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Institut für Informatik und
angewandte Mathematik
Universität Bern

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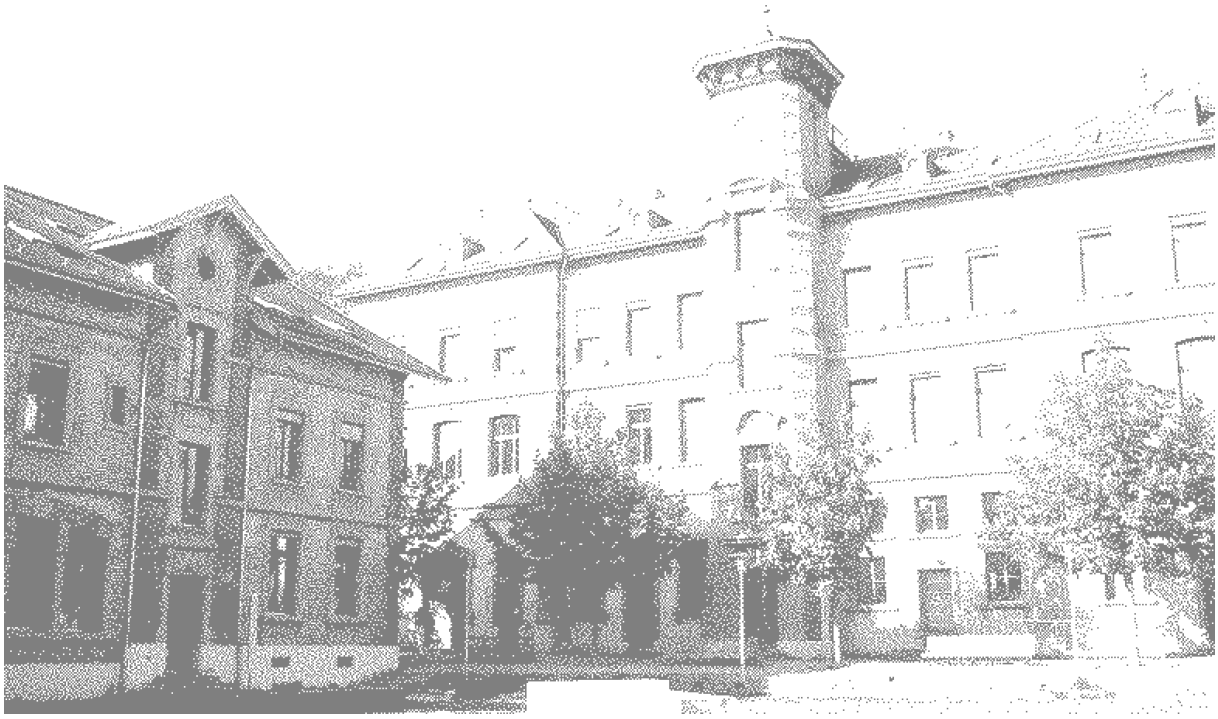
IAM Annual Report 08/09



IAM Annual Report

Academic Year 2008/2009

July, 2009

Contents

1 Institute of Computer Science and Applied Mathematics (IAM)

1.1 Address

Neubrückstrasse 10, CH-3012 Bern, Switzerland
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1.2 Personnel

Board of directors

Prof. Dr. Torsten Braun; Prof. Dr. Horst Bunke; Prof. Dr. Gerhard Jäger; Prof. Dr. Oscar Nierstrasz; Prof. Dr. Martin Zwicker.

Teaching staff

Prof. Dr. Torsten Braun; Dr. Kai Brünnler; Prof. Dr. Horst Bunke; Prof. János Csirik; Dr. Orla Greevy; Prof. Dr. Rolf Haenni; Marc Hugi; Prof. Dr. Gerhard Jäger; Dr. Urs-Viktor Marti; Prof. Dr. Oscar Nierstrasz; Sonja Schär, Prof. Dr. Kilian Stoffel; Prof. Dr. Thomas Strahm; Dr. Thomas Studer; Prof. Dr. Matthias Zwicker.

Director

Prof. Dr. Torsten Braun.

Administration

Ruth Bestgen; Bettina Choffat; Dragana Esser; Iris Keller; Susanne Thüler.

Technical staff

Peppo Brambilla; Dragan Milic.

Scientific staff

Dr. L. Alberucci; M. Anwander; P. Brambilla; M. Brogle; Dr. K. Brünnler; S. Bucheli; Dr. K. Dolfus; St. Fankhauser; A. Fischer; D. Flumini; V. Frinken; M. Ghari; Dr. T. Gîrba; R. Goetschi; Dr. T. Ha-Minh; Prof. Dr. R. Haenni; P. Hurni; E. Indermühle; J. Jonczy; J. Krähenbühl; Dr. R. Kuznets; Dr. R. McKinley; D. Milic; K. Riesen; Th. Buchberger; M. Hugi; C. Knaus; A. Kuhn; Dr. A. Lienhard; F. Perin; Dr. D. Probst; L. Renggli; J. Ressia; D. Röthlisberger; S. Schär; N. Schwarz; D. Spescha; T. Staub; D. Steiner; Ph. Stouppa; Prof. Dr. Th. Strahm; Dr. Th. Studer; T. Verwaest; M. Wachter; G. Wagenknecht; M. Wälchli; R. Wehbe;

2 Teaching Activities

2.1 Courses for Major and Minor in Computer Science

Autumn Semester 2008

- Bachelor 1st Semester

  Einführung in die Informatik (M. Hugi, S. Schär, 5 ECTS)
  Programmierung 1 (Th. Strahm, 5 ECTS)
  Grundlagen der technischen Informatik (Th. Studer, 5 ECTS)

- Bachelor 3rd Semester

  Information und Logik (G. Jäger, 5 ECTS)
  Einführung in Software Engineering (O. Nierstrasz, 5 ECTS)
  Computernetze (T. Braun, 5 ECTS)

- Bachelor 5th Semester

  Computergrafik (M. Zwicker, 5 ECTS)
  Künstliche Intelligenz (H. Bunke, 5 ECTS)
  Mensch Maschine Schnittstelle (Th. Strahm, 5 ECTS)

- Master Courses

  Compiler Construction (O. Nierstrasz, 5 ECTS)
  Graduate Seminar Logik und Information (G. Jäger, J. Schmid, K. Stoffel, U. Ultes-Nitsche, 5 ECTS)
  Grundlagen der Mustererkennung (H. Bunke, 5 ECTS)
  Hilbert, Gödel, Gentzen, Fundamental Developments in Logic (G. Jäger, 5 ECTS)
  Multimediakommunikation (T. Braun, 5 ECTS)

Seminar: Algebra und Logik (G. Jäger, J. Schmid, 5 ECTS)

Seminar: Künstliche Intelligenz (H. Bunke, 5 ECTS)

Seminar: Rechnernetze und Verteilte Systeme (T. Braun, 5 ECTS)

Seminar: Software Composition (O. Nierstrasz, 5 ECTS)

Seminar: Theoretische Information und Logik (G. Jäger, 5 ECTS)

Software Evolution (T. Girba, O. Nierstrasz, 5 ECTS)

- Service Course

  Anwendungssoftware (Th. Studer, 3 ECTS)

Spring Semester 2009

- Bachelor 2nd Semester

  Datenstrukturen und Algorithmen (M. Zwicker, 5 ECTS)

  Datenbanken (K. Stoffel, 5 ECTS)

  Programmierung 2 (O. Nierstrasz, 5 ECTS)

  Rechnerarchitektur (Th. Studer, 5 ECTS)

- Bachelor 4th Semester

  Automaten und formale Sprachen (H. Bunke, 5 ECTS)

  Betriebssysteme (T. Braun, 5 ECTS)

  Berechenbarkeit und Komplexität (Th. Strahm, 5 ECTS)

  Praktikum in Software Engineering (Th. Studer, 5 ECTS)

- Bachelor 6th Semester

  Proseminare (5 ECTS)

- Master Courses

  Automatische Sprachdienste (U. V. Marti, 5 ECTS)

  Computability Theory (Th. Strahm, 5 ECTS)

  Concurrent Programming (O. Nierstrasz, 5 ECTS)

  Graduate Seminar Logik und Information (G. Jäger, J. Kohlas, J. Schmid, K. Stoffel, 5 ECTS)

  Lambda Calculus (K. Brünnler, 5 ECTS)

  Mobilkommunikation (T. Braun, 5 ECTS)

  Mustererkennung 2 (H. Bunke, 5 ECTS)

  Rendering Algorithms (M. Zwicker, 5 ECTS)

  Seminar: Computer Graphics (M. Zwicker, 5 ECTS)

  Seminar: Künstliche Intelligenz (H. Bunke, 5 ECTS)

  Seminar: Rechnernetze und Verteilte Systeme (T. Braun, 5 ECTS)

  Seminar: Software Composition (O. Nierstrasz, 5 ECTS)

  Seminar: Theoretische Informatik und Logik (Th. Strahm, Th. Studer, 5 ECTS)

- Service Course

  Anwendungssoftware (Th. Strahm, 3 ECTS)

2.2 Colloquium in Computer Science

25/11/2008 Prof. Matthias Zwicker
Universität Bern
Festkolloquium anlässlich 25 Jahre Hauptfach Informatik an der Universität Bern, Antrittsvorlesung von Prof. Zwicker
Effiziente Berechnung realistischer Computerbilder

09/12/2008 Dr. Daniel Felix
CTO ergonomie & technologie (e&t) GmbH, Zürich
User Centred Design – aus Anwendersicht das Richtige entwickeln

2.3 Students

- Major Subject Students: HS 2008: 197, FS 2009: 188
- Minor Subject Students: HS 2008: 149, FS 2009: 124
- Ph.D. Candidates: HS 2007: 27, FS 2009: 27

2.4 Degrees and Examinations

- Ph.D.: 5
- Diploma: 0
- Master: 15
- Bachelor: 10
- Propädeutische Hauptfachprüfung: 0
- Completion of Minor Studies: 10 (90E: 1, 60E: 5, 30E: 2, 25E: 1, 15E: 1 (1025 ECTS)
- Semester Examinations Autumn Semester 2008: 319 (1595 ECTS)
- Bachelor/Diploma/Master Theses and Computer Science Projects Autumn Semester 2008: 13 (445 ECTS)
- Semester Examinations Spring Semester 2009: 226 (1130 ECTS)
- Bachelor/Diploma/Master Theses and Computer Science Projects Spring Semester 2009: 19 (518 ECTS)

2.5 Activities

- Offering a full day program for the “Tochtertag”, Bern, November 13, 2008
- Contributing to the “Fit in IT - Roadshow” at the Kantonsschule Willisau, Willisau, February 2, 2009
- Contributing to the “Fit in IT - Roadshow” at the Kantonsschule Wohlen, Wohlen, April 6–7, 2009

- Contributing to the “Fit in IT - Roadshow” at the Gymnasium Kirschgarten, Basel, May 5, 2009
- Contributing to the “Fit in IT - Roadshow” at the Kantonsschule Musegg, Luzern, May 19, 2009
- Contributing to the “Fit in IT - Roadshow” at the Gymnase de la rue des Alpes, Biel/Bienne, June 23–24, 2009

2.6 Awards

- Fakultätspreis 2008 from the Faculty of Science at University of Bern, for the Ph.D. dissertation “Sub-method Structural and Behavioral Reflection” of Markus Denker
- Fakultätspreis 2008 from the Faculty of Science at University of Bern, for the Master thesis “Explicit mathematics with positive existential stratified comprehension, join and uniform monotone inductive definitions” of Samuel Bucheli
- IAM Alumni Preis 2008, for the Master Thesis “Classification of dissimilarity space embedded graphs” of Andreas Fischer
- Informatica 08 Spezialpreis, for the Bachelor Thesis “JExample” of Lea Hänsenberger

3 Computer Graphics Group

3.1 Personnel

Head:	Prof. Dr. M. Zwicker	Tel.: +41 31 631 3301 email: zwicker@iam.unibe.ch
Office Manager:	D. Esser	Tel.: +41 31 631 4914 email: esser@iam.unibe.ch
Scientific Staff:	Th. Buchberger	Tel.: +41 31 631 4864 email: buchberg@iam.unibe.ch
	M. Hugi	Tel.: +41 31 631 3321 email: hugi@iam.unibe.ch
	C. Knaus	Tel.: +41 31 631 4679 (since January 2009) email: knaus@iam.unibe.ch
	S. Schär	Tel.: +41 31 631 8955 email: schaer@iam.unibe.ch
Guests:	W. Y. Chang	University of California, San Diego, June – Sept. 2009

3.2 Overview

The Computer Graphics Group (CGG) was established in September 2008, when Prof. Zwicker joined the University of Bern as the successor of Prof. Bieri. The research of the Computer Graphics Group focuses on fundamental methods to generate and manipulate images using computers. We develop algorithms and systems for realistic and real-time rendering, and animation and modeling of three-dimensional shapes. We are also interested in novel representations for 3D geometry, such as point-based representations. Finally, we investigate signal processing techniques, in particular for multi-view 3D displays. Our research has applications in digital entertainment, multimedia, and data visualization.

Rendering

Rendering, or image synthesis, is a core problem in computer graphics. We develop algorithms for efficient, physically-based rendering. We are also interested in rendering for interactive applications, and we investigate techniques to simulate light transport in real-time.

Animation and Modeling

Computer graphics scenes are composed of three-dimensional shapes that are stored in computer memory using mathematical representations. Our research is concerned with modeling and animating these three-dimensional shapes. We focus on developing sophisticated mathematical methods that allow for realistic shapes and motions, and intuitive user interfaces that make modeling and animation simple and efficient.

Point-Based Graphics

We are interested in novel mathematical representations of three-dimensional shapes. In our research, we show that point-based techniques are viable alternatives to conventional approaches, such as triangle meshes or parametric surfaces, for a variety of applications from rendering to modeling.

Multi-View 3D Displays

Automultiscopic displays show stereoscopic images that can be viewed from any viewpoint without special glasses. They hold great promise for the future of television and digital entertainment. We develop signal processing techniques to optimize image quality by reducing sampling artifacts and adapting the signal to the display properties. We are also interested in multi-view content creation and manipulation techniques.

3.3 Research Projects

Multi-Dimensional Sampling for Image Synthesis

In this project we address research challenges that are still limiting the capabilities of image synthesis technology. In particular, we are developing more efficient algorithms for image synthesis by studying this problem from the perspective of multidimensional sampling.
Images represent distributions of light. While light in the physical world can be interpreted as a continuous quantity, it needs to be represented discretely for computer processing. This leads to the problem of sampling, which is at the core of this project. Computer graphics deals with various forms of sampled light to achieve realistic and efficient image synthesis. This includes, for example, the notion of light paths that store the amount of

light transmitted along paths including several reflections at surfaces; the concept of transport operators that describe how light is passed between pairs of surface points; or radiance distributions that represent the light that is reflected in each direction at each surface point. All three concepts represent multidimensional functions, which means that we need multiple parameters to identify each sample. Light paths are identified by their sequence of intersection points with surfaces. The dimensionality of a light path depends on the number of intersections, but is potentially unbounded. A sample of a transport operator can be identified by a pair of surface points. A surface point is given by two parameters, hence a pair of points is four-dimensional. Radiance distributions are functions of surface locations and directions, therefore they are also four-dimensional. This is to explain why multidimensional sampling plays a central role in image synthesis.
Our research in this project focuses on two areas, realistic image synthesis and light transport for interactive rendering, which at their core involve multidimensional sampling issues. We analyse both topics from the perspective of multidimensional sampling, identify specific research challenges, and develop more efficient and flexible algorithms. Improvements of these core algorithms for image synthesis will find broad applications in computer graphics. They will reduce the resources required for realistic image synthesis, and enable more natural and effective interactive applications.

Research staff: Claude Knaus, Michael Pfeuti, Matthias Zwicker

Signal Processing for Multi-View 3D Displays

In this project we develop a multi-dimensional signal processing framework and signal processing algorithms for multi-view 3D displays. Multi-View 3D displays offer viewing of high-resolution stereoscopic images from arbitrary positions without glasses. These displays consist of view-dependent pixels that reveal a different color to the observer based on the viewing angle. Although the basic optical principles of multi-view auto-stereoscopy have been known for over a century, it is only recently that displays with increased resolution, or systems based on multiple projectors, have made them practical.
Multi-view displays feature a number of advantages over competing autostereoscopic display technologies, such as stereo-projection systems using shuttered or polarized glasses. Most importantly, multi-view displays do not require users to wear any special glasses, which leads to a more natural and unrestricted viewing experience. They also do not require

head tracking to provide motion parallax; instead, they provide accurate perspective views from any point inside a viewing frustum simultaneously. They are truly multi-user capable, since none of the display parameters needs to be adjusted to a specific individual user.
As a disadvantage, the amount of data that needs to be processed, rendered, and transmitted to such displays is an order of magnitude larger than for stereo-pair projection systems. In this project we develop techniques that aim at performing these operations as efficiently as possible based on a multi-dimensional signal processing framework for multi-view displays. This approach provides a concise tool to study various aspects of data acquisition, processing, rendering, and compression, and it promises to eliminate several drawbacks of multi-view displays that have been unresolved in the past.

Research staff: Sonja Schär, Stefan Frutig, Vikas Ramachandran, Matthias Zwicker

Acquiring 3D Surface Models of Deformable Shapes

The goal of this project is to develop algorithms for capturing and modeling deformable 3D geometry. A system that enables fast and accurate capture of moving shapes has many potential applications, for example in games, movie production, and virtual reality. This topic has recently received considerable attention specifically for capturing human performances.
Our approach assumes that surfaces are scanned using depth cameras. They are especially useful for this application because of their ability to capture detailed surface geometry. These cameras produce range scans, which measure the distance between the camera and the scene at each pixel. With depth cameras capturing at video frame rates, we can capture scans of deforming objects in real-time. This project addresses the challenging problem to produce a consistent model of the deforming shape from such a set of range scans.
Unlike static range scans, moving range scans contain both the information about the surface and how the underlying object moves. This provides an exciting opportunity to extract both the shape and a model of the motion. A key processing step with range data is registration: the process of aligning frames to reconstruct the complete surface. This problem has been solved for static objects, but it remains unsolved for moving objects that can take different poses in each scan.
In this project, we develop algorithms to reconstruct both a surface and

a motion model from a set of range scans. We assume that the object stays rigid during each scan but is allowed to move to a different pose between scans. Our approach to solve the modeling problem is to assume a certain motion model for the shape that captures all possible motions that we expect. We then solve for the model parameters to best predict the observed range scan data. Finally, the goal is to use the reconstructed model for re-posing and animating the shape. This approach promises to vastly simplify the task of generating detailed and realistic animations of complex deforming shapes.

Research staff: Will Chang, Matthias Zwicker

Interactive Motion Synthesis for Character Animation

The goal of this project is to develop algorithms for interactive character animation. Synthesizing realistic motion of human characters is a core topic in computer animation and has broad applications in virtual reality for tele-collaboration and training, computer games, and movie production.
Many of the most successful character animation techniques are based on recombining fragments of motion capture data. Motion capture data records the motion of real people captured using special cameras. To reuse captured motion data to generate new animations, fragments of the captured data are organized in so-called motion graphs. In motion graphs each graph node corresponds to a pose, and potential transitions between poses correspond to arcs in the graph. They produce natural motions because they directly reuse captured motion data, and they can generate complex motions by concatenating a large number of motion fragments. In most systems, a user needs to provide a number of constraints to specify a motion. Based on the user constraints, motion synthesis is cast as a search problem. A search algorithm finds a path through the motion graph that satisfies the user constraints while minimizing some additional cost function. There are many variations of this scheme available in the literature, describing various ways to construct motion graphs, specify constraints, concatenate and interpolate motion fragments, etc. Because the complexity of searching for an optimal path through a motion graph is exponential to the connectivity of the graph and in the length of the desired motion sequence, it is challenging to apply these techniques for interactive applications.
In this project we develop efficient algorithms to synthesize character animations for interactive applications. Our approach is based on a bidirec-

tional search strategy for motion synthesis using motion graphs. Our goal is to improve the search efficiency while preserving the search quality. In addition, we develop intuitive user interfaces to allow animators to easily specify desired motions. Our approach builds on a sketching metaphor, where the user controls and edits the character animation by indicating desired motions using pen strokes.

Research staff: Wan-Yen Lo, Matthias Zwicker

Creating Hierarchical 3D City Models

This project deals with various aspects of 3D city modelling. Its goal is the development of a generic framework supporting the creation, management, analysis and visualization of 3D city models. A main problem is the acquisition of the underlying geometric data. Today several methods are known, but most of them are time-consuming and expensive. Thus methods that support semi-automatic generation of the model from various easy accessible data sources as e.g. city maps or cadastral data are being developed. Due to the different accuracies of the input data, a data model supporting multiple levels of detail as well as its refinement and abstraction is being worked out. Another problem is the automation of modelling geometric details of house fronts such as windows and doors. Here a rule-based approach for generating house fronts depending on various parameters is pursued. As an example application the development of the city of Bern as a function of time shall be visualized and animated.

Research staff: Thomas Buchberger

Reconstruction of Classical City Models

The principal practical goal of this project is to digitize a famous classical city model in the Historical Museum of Bern which shows Bern at about 1800. The intended result is a representation with little loss of information and close to a CAD model. More generally, we try to establish a generic pipeline for the digital reconstruction of city and similar models, offering a fairly automatic conversion from an initial point cloud to the final CAD representation. At the moment, our scan data consists of approximately 80 million points. A number of established and new techniques relating to point cloud editing and 3D reconstruction are being combined and enhanced, in particular registration methods, point cloud filtering (local and

global), automatic noise and error correction, terrain recognition, mesh repair, 3D edge detection, pattern recognition methods, and large data handling.

Research staff: Marc Hugi, Hanspeter Bieri

Introducing Stereo Effects into Cel Animations

Animated cartoons are an imaginative movie genre, often, but not only, made for children. Stereo effects could improve the visual impact of such movies, especially since children are an audience amenable to different visual experiences. New, 3D computer generated imagery (CGI) animations can directly be rendered in stereo, but old, classical cartoons cannot be converted that easily. The goal of our work is to introduce stereo effects into such cartoon animations. The necessary conversion should be easy to perform by an unexperienced user and should not require much user interaction.
In this project, we analyze the characteristics of cel animations and the differences between them and live action movies. As 3D reconstruction from single images or videos is a broad field of research, we mainly study the prominent methods to estimate depth information for a monocular video input (e.g. shape from shading, structure from motion, shape from texture, etc.) and their applicability to cel animations. We implement a conversion framework, define test cases and perform quality ratings of the visual 3D effect.

Research staff: Sonja Schär, Xiaoyi Jiang, Hanspeter Bieri, Simon Willi, Matthias Zwicker

3.4 Further Activities

Conference Chairs

Matthias Zwicker

- Co-Chair of the IEEE/EG International Symposium on Volume and Point-Based Graphics, 10 – 11 August, 2008, Los Angeles, CA, USA

Conference Program Committees

Matthias Zwicker

- ACM SIGGRAPH Symposium on Interactive 3D Graphics and Games, February 27 – March 1, 2009, Boston, MA, USA
- Eurographics Conference and Exhibition, March 30 – April 3, Munich, Germany
- Eurographics Symposium on Rendering, June 29 – July 1, Girona, Spain

Ph.D. Jury Memberships

Matthias Zwicker

- Barbara Yersin, Real-time motion planning, navigation, and behavior for large crowds of virtual humans, EPFL Lausanne, April 21, 2009
- Manmohan Chandraker, Global optimization for geometric 3D reconstruction, University of California, San Diego, July 17, 2009

Reviewing Activities

Matthias Zwicker

- Swiss National Science Foundation
- ACM Transactions on Graphics
- IEEE Transactions on Visualization and Computer Graphics
- IEEE Transactions on Circuits and Systems for Video Technology
- Computer Graphics Forum, The International Journal of the Eurographics Association

Invited Talks

Matthias Zwicker

- Effiziente Berechnung realistischer Computerbilder, Antrittsvorlesung, Inst. of Computer Science and Applied Math., University of Bern, November 18, 2008
- Efficiently rendering realistic images, School of Computer and Communication Sciences Seminar, EPFL Lausanne, February 9, 2009
- Computer graphics research at the Institute of Computer science and applied mathematics, ARTORG Center for Biomedical Engineering, University of Bern, February 24, 2009
- A meshless representation for light transport, ETH Zürich Visual Computing Lunch, March 3, 2009
- A meshless hierarchical representation for light transport, Computer Graphics Seminar, University of Zaragoza, Spain, March 9, 2009

3.5 Publications

Publications appearing before Prof. Zwicker joined the University of Bern are not listed.

Journal Publications

- William Chang and Matthias Zwicker: Range scan registration using reduced deformable models, Computer Graphics Froum (Proc. Eurographics), Vol. 28, Nr. 2, 2009

Conference Presentations

- William Chang and Matthias Zwicker: Constructing deformable shapes from range scans, Poster Presentation, Eurographics Symposium on Geometry Processing, Berlin, July 15 – 17, 2009

4 Research Group on Computer Networks and Distributed Systems

4.1 Personnel

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Scientific Staff:	M. Anwander*	Tel.: +41 31 511 2634 email: anwander@iam.unibe.ch
	M. Brogle*	Tel.: +41 31 511 2632 email: brogle@iam.unibe.ch
	Dr. K. Dolfus*	Tel.: +41 31 511 2639 email: dolfus@iam.unibe.ch (since April 2009)
	P. Hurni*	Tel.: +41 31 511 2640 email: Wälchli@iam.unibe.ch
	D. Milic*	Tel.: +41 31 511 2633 email: milic@iam.unibe.ch
	T. Staub*	Tel.: +41 31 511 2637 email: staub@iam.unibe.ch
	G. Wagenknecht*	Tel.: +41 31 511 2636 email: wagen@iam.unibe.ch
	M. Wälchli*	Tel.: +41 31 511 2638 email: Wälchli@iam.unibe.ch (until June 2009)

* with financial support from a third party

4.2 Overview

The research group for Computer Networks and Distributed Systems (Rechnernetze und Verteilte Systeme, RVS) has been active since 1998 in several areas of computer communications and distributed systems.

Multimedia Communications The Internet is increasingly being used for multimedia data transfer (audio, video, data). We are investigating how services with high demands on the quality and reliability of communication systems and networks can be supported. Overlay networks and peer-to-peer systems are becoming more important for new Internet services, in particular to support communication within user groups. We are focusing on the design, development, and evaluation of methods to construct overlay networks supporting the quality-of-service requirements of distributed applications and using network resources efficiently.

Wireless and Mobile Communication Decentralized system architectures and self-organization are fundamental concepts of future wireless and mobile communication systems. These concepts are particularly important in application scenarios such as sensor networks, mobile ad hoc networks and wireless mesh networks. There is an urgent need for research on routing and transport protocols as well as on security and management mechanisms. In sensor networks, limited energy, computing and memory resources as well as limited reliability require special forms of distributed data processing and management.

Security in Distributed Systems The Internet simplifies access to distributed resources and services such as web services, e-learning contents, computer grids or sensor nodes. Traditional techniques for authentication and authorization are not very user-friendly and barely scalable. We investigate, design, implement, and evaluate novel schemes for efficient and secure authentication and authorization.

Distance Learning In all our lectures, we are using distance learning elements that are based on standard components but also on developments resulting from recent research projects. We are developing new methods and tools to support learners and teachers in e-learning environments. In particular, we aim to support practical experiments.

4.3 Research Projects

National Competence Center in Research for Mobile Information and Communication Systems (NCCR-MICS)

The NCCR-MICS (http://www.mics.ch) project was launched in 2001. Its goal is to study fundamental and applied research questions raised by new generation mobile communication and information services, based on self-organization. Such systems have become very topical with the advent of mobile ad-hoc, peer-to-peer, and sensor networks. The 2nd phase of NCCR-MICS is composed of more than twenty research projects distributed over four clusters. The research project of the RVS group on "Distributed event detection and localization architecture for wireless sensor networks" (IP4) aims at designing and implementing a distributed event detection, event localization, and event classification framework. It includes efficient and reliable signaling protocols as well as mechanisms to dynamically reconfigure its specific sensor network applications.
We investigated the classification of discrete events, computed on tiny wireless sensor nodes. Three different classifiers have been evaluated: a Bayesian classifier, a fuzzy logic controller, and a neural network approach. We assume that no a priori knowledge about the event classes is available and events are only observable as collections of raw sensor data. Accordingly, event classes need to be learned from that raw training data. In our work, event classes are learned by a k-means clustering algorithm. Any subsequent classifier training is based on these extracted event classes. Thus, the resulting classifiers are completely self-learning. Event classes are learned from emitted signal strength estimations, which are collected and processed by dynamically established tracking groups. The resulting event estimates are reported to a base station, where the classifiers are trained. The learned classifier parameters are then downloaded onto the sensor nodes, where any subsequent classification and filtering is performed.
Furthermore, we developed a node-level decision unit of a self-learning anomaly detection mechanism for office monitoring with wireless sensor nodes. The node-level decision unit is based on Adaptive Resonance Theory (ART), which is a simple kind of neural networks. The Fuzzy ART neural network used is an adaptive memory that can store a predefined number of prototypes. Any observed input is compared and classified in respect to a maximum number of M online learned prototypes. The Fuzzy ART neural network is used to process, classify, and compress time series of event observations on sensor node level. Based on simple computa-

tions, each node is able to report locally suspicious behaviour. A system-wide decision is subsequently performed at a base station. The system has been used for the detection and reporting of abnormal building access with a wireless sensor network. An office room, offering space for two working persons, has been monitored with ten sensor nodes and a base station. The task of the system is to report suspicious office occupation such as office searching by thieves. On the other hand, normal office occupation should not throw alarms. In order to save energy for communication, the system provides all nodes with some adaptive short-term memory. Thus, a set of sensor activation patterns can be temporarily learned. Unknown event patterns detected on sensor node level are reported to the base station, where the system-wide anomaly detection is performed. The anomaly detector is lightweight and completely self-learning. The system can be run autonomously or it could be used as a triggering system to turn on an additional high-resolution system on demand. Our building monitoring system has proven to work reliably in different evaluated scenarios. Communication costs of up to 90% could be saved compared to a threshold-based approach without local memory.
Moreover, research on sensor MAC and routing protocols for sensor-based distributed monitoring applications has been performed. Contention-based MAC protocols following periodic listen/sleep cycles face the problem of virtual clustering if different unsynchronized listen/sleep schedules occur in the network. Border nodes, which maintain all respective listen/sleep schedules, are required to interconnect these virtual clusters. This is however a waste of energy, if locally a common schedule can be determined. We propose to achieve local synchronization with a mechanism that is similar to gravitation. Clusters represent the material, whereas synchronization messages sent by each cluster represent the gravitation force of the according cluster. Due to the mutual attraction caused by the clusters, all clusters merge finally. Moreover, we developed a routing backbone construction mechanism that exploits and uses the synchronization messages exchanged by synchronized contention-based MAC protocols. Due to the usage of synchronization messages no additional control traffic is required to setup the routing backbone. Every node running a synchronized contention-based MAC protocol follows a given listen/sleep cycle. Because routing is supported by the backbone, non-backbone nodes can temporarily turn off their radios for multiple listen/sleep cycles. Thus, additional energy can be saved. Accordingly, non-backbone nodes do not have to wake up in every listen/sleep cycle to synchronize with other nodes, but wake up only if they have to report some sensor readings to a base station. In this case, they synchronize to the

backbone, send their data, and go back to sleep after successful transmission. Our approach is applicable to rather static networks with mainly source-to-sink traffic. Most monitoring applications are of this kind.

Research staff: Markus Wälchli, Reto Zurbuchen, Samuel Bissig, Torsten Braun

Financial support: Swiss National Science Foundation Project No. 5005-067322 and University of Bern

Mobile IP Telephony (MIPTel)

Wireless mesh networks (WMN) are evolving to an important access technology for wireless broadband services. They provide a cost efficient way to interconnect isolated networks as well as to enhance wireless network coverage. WMNs usually consist of static mesh routers and mobile or static mesh clients. Both support multi-hop communication and may act as routers. The mesh nodes might support multiple heterogeneous radio interfaces. WMNs offer a more robust and redundant communication infrastructure than many wireless networks deployed today. They provide communication facilities even in special situations where certain systems such as GSM are overloaded.
Our project aims at exploiting WMNs as an infrastructure for Mobile IP telephony. IP telephony requires short delays and moderate packet loss. In WMNs the quality of the routes may vary unpredictably because of the unreliable and erroneous wireless medium. Routes may break, if the network topology changes due to node or link failures. Links and nodes may become congested, which leads to larger delays or packet loss. This makes the deployment of a real time application such as IP telephony a challenging task.
We see two important approaches to improve the speech quality and to reduce outages in a Mobile IP telephony application in WMNs: path diversity and multi-stream coding. The characteristics of multiple paths are usually uncorrelated, i.e., the delay, jitter, and loss rate of the paths differ a lot from each other. Therefore, the transmission over multiple paths can be used to compensate for the dynamic and unpredictable nature of WMNs. In order to exploit this path diversity for improving the quality of the audio transmission, a robust multi-path routing protocol and a mechanism for selecting appropriate coding and path allocation for the given network conditions are needed.

ATOM (Adaptive Transport over Multipaths), which is an architecture to enable real-time communications in Wireless Mesh Networks, has been enhanced. ATOM reduces the problems of real-time transmissions over WMNs by using path diversity and multi-stream coding. At session establishment, ATOM decides on the used parameter set (encodings, paths etc.) considering current network conditions and collected historic data. After session establishment, the effect of this decision is continuously monitored and if necessary adapted.
Multi-stream coding is one of the key parts of the ATOM architecture. In order to evaluate video codecs, we have defined an video evaluation framework for the OMNeT++ simulator. At the source, a video file is transcoded by the open source library ffmpeg into streams with the defined codec/parameters and then transmitted through the simulated network. At the destination, the video is reconstructed from the received packets and then compared with the original file by quality metrics.
A heterogeneous real-world test bed has been established for the MIPTel project. The testbed consists of PCEngines Wireless Router Application Platform (WRAP), PCEngines ALIX, and Meraki Mini nodes. We tailored an embedded fully functional Linux with a small footprint to our three node types. The image build process is integrated in ADAM (Administration and Deployment of Adhoc Mesh networks). ADAM supports cross-compilation and individual build configuration for the three node types. The ADAM build and management system is highly modular and can be easily extended with additional software packages or ported to a new node type. It fully supports IPv6, flexible management nodes, and ad-hoc routing protocols. In addition, ADAM provides mechanisms for deployment and configuration a wireless mesh network. It guarantees the availability of the network despite configuration errors or faulty software updates by the mean of various fallback behaviors. It even provides a safe update of the operating system. ADAM has been selected as a candidate for the KuVS Communication Software award and has been presented to a wide audience at the KIVS conference.
We have revised VirtualMesh, which provides a virtualization of a complete wireless mesh network by using host virtualization (XEN) for the mesh nodes and redirecting their wireless network traffic to a network simulator. Our revisions include several performance enhancements and a new virtual wireless driver. For the Linux networking stack, the driver now behaves as a normal wireless driver although it is performing the traffic redirection to the simulator.
In addition, we have started the implementation of a temporary WMN based system to support video communication in large construction sites,

which faces the problem of missing communication facilities at the time of electric installation. By providing video communication over an "easy-to-install" temporary WMN, the requirement of costly on-site visits by an electrical engineer is reduced.

Research staff: Thomas Staub, Stefan Ott, Daniel Balsiger, Reto Gantenbein, Christine Müller, Daniel Balsiger, Simon Morgenthaler, Roger Strähl, Torsten Braun

Financial support: Swiss National Foundation Project No. 200020-113677/1

Efficient and Robust Overlay Networks (ERON)

The ERON projects aims at developing an efficient and robust overlay network. An overlay network is a virtual communication network built on top of an existing communication network such as the Internet. Overlay networks are used for different tasks such as routing of multicast messages. Since the full-mesh overlay network, in which every pair of participants is communicating directly with each other, is not scalable, overlay networks usually have other structures. One of the most important criteria for deciding, which overlay network participants get "connected" is the communication delay, since it is the limiting factor on the maximum effective bandwidth for the TCP connections. Similar to a full-mesh overlay network, measuring the communication delay between all overlay participants does not scale. To exploit the communication delay information, numerous communication delay prediction systems such as IDMaps, GNP, ICS, Vivaldi, S-Vivaldi etc. were developed. Most promising communication delay prediction systems are coordinates-based. In coordinates-based systems, communication partners are represented as points in an n-dimensional Euclidean space such that the distance function in that space predicts the communication delay.
In the last year, we have focused our research on building of topology aware overlay networks and assigning positions to end systems. The challenge of building an overlay network is the scalability. This means that the size of the overlay network should not be limited. If every end system participating in the overlay network would store the information about every other end system, the size of the overlay network would be limited by the memory available to end systems and this should be avoided. Instead, every end system should store a constant number of "neighbors" known to

him. This choice of neighbors is crucial for the performance of the overlay network. Most overlay networks choose the neighbors randomly or based on some criteria that does not correlate with the topology of the underlying network. For example, Chord chooses the neighbors in such a way, that the number of routing hops in the overlay network is minimized.
For building of an topology aware overlay network, we pursued the approach, where each end system should have a so called “fisheye view” of the overlay network. A “fisheye view” of the overlay network means that each end system makes a choice of limited number of neighbors in such a way, that this choice of neighbors resembles to a fisheye view. In this context, fisheye view means that the chosen neighbors are equally distributed in each direction around the end system (geographical diversity) and that the density of the neighbors decreases with increasing distance to the center of the view. As a result of our research, we were able to define a communication protocol that is able to build a fisheye view on each end system. We were also able to enhance this communication protocol in such a way, that the resulting graph of the overlay network is bi-directional. Having an overlay network that is a bi-directional overlay graph has an advantage that the graph is guaranteed to be connected. This means that there is at least one route for every pair of end systems participating in the overlay network. Simulations of our overlay network protocol have shown that the overlay network we create performs better than the overlay network created using another topology aware approach called binning in the terms of RTT stretch. Our approach for creating the overlay network does not require embedding of end systems into a virtual space. This makes it suitable for performing the embedding of end systems into a virtual space. After evaluating different methods, we have decided to an existing approach named VIVALDI as the basis for the embedding and to improve it. The main drawback of VIVALDI is its instability. Namely, in VIVALDI hosts tend to permanently change their positions even if the RTTs in the network do not change. Our improvements of VIVALDI included using our fisheye overlay network. We also improved VIVALDI in the sense of changing how end system changes its position. Both improvements combined resulted in an approach we named NetICE9. Our evaluation of NetICE9 has shown, that NetICE9 outperforms VIVALDI both in terms of precision of RTT embedding and stability of the end system positions. At the same time NetICE9 also performs better in terms of RTT embedding precision compared to GNP.
We also showed that our proposed approach for exploiting statistical properties of performed measurements of RTTs results in worse RTT predictions. Hence, we will not continue pursuing this idea.

Research staff: Dragan Milic, Roger Strähl, Torsten Braun

Financial support: Swiss National Foundation Project No. 200021-109270/1

E-learning in Distributed Data Network Laboratory (Edinet)

Edinet (http://www.svc-edinet.eu) is a multilateral cooperation project in the 'Lifelong Learning Programme' of the European Commission. Its objectives are to a) analyse common pedagogical principles for blended learning (blended learning include several forms of learning tools) based on common understanding as a ground for curriculum development and implementation; b) promote virtual mobility by implementation of semi-virtual campus (a virtual campus where actually studies will be done with real equipment via network connections); c) enhance open education resources by sharing, integrating, and mutually improving local resources (including knowledge) and best practices by establishing a semi-virtual campus; and d) to promote the usage of expensive laboratory environment through an innovative blended eLearning system in the field of data network technology.

Our research group is mainly involved in two work packages. For the Edinet infrastructure we have developed the Authentication and Authorization Infrastructure (AAI). We have established a European AAI federation for Edinet, which is comparable and compatible to the SWITCHaai. This includes the creation of a software package and an installation guide for an identity provider (IdP) as well as supporting partners during setup and maintenance. In addition, we integrated the existing IdP of the University of Bern in the Edinet federation (multi-federated IdP).

An e-learning module on TCP congestion control has been developed and several contributions to other work packages like for the pedagogical framework of the Edinet virtual campus have been provided.

Research staff: Markus Anwander, Thomas Staub, Torsten Braun

Financial support: Staatssekretariat für Bildung und Forschung SBF, LLP/Erasmus, Edinet, SBF-No. LLP/07/06-E

Energy-efficient Management of Heterogeneous Wireless Sensor Networks

This project investigates efficient and reliable communication mechanisms for the operation of a wireless sensor network (WSN) management framework. Reliable and robust transport protocols are needed to distribute operating system / application level code and node parameters efficiently as well as to solicit specific node information.

ESB, tmote SKY, BTnodes and micaZ nodes have been chosen to build a heterogeneous sensor network. For the backbone a Wireless Router Application Platform Board (WRAP) has been selected. The mesh network allows to interconnect WSNs with sensor nodes of different types.

In order to realize such interconnection between the WSN and an external network without any proxies or middle-boxes, we propose to use TCP/IP as the standard protocol for all network entities, e.g., for configuration and uploading application code to the sensor nodes. We developed the TSS (TCP Support for Sensor Nodes) protocol, which enables using TCP in wireless sensor networks. TCP/IP allows to connect a WSN to other networks such as the Internet. Thus, a user can monitor, control and manage WSNs remotely. The TSS protocol is located between IP and TCP. It contains a number of mechanisms, such as caching packets, local retransmission, aggressive acknowledgment regeneration and recovery. Packets are cached on intermediate nodes on the path from the sender to the receiver. In case of a lost packet a end-to-end retransmission is avoided. This reduces the number of transmitted packets and thus energy consumption. In case of lost acknowledgment packets the intermediate node can regenerate the acknowledgment to avoid unnecessary retransmissions.

We developed a MAC protocol called BEAM (Burst-enabled Energy-Efficient Adaptive MAC) implementing the MAC layer of nonbeacon-enabled personal area networks defined in the IEEE 802.15.4 standard for peer-to-peer topologies. It provides multihop communication and is the first implementation in this way. The MAC protocol holds a buffer of configurable size to store the incoming frames from the lower layer (radio transceiver) and the upper layers (H2HR). To ensure a reliable hop-to-hop transmission we use explicit acknowledgments and implicit acknowledgments. The energy efficiency is ensured using adaptive duty cycles.

A good way to support end-to-end reliability is to ensure hop-to-hop reliability between two neighbor nodes. We developed the H2HR (Hop-to-Hop Reliability) protocol. Informed by the MAC protocol, H2HR reacts on two different kinds of problems. A packet can be lost due to interferences or

due to congestion. If a packet has been transmitted, but there are no implicit or wxplicit acknowledgements, the packet is considered lost due to interferences by a hidden node. In this case the transmission is retried immediately. If the transmission has failed, because the channel is busy, congestion is detected. H2HR initiates the retransmission after a random time.

To optimize the performance of the protocols interchanging cross layer information is necessary. Thus, we designed a cross layer interface. Every protocol can subscribe for information from another protocol. Thus, protocols on different layers can better collaborate. For example, the physical layer can provide additional information about the transmissions. The radio transceiver provides information about the channel and the signal to the MAC protocol, which decides whether a frame can be transmitted to a neighbor node. The MAC and the H2HR protocol exchange information about retransmission state of a frame. This information is important for reliability and congestion control mechanisms.

The protocols have been implemented in the OMNeT++ simulator and evaluated with several scenarios. We compared a pure TCP and UDP implementation and a TCP and UDP implementation with H2HR. To compare our approach with with other related work, we implemented RMST as well and compared the performance using H2HR. Our simulations showed that in general, hop-to-hop reliability mechanisms affect the performance of TCP, UDP, and RMST significantly in WSNs.

In management scenarios such as code updates is it necessary to transmit the same data to many sensor nodes. Multicast communication on transport layer would reduce the amount of transmitted packets. We implemented SNOMC (Sensor Node Overlay Multicast) protocol which realize a source driven decentralized multicast scheme. Thus, the number of transmitted packets is decreased significantly. As less packets are in the network at the same time as less interferences and less packet loss can occur. Thus less packets have to be retransmitted and the transmission time decreases significantly as well.

Research staff: Markus Anwander, Gerald Wagenknecht, James Matheka, Simon Morgenthaler

Financial support: Hasler Foundation under grant number ManCom 2060 and the Swiss National Science Foundation under grant number 200020-113677/1

Wireless Sensor Network Testbeds (WISEBED)

The *WISEBED* project (http://www.wisebed.eu) started in June 2008. It aims is to provide a multi-level infrastructure of interconnected testbeds of large-scale wireless sensor networks for research purposes, pursuing an interdisciplinary approach that integrates the aspects of hardware, software, algorithms, and data. In the *WISEBED* project, researchers are implementing recent theoretical results on algorithms, mechanisms and protocols. The project intends to later make these distributed laboratories available to the European scientific community, so that other research groups will take advantage of the federated infrastructure. Our research group is involved as task leaders in several work packages.

Within WP1 (*Hardware Installation*) we have been installing a persistent testbed of 20 TelosB sensor nodes, using a backbone of 10 mesh nodes. The sensor/mesh nodes network spans over 5 floors of the building Neubrückstrasse 10. The 20 TelosB sensor nodes are attached via USB cables to the USB ports of the mesh node, which also forms the power supply for the TelosB nodes.

Within WP2 (*Testbed operation, access, and management*) we have designed and implemented a first prototype of a Testbed Architecture for Wireless Sensor Networks (TARWIS), an experiment and testbed management system for wireless sensor network testbeds. TARWIS is currently running on our WISEBED portal server and hosts a web-based user interface over which each user of the WISEBED project can operate the testbed. The TARWIS server component prepares and controls the experiment execution steps and connects to the individual sensor nodes. The system has been designed to remain independent of the type and the operating system of the sensor nodes, but relies on a set of APIs to access the sensor nodes and obtain experiment data. During the next project phase, each partner will start integrating the TARWIS system at their testbed site.

Real-world environmental data is of major importance for significant simulation results. The idea of the sub-task *Producing traces for hardware* of WP4 is to feed recorded data back into the simulator. Together with the WISEBED project partners, UBERN is in the process of defining a common data representation language WiseML.

Research staff: Philipp Hurni, Markus Anwander, Gerald Wagenknecht, Torsten Braun

Financial support: EU project ICT-2008-224460

Traffic Adaptivity in Wireless Sensor Networks

Energy efficiency is a major concern in the design of Wireless Sensor Networks (WSNs) and their communication protocols. As the radio transceiver typically accounts for a major portion of a WSN node's power consumption, researchers have proposed Energy-Efficient Medium Access (E^2-MAC) protocols that switch the radio transceiver off for a major part of the time. Today's E^2-MAC protocols are able to deliver little amounts of data with a low energy footprint, but introduce severe restrictions with respect to throughput and latency. Regrettably, they yet fail to adapt to varying traffic loads and changing requirements of the imposed traffic load.

Strong restrictions with respect to throughput and latency may be tolerable in networks with low quality of service requirements. However, many event-based scenarios require reasonable quality of service during short periods of intense activity, and a high energy-efficiency and lower quality of service during long periods of inactivity. Such scenarios can be found e.g. in monitoring systems for the healthcare system, in disaster-aid-systems, but also in the broad area of environmental monitoring. Varying, temporarily high traffic can further be expected to appear in the emerging field of multimedia sensor networks WMSNs. Once an event has been triggered, e.g., a patient's pulse monitor registering anomalies in a hospital or geriatric clinic, the MAC protocol's primary objective should shift towards delivering good quality of service (high throughput, low delay) rather than saving energy. In such scenarios, today's existing E^2-MAC protocols do not provide reasonable flexibility, as most of them were designed under the assumption of very sparse low-rate traffic.

The issue of E^2-MAC protocol adaptivity with respect to changing traffic load has yet only been used as an ambiguous but popular buzzword in many WSN studies. There is no consistent notion of how to assess or measure traffic adaptivity. We have defined a notion of *traffic adaptivity* in the context of E^2-MAC protocols as *the ability of the protocol to dynamically and autonomously react to changing traffic requirements with (de)allocation of the respective resources needed to handle the imposed traffic with adequate quality of service at run-time*. We have introduced a tri-partite metric to quantify the *traffic-adaptivity* of an E^2-MAC protocol, and applied this metric to experimental results of a selection of today's E^2-MAC protocols.

We have further explored the design space of today's most frequently cited E^2-MAC protocols with respect to their ability to react to changing traffic conditions in state-of-the art network simulation environments. By comparing against an idealized concept of an E^2-MAC protocol, we have shown how far today's E^2-MAC protocols still are from the goal of being able to truly allocate the radio transceiver in an *on-demand manner*. Many of todays E^2-MAC protocols exhibit a very high energy-efficiency - some of them yet come close to the theoretic lower bounds. This gain in efficiency however comes at the cost of severely restrained maximum throughput, as well as massively increasing end-to-end packet latency.
We envisage advance towards an E^2-MAC protocol that is able to achieve a very high efficiency in case of low traffic, but that is capable to adapt its behavior in case of higher traffic. In such situations, E^2-MAC protocol should be able to exploit the entire channel capacity and achieve a throughput that is similar to that of energy-unconstrained CSMA. Such a maximally-adaptive behavior would be very advantageous in many event-based WSN application scenarios, and would constitute a real novelty in the design space of E^2-MAC protocols.

Research staff: Philipp Hurni, Torsten Braun

Wireless Mesh Networks for Interconnection of Remote Sites to Fixed Broadband Networks

This technology transfer project intends to evaluate the usefulness and feasibility of wireless mesh networks (WMNs) in meteorological monitoring applications. We try to identify application and usage scenarios for WMNs. We investigate whether and how the used hardware and software components are appropriate for the intended application scenarios and whether the application requirements such as bandwidth, delay, reliability, recovery times etc. can be met. Potential weaknesses and bottlenecks will also be identified.
We investigate whether wireless mesh networks (WMNs) are appropriate for connecting sensor networks or other devices deployed in remote areas, where no fixed network access is available, to a fixed broadband network. To support a variety of application scenarios, the WMN must meet reliability requirements and bandwidth in the 10 Mbps range over distances of several 10 km, e.g., by using directional radio transmission. During the project a WMN based on IEEE 802.11a/h (5 GHz) has to be deployed in

the area of Neuchâtel and Payerne.
Our three industry partners have manifold interests in the project. MeteoSwiss, the operator of the meteorological network of Switzerland, has approximately 130 weather stations (distances between them are 30 km in average) with environmental sensing equipment deployed all over Switzerland. WMNs are a possibility to interconnect weather stations or even some sensors with an own broadband network. WMNs would allow SWITCH, the provider of the Swiss national research and education network, to extend the geographic coverage of their fiber network and to offer broadband services to further locations that are not close to the fiber network. PCEngines provides us with their mesh nodes and expect to extend its business with the results.
For the project we have mounted one mesh node on the roof of the University of Neuchâtel and another mesh node on the roof of SwissMeteo at Payerne. Intermediate nodes equipped with solar equipment (panels, chargers, and batteries) have been placed on the hills in the area to interconnect Payerne with the fiber network in Neuchâtel.
The network has been first tested on a small area in front of the weather station. Afterwards, the nodes have been moved to their final locations. First measurements show the necessity of a careful selection of the node locations, a good alignment of the antennas, and a strong tensioning of the antenna masts. In addition, aspects like birds using masts as raised blinds, storms, and the subsidence of tripod due to rain have to be considered during the deployment.
With the experiences gained from the deployment, we are now able to easily dimension further outdoor wireless mesh networks (approved equipment, possible distances, planning and setup time).

Research staff: Thomas Staub, Markus Anwander, Marc Brogle, Torsten Braun

Financial support: Swiss Commission for Technology and Innovation under grant number 9795.1 PFES-ES and the industry partners (SwissMeteo, SWITCH, and PCEngines)

Testbed for Mobile and Internet Communications

Our research group maintains its own testbed network for various purposes. The testbed is used to build networks of experimental routers and end systems in order to be able to evaluate the behavior of new networking

procedures and architectures in a realistic environment. The testbed also forms a productive network of Linux PCs and provides the storage capacity and CPU power for many of the RVS group's projects. The ERON project for example uses the available CPU power to compute embeddings of network distances into Euclidean space. An educational laboratory network for students' training is also connected and being extended by the OSLab project. The RVS group also takes part in PlanetLab (http://planet-lab.org), an open platform for developing, deploying, and accessing planetary-scale services. For this purpose we are hosting four PlanetLab nodes in our testbed network. The RVS group owns a number of sensor nodes: Embedded Sensor Board (ESB), Modular Sensor Board (MSB), tmote SKY nodes, BTnodes, TelosB nodes, and micaZ nodes. A testbed consisting of multiple mesh nodes (17 x PCEngines WRAP, 10 x Meraki Mini, 6 x PCEngines ALIX) has been deployed throughout the building and work environment of the research group. In this testbed, multi-channel communication, multi-path routing and the management framework ADAM have been evaluated. The testbed is currently used by several student projects.

Research staff: All members of the RVS research group

4.4 Ph.D. Theses

- Markus Wälchli: Distributed Event Detection in Wireless Sensor Networks, May, 2009

4.5 Master and Diploma Theses

- Daniel Balsiger: Administration and Deployment of Wireless Mesh Networks, April, 2009
- Reto Zurbuchen: Backbone Construction Based on Sync-Messages and Energy-Savings in Wireless Sensor Networks, March, 2009

4.6 Bachelor Theses and Computer Science Projects

- Stefan Ott: Experimental Evaluation of Multi-Path Routing in a Wireless Mesh Network Inside a Building, February, 2009

- Abdalla Hassan: Simulations on Multipath Routing Based on Source Routing, August, 2008

4.7 Further Activities

Memberships

- Chair of ERCIM working group on eMobility (Torsten Braun)
- Secretary General of ERCIM working group on eMobility (Marc Brogle)
- Erweitertes Leitungsgremium Fachgruppe “Kommunikation und Verteilte Systeme”, Gesellschaft für Informatik (Torsten Braun)
- Integration Coordination Board and Steering Committee of EU IST project Wisebed (Torsten Braun)
- SWITCH Stiftungsrat (Torsten Braun)
- SWITCH Stiftungsratsausschuss (Torsten Braun)
- Kuratorium Fritz-Kutter-Fonds (Torsten Braun)
- Expert for Diploma Exams at Fachhochschule Bern (Torsten Braun)

Editorial Boards

Torsten Braun

- Editorial Board of Elsevier’s Computer Communications Journal
- Editorial Board of Elsevier’s Computer Networks Journal
- Editorial Board of Informatik Spektrum / Springer-Verlag
- Editorial Board of Journal of Internet Engineering (Editor in Chief)

Conference Chairs

- General Chair of 3rd ERCIM Workshop on eMobility, May 27-28, 2009, University of Twente, The Netherlands (Torsten Braun)
- TPC Co-Chair of 3rd ERCIM Workshop on eMobility, May 27-28, 2009, University of Twente, The Netherlands (Marc Brogle)
- TPC Chair of 2nd International Workshop on OMNeT++ (OMNeT++ 2009) , March 6, 2009, Rome, Italy (Torsten Braun)

Conference Program Committees

Torsten Braun

- 5th International Wireless Communications and Mobile Computing Conference (IWCMC 2009), Leipzig, Germany, June 21–24, 2009
- IEEE International Conference on Communications (ICC 2009), Dresden, June 14–18, 2009
- 2nd International Workshop on Sensor Network Engineering (IWSNE'09), Marina Del Rey, CA, USA, June 10, 2009
- 4th IEEE Workshop on advanced EXPerimental activities ON WIRELESS networks & systems (EXPONWIRELESS09), Kos, Greece, June 15, 2009
- 11th IFIP/IEEE International Symposium on Integrated Network Management (IM 2009), Long Island, NY, USA, June 1–5, 2009
- 3rd GI/ITG KuVS Workshop on the Future Internet, Munich, Germany, May 28, 2009
- 7th International Conference on Wired / Wireless Internet Communications (WWIC 2009), University of Twente, The Netherlands, May 27–29, 2009
- 8th IFIP Networking 2009, Aachen, Germany, May, 11–15, 2009
- 16. ITG/GI - Fachtagung Kommunikation in Verteilten Systemen (KiVS 2009), Kassel, Germany, March 2–6, 2009
- 1st Workshop on Overlay and Network Virtualization, in conjunction with KiVS 2009, Kassel, Germany, March 6, 2009

- 5th Workshop on Mobile Ad-Hoc Networks (WMAN 2009) in conjunction with KiVS 2009, Kassel, Germany, March 6, 2009
- 6th European Conference on Wireless Sensor Networks (EWSN 2009), Cork, Ireland, February 11–13, 2009
- 4th IEEE Conference on Wireless Communication and Sensor Networks (WCSN 2008), Allahabad, India, December 27-29, 2008
- 1st Workshop on Wireless Broadband Access for Communities and Rural Developing Regions - WIRELESS4D'08, Karlstad University, Sweden, December 11–12, 2008
- 4th IEEE Broadband Wireless Access Workshop, New Orleans, LA, USA, November 30 - December 4, 2008
- IEEE Global Communications Conference 2008 (GLOBECOM 2008), New Orleans, LA, USA, November 30 - December 4, 2008
- 11th Asia Pacific Network Operations and Management Symposium (APNOMS 2008), Bejing, China, October 22–24, 2008
- 33rd IEEE Conference on Local Computer Networks (LCN 2008), Montreal, Quebec, Canada, October 14–17, 2008
- 2nd IEEE International Workshop on Enabling Technologies and Standards for Wireless Mesh Networking (MeshTech'08), Atlanta, GA, USA, September 29, 2008
- 16th IEEE LAN/MAN Workshop on Local and Metropolitan Area Networks (LANMAN 2008), Cluj-Napoca, Transylvania, Romania, September 3–6, 2008
- 34th EUROMICRO Conference on Software Engineering and Advanced Applications (SEAA), Parma, Italy, September 3–5, 2008
- 8th IEEE International Conference on Next Generation Wired/Wireless Networking (NEW2AN 2008), St. Petersburg, Russia, September 3–5, 2008
- 17th International Conference on Computer Communications and Networks (ICCCN 2008), St. Thomas, Virgin Islands, USA, August 3–7, 2008

Ph.D. Jury Memberships

Torsten Braun

- Licentiate Thesis, Marcel Cavalcanti de Castro, Karlstads University

Reviewing Activities

Torsten Braun

- IEEE Journal on Selected Areas in Communications
- IEEE Network Magazine
- IEEE Transactions on Network and Service Management
- IEEE Transactions on Parallel and Distributed Systems
- Mobile Networks and Applications, Springer
- Simulation: Transactions of the Society for Modeling and Simulation International
- Research Council of Norway
- Swiss National Science Foundation
- Qatar National Research Fund
- Vinnova, Sweden
- Royal Melbourne Institute of Technology

Invited Talks and Tutorials

- Thomas Staub: Telematiknetze, Kaderkurs Telematik, Bundesamt für Bevölkerungsschutz, May 12, 2009, Schwarzenburg, Switzerland
- Thomas Staub: Réseaux de communications, cours de cadres pour chefs de la télématique, Office fédéral de la protection de la population, November 25, 2008, May 12, 2009, Schwarzenburg, Switzerland
- Thomas Staub, Torsten Braun: Wireless Mesh Networks for Meteorological Monitoring (SAHNS 2009), Keynote Talk, July 26, 2009, Montreal, Canada

- Torsten Braun: Telematiknetze, Kaderkurs Telematik, Bundesamt für Bevölkerungsschutz, November 25, 2008, May 26, 2009, Schwarzenburg, Switzerland
- Cognitive Wireless Mesh Networks, Dagstuhl Seminar Architecture and Design of the Future Internet, April 16, 2009, Schloss Dagstuhl, Germany
- Energy-efficient and Adaptive Protocols for Wireless Sensor Networks, Computer Science Colloquium, June 3, 2009, Karlstad, Sweden
- Quality-of-Service in Overlay Multicast, Dagstuhl Seminar Bandwidth on Demand, February 10, 2009, Schloss Dagstuhl, Germany
- Optimizing Communication Protocols for Wireless Sensor Networks, Queensland University of Technology, December 18, 2008, Brisbane, Australia
- Optimizing Routing and MAC Protocols for Wireless Sensor Networks, NICTA, December 15, 2008, Sydney, Australia
- Effiziente und adaptive Kommunikationsprotokolle für drahtlose Sensornetze, Informatikkolloquium, RWTH Aachen, May 4, 2009, Aachen, Germany
- Energy-efficient Protocol Design in Wireless Sensor Networks, Tutorial at PIMRC 2008, September 15, 2008, Cannes, France

Organized Events

- Organizing a Computer Science Summer School seminar together with the TNS group of University Fribourg and the IIUN of University Neuchâtel, at Münchenwiler, Switzerland, June 10–12, 2009

Awards

- Communications-Software-Award (Communications-Software-Preis für die beste “Software aus einem KMU, einem Forschungsprojekt an einer Hochschule oder einem Forschungsinstitut”), awarded by the GI/ITG Fachgruppe “Kommunikation und Verteilte Systeme” (KuVS) for the Multicast Middleware to Marc Brogle, Dragan Milic and Torsten Braun.

4.8 Publications

Publications submitted in the academic year 2008/2009 and appearing in 2009/2010 or later are not listed.

Books

- Y. Koucheryavy, G. Giambene, D. Staehle, F. Barcelo-Arroyo, Torsten Braun, V. Siris: Traffic and QoS Management in Wireless Multimedia Networks, Lecture Notes in Electrical Engineering, Vol. 31, June, 2009, Springer, ISBN 978-0-387-85572-1

- Marc Brogle, Geert Heijenk, Torsten Braun, Dimitri Konstantas: Proceedings of the Third ERCIM Workhop on eMobility, University of Twente, Enschede, The Netherlands, May 27 - 28, 2009, ISBN 978-90-365-2846-7

- Torsten Braun, Michel Diaz, Jos Enrquez Gabeiras, Thomas Staub: End-to-End Quality of Service Over Heterogeneous Networks, August 14, 2008, Springer, ISBN 978-3-540-79119-5

Reviewed Journal and Conference Papers

- Gerald Wagenknecht, Markus Anwander, Torsten Braun: Hop-to-Hop Reliability in IP-based Wireless Sensor Networks - a Cross-Layer Approach, International Conference on Wired/Wireless Internet Communications 2009 (WWIC'09), Enschede, The Netherlands, Vol. 5546/2009, May 27 - 29, 2009, pp. 61-72, Springer LNCS, ISBN 978-3-642-02117-6

- Thomas Staub, Marc Brogle, Kurt Baumann, Torsten Braun: Wireless Mesh Networks for Interconnection of Remote Sites to Fixed Broadband Networks, Third ERCIM Workshop on eMobility, University of Twente, Enschede, The Netherlands, May 27 - 28, 2009, pp. 97-98, ISBN 978-90-365-2846-7

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- Philipp Hurni: Unsynchronized Energy-Efficient MAC and Routing in Wireless Sensor Networks, 16th bi-annual Conference on Communication in Distributed Systems (KiVS), Kassel, Germany, Vol. 17, March 2 - 6, 2009, pp. 321, Springer, ISBN 978-3-540-92665-8

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- Marc Brogle, Dragan Milic, Torsten Braun: Quality of Service for Peer-to-Peer based Networked Virtual Environments, P2P-NVE 2008 Workshop at the 14th IEEE International Conference on Parallel and Distributed Systems (ICPADS'08), Melbourne, Victoria, Australia, December 8 - 10, 2008, pp. 847-852, IEEE Computer Society, ISBN 978-0-7695-3434-3

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- Geoff Coulson, Barry Porter, Philipp Hurni et al: Report on the Implementation of the Software Infrastructure, WISEBED Deliverable D2.2, June, 2009

- Stefan Fischer, Dennis Pfisterer, Philipp Hurni et al: Design of the Hardware Infrastructure, Architecture of the Software Infrastructure, and Design of Library of Algorithms, WISEBED Deliverable D1.1, D2.1, and D3.1, December, 2008

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5 Research Group on Computer Vision and Artificial Intelligence

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Guests:	Prof. J. Csirik	University of Szeged, Szeged, Hungary August – December 2008

* with financial support from a third party

5.2 Overview

Since 1984, the FKI group has been working on various topics in pattern recognition, machine vision, and computational intelligence. One of the current subject areas is document image analysis and handwriting recognition, where we have recently extended our activities from pure off-line to both on-line and off-line data. Furthermore, we are working in the field of structural pattern recognition, where we aim at developing methods to extend and improve current algorithms for clustering and classification using non-vectorial object representations.

5.3 Research Projects

Document Image Analysis and Understanding

A variety of problems occurring in the context of document image analysis are being investigated. These include the processing and analysis of both machine printed and handwritten documents. Current focus is on handwriting recognition, particularly on general text recognition and the use of natural language processing techniques for both on-line and off-line handwriting data. Currently, the problem of text/non-text distinction in online documents and the application of handwriting recognition on mediaeval documents are studied. Furthermore, semi-supervised learning for handwriting recognition is under investigation. Some of these activities are carried out as part of the Swiss NCCR project “Interactive Multimodal Information Management Systems”. Others are part of the Swiss National Science Foundation Project “HisDoc: Historical Document Analysis, Recognition, and Retrieval”.

Research staff: V. Frinken, Dr. T. Ha-Minh, E. Indermühle, A. Fischer

Structural Pattern Recognition

Feature vectors are the predominant representation formalism in pattern recognition. Recently, however, non-vectorial representations, such as strings, trees and graphs, are becoming more and more popular for a number of reasons. But in contrast to vector spaces, the domain of symbolic data structures does not have a rich mathematical structure. Therefore, there is a severe lack of mathematical tools and algorithms for graph clustering and classification. In this project, we study a variety of issues, including efficient algorithms for graph matching, graph kernels, embedding of symbolic data structures in vector spaces, and the adaptation of concepts from vector representations to the domains of strings, trees, and graphs.

Research Staff: K. Riesen

5.4 Master Theses

- Wüthrich, M.: Automatic Recognition of Medieval German Manuscripts (September 2008)

- Fankhauser, S.: Suboptimale Berechnung von Graph- und Subgraphisomorphismen (April 2009)

5.5 Bachelor Theses

- Peter, T.: Classifier Combination For Handwritten Word Recognition (March 2009)
- Stolz, M.: Erweiterte Einbettung von Graphen in Vektorräume (September 2008)

5.6 Further Activities

Editorial Boards

H. Bunke

- Editor-in-Chief of *Electronic Letters on Computer Vision and Image Analysis*
- Member of the editorial board of the *International Journal of Pattern Recognition and Artificial Intelligence*
- Member of the editorial board of *Acta Cybernetica*
- Member of the editorial board of *Frontiers of Computer Science in China*
- Member of the advisory board of *Pattern Recognition*
- Editor-in-chief of the book series *Machine Perception and Artificial Intelligence* by World Scientific Publ., Singapore

Membership in Committees

H. Bunke

- Technical Program Chair “11th Int. Conf. on Frontiers in Handwriting Recognition”, Montreal, August 19 – 21, 2008
- Program Committee Member “13th Iberoamerican Congress on Pattern Recognition”, Havana, September 9 – 12, 2008

- Program Committee Member “8th IAPR Workshop on Document Analysis Systems”, Nara, Japan, Sepember 17 – 19, 2008
- Program Committee Member “19th Int. Conf. on Pattern Recognition”, Tampa, December 8 – 11, 2008
- Program Committee Member “7th IAPR Workshop on Graph-based Representations”, Venice, May 26 – 28, 2009
- Program Committee Member “4th Iberian Conf. on Pattern Recognition and Image Analysis”, Povoa de Varzim, Portugal, June 10 – 12, 2009
- Program Committee Member “8th Int. Workshop on Multiple Classifier Systems”, Reykjavik, June 10 – 12, 2009
- Program Committee Member “6th Int. Conf. on Machine Learning and Data Mining”, Leipzig, July 23 – 25, 2009
- Program Committee Member “Int. Workshop on Multilingual OCR”, Barcelona, July 25
- Program Committee Member “10th Int. Conf. Document Analysis and Recognition”, Barcelona, July 27 – 29, 2009
- Advisory Committee Member “12th Int. Workshop on Structural and Syntactic Pattern Recognition”, Orlando, December 4 – 6, 2008

Activities in National NCCR

H. Bunke

- Member of the individual project “Video Processing” of the NCCR Project IM2 (Interactive Multimodal Information Management Systems)
- Member of the Steering Commitee of the NCCR Project IM2

Additional Activities

H. Bunke

- Member Scientific Advisory Board of the German Research Center for Artificial Intelligence

5.7 Awards

At the 10th International Conference on Document Analysis and Recognition, Horst Bunke received the IAPR/ICDAR Outstanding Achievements Award “for his outstanding and continued contributions to research and education in handwriting recognition and document analysis, and services to the community”.

5.8 Publications

Books

- M. Liwicki, and H. Bunke. Recognition of Whiteboard Notes – Online, Offline and Combination. World Scientific, 2008.

Journal Publications

- R. Bertolami, and H. Bunke. Hidden Markov model based ensemble methods for offline handwritten text line recognition. Pattern Recognition, 41:3452–3460,2008.

- R. Bertolami, and H. Bunke. Integration of n-gram language models in multiple classifier systems for offline handwritten text line recognition. Int. Journal of Pattern Recognition and Art. Intelligence, 22(7):1301 - 1321, 2008.

- K. Riesen, and H. Bunke. Approximate graph edit distance computation by means of bipartite graph matching. Image and Vision Computing, 27(7):950–959, 2009.

- K. Riesen, and H. Bunke. Reducing the dimensionality of dissimilarity space embedding graph kernels. Engineering Applications of Artificial Intelligence, 22(1):48–56, 2009.

- A. Graves, M. Liwicki, S. Fernandez, R. Bertolami, H. Bunke, and J. Schmidhuber. A novel connectionist system for unconstrained handwriting recognition. IEEE Trans. PAMI, 31(5):855–869, 2009.

Papers in Refereed Conference Proceedings and Chapters in Edited Books

- M. Liwicki, and H. Bunke. Combining on-line and off-line BLSTM networks for handwritten text line recognition. Proc. 11th Int. Conf. on Frontiers in Handwriting Recognition, pages 31–36, 2008.

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- E. Indermühle, M. Liwicki, and H. Bunke. Recognition of handwritten historical documents: HMM-adaptation vs. writer specific training. Proc. 11th Int. Conf. on Frontiers in Handwriting Recognition, pages 186–191, 2008.

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- A. Schlapbach, F. Wettstein, and H. Bunke. Automatic estimation of the readability of handwritten text. Proc. 16th European Signal Processing Conference, 2008.

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- K. Riesen, and H. Bunke. Cluster ensembles based on vector space embeddings of graphs. In J.A. Benediktsson, J. Kittler, F. Roli, editors, Multiple Classifier Systems, Springer, LNCS 5519, pages 211–221, 2009.

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6 Research Group on Theoretical Computer Science and Logic

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6.2 Overview

The TIL research group (theoretical computer science and logic) focuses on theoretical computer science and mathematical logic, especially proof theory, computational logics and theory of computation. We have been dealing for many years with formal methods, analysis of deductions, general computations and, in particular, applications of mathematical logic to computer science. The three main subject areas are the following:

Computational Logic: Logical formalisms are perfectly suited to the specification of complex systems, the representation of knowledge and information, the description of processes (e.g. in distributed multi-agent systems) and for providing formal proofs of important system properties such as, for example, correctness and fairness. The research group has long been interested in the deductive, procedural and dynamic aspects of the corresponding formalisms and in the design of modern deductive systems. New approaches are being developed for information update purposes. In addition, the way in which simple, logical formalisms can be extended to become genuine multi-user systems taking into account the dynamic aspects of ontologies in the data mining context and in connection with the semantic web is being investigated.

Proof Theory: This research topic focuses on the development and analysis of formal systems of first and second order arithmetic, set theory and of what are known as logical frameworks (type and set theoretical, explicit, constructive, extensional, intentional). Our interests range from feasible subsystems of arithmetic to highly impredicative set and type theories and

deals with the interplay between constructive, recursive and operational approaches. In addition, abstract computations and computable knowledge are being investigated.

Reasoning under Uncertainty: This area covers researches on reasoning and decision under uncertainty both on the methodological and on the applicative sides. Reasoning is the process of deriving conclusions from given evidence, and these conclusions are then used as a basis for possible decisions. One of the main difficulties in this reasoning and decision-making process is the uncertainty often included in the available evidence. The goal in this research area is to define and implement formal methods to describe and represent all possible aspects of uncertainty. Most of the techniques rely on logical and probabilistic methods.

6.3 Research Projects

A Proof Theory for Modal Fixed Point Logics

Temporal logics are widely used to specify and verify the correctness of information systems when system reliability is crucial. Epistemic logics with common knowledge are important for reasoning about knowledge. Both types of logics are examples of modal fixed point logics. While these logics are well-understood semantically, our syntactic understanding of them is lacking. The state of proof theory for modal logics in general is widely recognised as unsatisfactory. For modal fixed point logics in particular there are no satisfactory cut-free sequent systems. Such systems generally are suitable for automated proof search and, together with their cut elimination procedures, can serve as a basis for declarative programming languages. We intend to address the problem of designing cut-free sequent systems for modal fixed point logics on two levels:

1. Whenever possible we plan to develop such systems together with syntactic cut elimination procedures. If possible, we aim for traditional sequent systems in Gentzen style, but if needed we will also employ ideas from richer proof theoretic formalisms such as the display calculus or deep inference.

2. On the other hand, if no cut-free systems exist for modal fixed point logics, we hope to gain a better understanding of why they do not exist. In this case we are interested in good syntactic approximations.

The development of a proof theory for modal fixed point logics is an important theoretical contribution to the understanding of inference and deduction in these logics, and thus in particular a relevant underpinning of specification and verification of information systems. It is central ground work concerning the procedural aspects of frameworks dealing with information.

Research staff: L. Alberucci, K. Brünnler, G. Jäger, R. Wehbe

Financial support: Hasler Foundation

Algebraic and Logical Aspects of Knowledge Processing

In this project, we employ and set up conceptual frameworks, in particular, theories relating classical mathematics with constructive mathematics and feasible mathematics. Thereby we always emphasize the computational properties and complexities of our formalisms. We use proof theory as our main tool for analyzing the constructive and computational content of various formalisms and aim at further exploiting the proofs as computations paradigm. Besides the traditional subsystems of first- and second-order arithmetic and (admissible) set theory, we will focus on theories of explicit mathematics, operational set theories, and theories of partial truth.

Research staff: G. Jäger, J. Krähenbühl, R. McKinley, D. Probst, D. Spescha, Th. Strahm

Financial support: Swiss National Science Foundation

Structural Proof Theory and the Logic of Proofs

The Logic of Proofs was developed by S. Artemov in the nineties in order to solve a problem posed by K. Gödel in the thirties. It is based on the notion of a so-called ”proof polynomial”, which allows to talk about proofs inside of the logical language. Because of that it has found numerous applications in the areas of epistemic logic, verification systems and foundations of functional programming languages. Epistemic logic is the study of knowledge. Here the Logic of Proofs allows to reason not only about knowledge, but also about the evidence from which we obtain the knowledge. Verification is used to ensure the correctness of computational

systems. Here the Logic of Proofs allows to reason about the correctness of the verifier itself. The Logic of Proofs also led to foundations of functional programming languages in which the execution itself can be part of the program, in a certain sense.
Even though the field has been growing rapidly, there still are areas which are not well understood. In particular, it is not known how to design proof polynomials for logics with so-called ”fixed points”. This is unfortunate, because this includes important logics such as epistemic logics with common knowledge and various temporal logics. Common knowledge is a central concept in epistemic logic. It describes the fact that not only everybody knows a fact, but also everybody knows that everybody knows this fact, and everybody knows that everybody knows that... and so on. That we should go at a green light and stop at a red light, for example, is common knowledge among car drivers. Temporal logics, on the other hand, can reason about time and are central in the verification of the correctness of computational systems.
The lack of proof polynomials for fixed points in particular means that there is no formal setting in which evidence-based knowledge and common knowledge can be studied together. Also, there is no evidence-based formal setting for reasoning about time. This is the first problem we want to attack.
Also, the relationship between proof polynomials and the so-called cut elimination is not well understood. Cut elimination is arguably the most important operation on proofs. Crudely speaking it transforms a short creative proof into one that is long and not creative. Among many other things this ensures that proofs can be found even without creativity, such as by a computer. The study of cut elimination in the presence of proof polynomials is the second problem we want to attack.

Research staff: K. Brünnler, S. Bucheli, R. Goetschi, G. Jäger, R. Kuznets

Financial support: Swiss National Science Foundation

Logic and Computation

This very general project deals with the close connections between mathematical logic and certain parts of computer science, and emphasis is put on a proof-theoretic approach to some of the central questions in this area

of research. These include the development of perspicuous and feasible logical frameworks for studying typical questions in computer science like termination and correctness of functional programs, properties of distributed systems and the like.
We study applicative theories as well as strongly typed formalisms and are interested in the connections to constructive and explicit mathematics. Furthermore, we are interested in analyzing the close connections between the complexities of computations and proofs in suitable formalizations, ranging from propositional calculi up to abstract frameworks for computations (in higher types).

Research staff: All members of the research group

Resource-Bounded Reasoning and Anytime Algorithms

Anytime algorithms are computational procedures for which the quality of the result improves gradually as computation time increases. They give the user the possibility to trade off computational resources against accuracy of the results. Anytime algorithms provide thus a flexible solution to the widespread problem of limited computational resources and are nowadays an emerging research topic in various areas. Of particular importance for this project is the field of real-time reasoning in intelligent knowledge-based systems.
The goal of the project is to analyze the foundations and properties of resource-bounded reasoning and anytime algorithms in intelligent systems more deeply. The project will study generic resource-bounded procedures in the framework of valuation algebras and develop corresponding methods in various specific formalisms such as Bayesian networks, Dempster-Shafer theory, or constraint satisfaction. The expected results will then be implemented and tested with respect to existing techniques, and their relevance to specific application domains will be evaluated.

Research staff: R. Haenni, J. Jonczy, M. Wachter

Financial support: Swiss National Science Foundation

6.4 Ph.D. Theses

- D. Steiner: Belief Change Functions for Multi-Agent Systems

- P. Stouppa: Deciding Data Privacy for ALC Knowledge Bases
- M. Wachter: Knowledge Compilation Map – Theory and Application

6.5 Master and Diploma Theses

- C. Larrzabal: Automatic Model Checking of UML models
- S. Liniger: The Basic Feasible Functionals in Bounded Arithmetic
- R. Traber: Proof-Systems for PLTL: Cycling Sequents and their Use in a Finitisation for PLTL

6.6 Bachelor Theses and Computer Science Projects

- J. Marti: Das Girard Paradox
- M. Pfeuti: The Logic of Justified Belief

6.7 Further Activities

Editorial Boards

- Member of the editorial board of Archive of Mathematical Logic (G. Jäger)
- Member of the editorial board of Logica Universalis (G. Jäger)
- Member of the consulting board of Dialectica (Th. Strahm)
- Member of the editorial board of International Journal of Approximate Reasoning (R. Haenni)
- Member of the editorial board of The Reasoner (R. Haenni)
- Member of the editorial board of Journal of Applied Logic, Special Issue on Probabilistic Logic and Probabilistic Networks (R. Haenni)

Technical and Research Committees

- Research Council Member of the Swiss National Science Foundation (G. Jäger)
- Member of the Steering Committee of the Platform Mathematics, Astronomy and Physics (MAP) of the Swiss Academy of Sciences (G. Jäger)
- Member of the Scientific Council of the European Association for Computer Science Logic (G. Jäger)
- PC Member, CSL 2009 (G. Jäger)
- Expert for Maturitätsprüfungen Mathematik (L. Alberucci, G. Jäger, D. Probst, Th. Strahm, Th. Studer)
- Secretary of the Swiss Society for Logic and Philosophy of Science (Th. Strahm)
- Swiss representative in the International Union of History and Philosophy of Science (Th. Studer)
- Program Committee member of the 4th European Workshop on Probabilistic Graphical Models 2008 (R. Haenni)

6.8 Publications

- L. Alberucci, Sequent calculi for the modal μ-calculus over S5, *Journal of Logic and Computation*, 2009
- L. Alberucci and A. Facchini, On modal μ-calculus and Gödel-Löb logic, *Studia Logica*, 2009
- L. Alberucci and A. Facchini, The modal μ-calculus hierarchy over restricted classes of transition systems, *Journal of Symbolic Logic*, to appear
- K. Brünnler, Deep sequent systems for modal logic, *Archive for Mathematical Logic*, 2009
- K. Brünnler, Modular sequent systems for modal logic, *Proceedings of Tableaux 2009*, 2009

- K. Brünnler and R. McKinley, An Algorithmic Interpretation of a Deep Inference System, *LPAR 2008*, 2008
- K. Brünnler and Th. Studer, Syntactic cut-elimination for common knowledge, *Annals of Pure and Applied Logic*, 2009
- K. Brünnler and Th. Studer, Syntactic cut-elimination for common knowledge (superseded by the journal version), *Proceedings of Methods for Modalities M4M5*, 2009
- R. Haenni, F. Cozman, J. W. Romeijn, F. Russo, G. Wheeler and J. Williamson, Combining Probability and Logic, *Journal of Applied Logic*, 2009
- R. Haenni, Non-Additive Degrees of Belief, *Degrees of Belief*, 2009
- R. Haenni, Probabilistic Argumentation, *Journal of Applied Logic*, 2009
- R. Haenni, Aggregating Referee Scores: an Algebraic Approach, *COMSOC'08, 2nd International Workshop on Computational Social Choice*, 2008
- R. Haenni, Editorial, *The Reasoner*, 2008
- R. Haenni, Interview with Arthur P. Dempster, *The Reasoner*, 2008
- R. Haenni, J. W. Romeijn, G. Wheeler and J. Williamson, Probabilistic Logic and Probabilistic Networks, *Technical Report, University of Kent Centre for Reasoning*, 2008
- G. Jäger, Operations, sets and classes, *Logic, Methodology, and Philosophy of Science: Proceedings of the Thirteenth International Congress*, to appear
- G. Jäger, Full operational set theory with unbounded existential quantification and power set, *Annals of Pure and Applied Logic*, 2009
- G. Jäger and J. Krähenbühl, Σ^1_1 choice in a theory of sets and classes, *Festschrift for Wolfram Pohlers*, to appear
- J. Jonczy and R. Haenni, Reliability Evaluation and Diagnostics with Propositional Directed Acyclic Graphs, *Technical Report, University of Bern*, 2009

- R. Kuznets, Self-Referential Justifications in Epistemic Logic, *Theory of Computing Systems*, 2009
- R. Kuznets, A Note on the Use of Sum in the Logic of Proofs, *Proceedings of Panhellenic Logic Symposium PLS7*, 2009
- R. Kuznets and S. Buss, The NP-completeness of reflected fragments of justification logics, *Proceedings of Symposium on Logical Foundations of Computer Science LFCS'09*, 2009
- R. Kuznets and S. Buss, Lower Complexity Bounds in Justification Logic, submitted
- R. Kuznets and S. Artemov, Logical Omniscience as a Computational Complexity Problem, *Proceedings of Theoretical Aspects of Rationality and Knowledge TARK XII*, 2009
- R. McKinley, The alpha-epsilon calculus, *Structures and Deduction 09*, submitted
- R. McKinley, On Herbrand's Theorem and Cut-Elimination, *Annals of Pure and Applied Logic*, submitted
- D. Spescha and Th. Strahm, Elementary explicit types and polynomial time operations, *Mathematical Logic Quarterly*, 2009
- P. Stouppa and Th. Studer, Data Privacy for ALC Knowledge Bases, *Proceedings of Logical Foundations of Computer Science LFCS'09*, 2009
- Th. Strahm, Weak theories of operations and types, *Festschrift for Wolfram Pohlers*, to appear
- Th. Strahm (ed.), Gödel's Dialectica Interpretation (Introduction), *Special Edition ed. Dialectica*, 2008
- Th. Studer, Privacy Preserving Modules for Ontologies, *Proceedings of Perspectives of System Informatics PSI'09*, to appear
- Th. Studer, Common knowledge does not have the Beth property, *Information Processing Letters*, 2009
- Th. Studer, On the proof theory of the modal μ-calculus, *Studia Logica*, 2008

7 Research Group on Software Composition

7.1 Personnel

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*with financial support from a third party

7.2 Overview

Complex software systems must continuously change if they are to remain useful. The Software Composition Group carries out research in (1) programming language design, and (2) software reengineering with the goal of facilitating the development of flexible, open software systems. In both cases we are investigating mechanisms and techniques that enable the graceful evolution of software systems by putting change at the center of the software process.

7.3 Research Projects

Bringing Models Closer to Code

Software models are notoriously disconnected from source code. At the start of a software development project, the emphasis is on eliciting system requirements and defining domain and architectural models. Once development commences, the original models become disconnected from the code that they describe. It becomes increasingly difficult to reestablish traceability links as crucial knowledge of design decisions and user features are implicit in the code.
In this project we investigate the problem of bringing models closer to code along several paths.

- *Hermion* is an IDE that integrates static and dynamic information concerning applications under development. In this way, the runtime model of the application is more closely tied to the static model of the source code.

- *Helvetia* is a framework for developing embedded domain specific languages that integrate with the tools of the host programming language. Helvetia has been used to develop a series of high-level domain specific languages that can be freely mixed with the host language, thus bridging the gap between code and domain models.

- *Pinocchio* is an open language system that provides reflective access to its entire implementation. Whereas conventional language implementations do not provide access to the virtual machine level, Pinocchio provides a high-level model to access to all aspects of its own implementation.

- *Reflectivity* is a framework providing fine-grained structural and behavioural reflection. We are using and extending Reflectivity to explore ways of embedding high-level requirements in code to automatically generate required behaviour in a context-dependent way. For example, instead of cluttering concurrent applications with synchronization code, we specify high-level safety and liveness constraints and generate the needed synchronization code where and when it is needed.

Research staff: All members of the research group.

Duration: Oct. 2008 – Sept. 2010

Financial support: Swiss National Science Foundation,
Project #200020-121594

For further details, please consult:
`http://scg.unibe.ch/research/snf08`

Analyzing, Capturing and Taming Software Change

In this project we investigated means to understand and enable the evolution of software systems.
Over the past year, we have refined our approach to partial behavioral reflection to exploit a runtime model of the source code. We have completed our infrastructure for object flow analysis to aid in the post-hoc development of unit tests for existing applications, and we have extended our support for object flow analysis to the virtual machine level, thus making novel applications such as back-in-time debuggers practical and efficient.
Furthermore, we have explored various ways of bringing information about the run-time behaviour of software entities and the long-term evolution of software to the developer, and we have begun to assess how well this information can support common developer tasks.

Research staff: All members of the research group.

Duration: Oct. 2006 – Sept. 2008

Financial support: Swiss National Science Foundation,
Project #200020-113342

For further details, please consult:
`http://scg.unibe.ch/research/snf06`

Enabling the evolution of J2EE applications through reverse engineering and quality assurance

Enterprise applications are complex software products that manipulate much persistent data and interacts with the user through a vast and complex user interface. Modern technologies, like Java 2 Platform Enterprise Edition (J2EE), that address this field rely of a conglomerate of technologies requiring implementations written in several languages (e.g., Java, XML or SQL).

In this context, simply applying existing reverse engineering and quality assurance techniques developed for object-oriented systems fails because these techniques focus only on the Java source code. This project aims to conduct a systematic study in reverse engineering and quality assurance of J2EE applications.
During the past year we worked together with an industrial partner on investigating problems that specific to J2EE. To analyze the code, we developed a meta-model that complements the Java code information with information present in the XML descriptors. We used this new information to detect problems like unsafe or unnecessary transactions.

Research staff: All members of the research group.

Duration: Oct. 2007 – Sept. 2010

Financial support: Hasler Foundation (project no. 2234).

For further details, please consult:
`http://scg.unibe.ch/research/hasler07`

7.4 Ph.D. Theses

- Adrian Lienhard. *Dynamic Object Flow Analysis*. Phd thesis, University of Bern, December 2008.

7.5 Master Theses

- Philipp Bunge. Scripting browsers with Glamour. Master's thesis, University of Bern, April 2009.
- Julien Fierz. Compass: Flow-centric back-in-time debugging. Master's thesis, University of Bern, January 2009.
- Matthias Junker. Kumpel: Visual exploration of file histories. Master's thesis, University of Bern, January 2009.
- Dominique Matter. Who knows about that bug? — automatic bug report assignment with a vocabulary-based developer expertise model. Master's thesis, University of Bern, June 2009.
- Anselm Strauss. Dynamic aspects — an AOP implementation for Squeak. Master's thesis, University of Bern, November 2008.

7.6 Bachelor Theses and Computer Science Projects

- Camillo Bruni. Development and debugging of a whole-system VM in RPython. Bachelor's thesis, University of Bern, January 2009.
- David Erni. JAG — a prototype for collective behavior in Java. Bachelor's thesis, University of Bern, August 2008.
- Daniel Langone. Recycling trees: Mapping Eclipse ASTs to Moose models. Bachelor's thesis, University of Bern, January 2009.
- Andrea Quadri. Sourcetalk, smalltalk code repository. Bachelor's thesis, University of Bern, December 2008.
- Dennis Schenk and Peter Siska. Archie — a statistics framework for Elexis. Informatikprojekt, University of Bern, March 2009.

7.7 Further Activities

Editorial Boards

Oscar Nierstrasz:

- Springer LNCS – SL2 – Programming Techniques and Software Engineering (Series Editor)
- ACM TOSEM – Transactions on Software Engineering and Methodology (Associate Editor)

Memberships

Oscar Nierstrasz:

- Springer LNCS (SL2 – Programming Techniques and Software Engineering) (Series Editor)
- SARIT – Swiss Association for Research in Information Technology (Board Member)
- AITO – Association Internationale pour les Technologies Objets (Member)

- CHOOSE – Swiss Group for Object-Oriented Systems and Environments (Board Member)
- ESEC – European Software Engineering Conference (Steering Committee Member)
- MoDELS – International Conference on Model Driven Engineering Languages and Systems (Steering Committee Member)
- SC – Software Composition Symposium (Steering Committee Member)
- Moose Association (Board Member)

Tudor Girba:

- CHOOSE – Swiss Group for Object-Oriented Systems and Environments (Treasurer)
- Moose Association (President)

Program Committees

Oscar Nierstrasz:

- PC Member of IWST09 (International Workshop on Smalltalk Technologies Colocated with ESUG 2009, Brest, France, Aug 31, 2009).
- PC Member of the ESEC/FSE 2009 Doctoral Symposium (At ESEC/FSE 2009, Amsterdam, The Netherlands, August 25, 2009).
- Program Chair of CASTA 2009 (Workshop on Context-Aware Software Technology and Applications Colocated with ESEC/FSE 2009, Amsterdam, The Netherlands, August 24, 2009).
- PC Member of RAM-SE 2009 (Workshop on Reflection, AOP and Meta-Data for Software Evolution, colocated with ECOOP 2009 Genova, Italy, July 7, 2009).
- PC Member of ECOOP 2009 (23rd European Conference on Object-Oriented Programming Genova, Italy, July 6-10 2009).
- PC Member of ETSM 2009 (First International Symposium on Emerging Trends in Software Metrics Colocated with XP 2009, Pula, Sardinia, Italy, May 26, 2009).

- PC Member of SUITE 2009 (First Intl. Workshop on Search-Driven Development Users, Infrastructure, Tools and Evaluation Colocated with ICSE 2009, Vancouver, Canada, May 16 2009).
- PC Member of Models@run.time (Colocated with Models 2008 Toulouse, France, Sept 28-Oct 3, 2008).
- PC Member of FAMOOSr 2008 (2nd Workshop on FAMIX and Moose in Reengineering Colocated with WCRE 2008 Antwerp, Belgium, Oct. 17, 2008).
- PC Member of OOPSLA Onward! 2008 (Object-Oriented Programming Systems, Languages and Applications Nashville, US, Oct. 19-23, 2008).

Tudor Gîrba:

- PC Member of IWST09 (International Workshop on Smalltalk Technologies Colocated with ESUG 2009, Brest, France, Aug 31, 2009)
- PC Member of MSR 2009 (Working Conference on Mining Software Repositories).
- PC Member of TOOLS 2009 (International Conference Objects, Models, Components, Patterns — Zurich)
- PC member of ENASE 2009 (International Conference on Evaluation of Novel Approaches to Software Engineering —)
- Co-organizer of FAMOOSr 2008 (2nd Workshop on FAMIX and Moose in Reengineering co-located with WCRE 2008).
- PC Member of WCRE 2008 (Working Conference on Reverse Engineering).
- PC Member of ICSM 2008 (International Conference on Software Maintenance — Beijing, China, Sept. 28 - Oct 4, 2008).
- PC Member of MODELS 2008 (International Conference on Model Driven Engineering Languages and Systems).
- PC Member of MCCM 2008 (International Workshop on Model Co-Evolution and Consistency Management - co-located with MODELS 2008).

- Tool Demonstration PC Member for ASE 2008 (International Conference on Automated Software Engineering 2008).

Adrian Kuhn:

- Co-organizer of SUITE 2009 (Workshop on Search-driven Development) at ICSE 2009, 16 May 2009, Vancouver, Canada.

Lukas Renggli:

- PC Member of IDM 2009 (L'Ingnierie Dirige par les Modles – Nancy, France, Mars 25 - 16, 2009)
- PC Member of IWST 2009 (International Workshop on Smalltalk Technologies – Brest, France, August 31, 2009)

Jorge Ressia:

- Co-organizer of CASTA 2009 (Workshop on Context-Aware Software Technology and Applications – co-located with ESEC/FSE 2009, August 24 2009, Amsterdam, The Netherlands.

David Röthlisberger:

- Co-organizer of PCODA 2008 (Workshop on Program Comprehension through Dynamic Analysis – co-located with WCRE 2008, Antwerpen, Belgium, Oct 16, 2008).

Reviewing Activities

Oscar Nierstrasz:

- Journal of Information and Software Technology (Elsevier)

Tudor Gîrba:

- EuroVis 2009 (Eurographics/IEEE Symposium on Visualization)
- SCP (Science of Computer Programming)
- SoSyM (Journal on Software & System Modeling)
- ECOOP 2009 (European Conference on Object-Oriented Programming)

Adrian Kuhn:

- CGF (Journal of the Eurographics Association)
- RAMSE 2009 (ECOOP Workshop on Reflection, AOP and Meta-Data for Software Evolution)
- ECOOP 2009 (European Conference on Object-Oriented Programming)
- SCICO (Journal of Science of Computer Programming), Elsevier
- EUROVIS 2009 (Eurographics/IEEE Symposium on Visualization)

Lukas Renggli:

- ECOOP 2009 (European Conference on Object- Oriented Programming).
- MODELS 2008 (International Conference on Model Driven Engineering Languages and Systems).

Jorge Ressia:

- ECOOP 2009 (European Conference on Object-Oriented Programming)

David Röthlisberger:

- SCP (Science of Computer Programming) Special Issue for ICPC 2008
- ECOOP 2009 (European Conference on Object-Oriented Programming)

Toon Verwaest:

- RAM-SE 2009 (Workshop on Reflection, AOP and Meta-Data for Software Evolution)
- ECOOP 2009 (European Conference on Object-Oriented Programming)

Invited Talks

Tudor Gîrba:

- Invited Speaker at Club Qualimetrié (The humane software assessment — Paris, France, July 9, 2009)

7.8 Publications

Books

- Serge Demeyer, Stéphane Ducasse, and Oscar Nierstrasz. *Object-Oriented Reengineering Patterns*. Square Bracket Associates, 2008.

Journal Papers

- Mariangiola Dezani-Ciancaglini, Paola Giannini, and Oscar Nierstrasz. A calculus of evolving objects. *Scientific Annals of Computer Science*, XVIII:63–98, 2008.

- Gisèle Douta, Haydar Talib, Oscar Nierstrasz, and Frank Langlotz. CompAS: A new approach to commonality and variability analysis with applications in computer assisted orthopaedic surgery. *Information and Software Technology*, 51(2):448–459, 2009.

- Stéphane Ducasse, Tudor Gîrba, Adrian Kuhn, and Lukas Renggli. Meta-environment and executable meta-language using smalltalk: an experience report. *Journal of Software and Systems Modeling (SOSYM)*, 8(1):5–19, February 2009.

- Adrian Lienhard, Stéphane Ducasse, and Tudor Gîrba. Taking an object-centric view on dynamic information with object flow analysis. *Journal of Computer Languages, Systems and Structures*, 35(1):63–79, 2009.

- Lukas Renggli and Oscar Nierstrasz. Transactional memory in a dynamic language. *Journal of Computer Languages, Systems and Structures*, 35(1):21–30, April 2009.

Conference Papers

- Sushil Bajracharya, Adrian Kuhn, and Yunwen Ye. Suite 2009: First international workshop on search-driven development - users, infrastructure, tools and evaluation. In *Software Engineering - Companion Volume, 2009. ICSE-Companion 2009. 31st International Conference on*, pages 445–446, 2009.

- Andrea Brühlmann, Tudor Gîrba, Orla Greevy, and Oscar Nierstrasz. Enriching reverse engineering with annotations. In Krzysztof Czarnecki et al., editor, *International Conference on Model Driven Engineering Languages and Systems (Models 2008)*, volume 5301 of *LNCS*, pages 660–674. Springer-Verlag, 2008.

- Camillo Bruni and Toon Verwaest. Pygirl: Generating whole-system vms from high-level prototypes using pypy. In *Objects, Components, Models and Patterns, Proceedings of TOOLS Europe 2009*, volume 33 of *LNBIP*, pages 328–347. Springer-Verlag, 2009.

- Stéphane Ducasse, Tudor Gîrba, Orla Greevy, Michele Lanza, and Oscar Nierstrasz. Workshop on FAMIX and Moose in software reengineering (FAMOOSr 2008). In *15th Working Conference on Software Maintenance and Reengineering (WCRE 2008)*, pages 343–344, October 2008.

- Adrian Kuhn. Automatic labeling of software components and their evolution using log-likelihood ratio of word frequencies in source code. In *MSR '09: Proceedings of the 2009 6th IEEE International Working Conference on Mining Software Repositories*, pages 175–178. IEEE, 2009.

- Adrian Kuhn, Peter Loretan, and Oscar Nierstrasz. Consistent layout for thematic software maps. In *Proceedings of 15th Working Conference on Reverse Engineering (WCRE'08)*, pages 209–218, Los Alamitos CA, October 2008. IEEE Computer Society Press.

- Adrian Lienhard, Julien Fierz, and Oscar Nierstrasz. Flow-centric, back-in-time debugging. In *Objects, Components, Models and Patterns, Proceedings of TOOLS Europe 2009*, volume 33 of *LNBIP*, pages 272–288. Springer-Verlag, 2009.

- Dominique Matter, Adrian Kuhn, and Oscar Nierstrasz. Assigning bug reports using a vocabulary-based expertise model of developers. In *MSR '09: Proceedings of the 2009 6th IEEE International Working Conference on Mining Software Repositories*, pages 131–140. IEEE, 2009.

- David Röthlisberger and Orla Greevy. Representing and integrating dynamic collaborations in IDEs. In *Proceedings of the 15th Working Conference on Reverse Engineering (WCRE 2008)*, pages 74–78, Los Alamitos, CA, USA, 2008. IEEE Computer Society.

- David Röthlisberger, Oscar Nierstrasz, Stéphane Ducasse, Damien Pollet, and Romain Robbes. Supporting task-oriented navigation in IDEs with configurable heatmaps. In *Proceedings of the 17th International Conference on Program Comprehension (ICPC 2009)*, pages 253–257, Los Alamitos, CA, USA, 2009. IEEE Computer Society.

- Andy Zaidman, Orla Greevy, Abdelwahab Hamou-Lhadj, and David Röthlisberger. Workshop on program comprehension through dynamic analysis (PCODA). In *Proceedings of IEEE 15th Working Conference on Software Maintenance and Reengineering (WCRE)*, pages 345–346, October 2008.

Book Chapters

- Oscar Nierstrasz, Marcus Denker, Tudor Gîrba, Adrian Lienhard, and David Röthlisberger. Change-enabled software systems. In Martin Wirsing, Jean-Pierre Banâtre, and Matthias Hölzl, editors, *Challenges for Software-Intensive Systems and New Computing Paradigms*, volume 5380 of *LNCS*, pages 64–79. Springer-Verlag, 2008.

- Oscar Nierstrasz, Marcus Denker, and Lukas Renggli. Model-centric, context-aware software adaptation. In Betty H.C. Cheng, Rogerio de Lemos, Holger Giese, Paola Inverardi, and Jeff Magee, editors, *Software Engineering for Self-Adaptive Systems*, volume 5525 of *LNCS*, pages 128–145. Springer-Verlag, 2009.

Technical Reports

- Camillo Bruni, Toon Verwaest, and Marcus Denker. Pygirl: Generating whole-system vms from high-level models using pypy. Technical Report IAM-09-002, University of Bern, Institute of Applied Mathematics and Computer Sciences, 2009.

- David Röthlisberger, Oscar Nierstrasz, Stéphane Ducasse, Damien Pollet, and Romain Robbes. Supporting task-oriented navigation in IDEs with configurable heatmaps. Technical Report IAM-09-005, Institut für Informatik, Universität Bern, Switzerland, July 2009.

Workshop Papers

- Carl Friedrich Bolz, Adrian Lienhard, Nicholas D. Matsakis, Oscar Nierstrasz, Lukas Renggli, Armin Rigo, and Toon Verwaest. Back to the future in one week — implementing a Smalltalk VM in PyPy. In *Self-Sustaining Systems*, volume 5142 of *LNCS*, pages 123–139. Springer, 2008.

- Lea Haensenberger, Adrian Kuhn, and Oscar Nierstrasz. Using dynamic analysis for api migration. In *Proceedings IEEE Workshop on Program Comprehension through Dynamic Analysis (PCODA 2008)*, pages 32–36, October 2008.

- Adrian Kuhn and Oscar Nierstrasz. Composing new abstractions from object fragments. In Hridesh Rajan, editor, *Proceedings of the 2nd Workshop on Virtual Machines and Intermediate Languages for Emerging Modularization Mechanisms (VMIL 2008), Nashville, Tennessee, Oct. 19, 2008*, pages 1–12, 2008.

- Adrian Kuhn and Toon Verwaest. FAME, a polyglot library for metamodeling at runtime. In *Workshop on Models at Runtime*, pages 57–66, 2008.

- Daniel Langone and Toon Verwaest. Extracting models from IDEs. In *2nd Workshop on FAMIX and Moose in Software Reengineering (FAMOOSr 2008)*, pages 32–35, October 2008.

- David Röthlisberger. Embedding moose facilities directly in IDEs. In *FAMOOSr, 2nd Workshop on FAMIX and Moose in Reengineering*, 2008.

- David Röthlisberger and Orla Greevy. Towards seamless and ubiquitous availability of dynamic information in IDEs. In *Proceedings of the 4th International Workshop on Program Comprehension through Dynamic Analysis (PCODA 2008)*, pages 27–31. Technische Universiteit Delft, 2008.

8 Administration

University:

T. Braun:	Member of the Committee for Computing Services (Kommission für Informatikdienste)
	Delegate of the University of Bern at SWITCH Stiftungsrat
H. Bunke:	Member of the Senat
G. Jäger:	Member of the Committee for Qualitätssicherung und Qualitätsentwicklung (until January 2009)
	Member of the Kantonale Maturitätskommission

Faculty:

H. Bunke:	Faculty Delegate for Mathematics / Computer Science
G. Jäger:	Member of the Planning Board
	Qualitätsbeauftragter (until January 2009)

Institute:

T. Braun:	Director of IAM
H. Bunke:	Member of Hauskommission Engehalde
G. Jäger:	Director of Studies
O. Nierstrasz:	Deputy Director of IAM
T. Strahm:	Member of Library Committee Exakte Wissenschaften
	Member of Hauskommission Exakte Wissenschaften
M. Zwicker:	Deputy Director of Studies (Spring Semester 2009)