christian Siemers.

[Melchior, 2013] F. Melchior. Konzepte zur Varianz in der Signalflosssprache AS- 
(Institute for Electrical Information Engineering, Clausthal).

[Oueslati, 2012] T. Oueslati. Modellbasierte Absicherung der funktionalen Sicher- 
Braunschweig).

Michael Armbruster (Siemens AG, München).

[Schneider, 2013] M. Schneider. Engineering im Bereich der Gebäudeautomation 

(University of Applied Sciences and Arts, Göttingen).

[Strasser, 2012] A. Strasser. Modellbasierte Anforderungsspezifikation für 
Steuergeräte-Software am Beispiel eines Bremskraftverstärkers aus dem Au- 
Co-supervisor: Andreas Rausch.

uation eines auf Bewegungssteuerung basierenden Kommunikationskanals für 
Gesten in einer kollaborativen virtuellen 3D Welt. May 2013. Supervisor: Niels 