

IAM Annual Report
Academic Year 2005/2006

August, 2006

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1 Institute of Computer Science and Applied Mathematics (IAM)

1.1 Address

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1.2 Personnel

Board of directors

Prof. Dr. Hanspeter Bieri; Prof. Dr. Torsten Braun; Prof. Dr. Horst Bunke;
Prof. Dr. Gerhard Jäger; Prof. Dr. Oscar Nierstrasz.

Teaching staff

Prof. Dr. Hanspeter Bieri; Prof. Dr. Torsten Braun; Prof. Dr. Horst Bunke;
Dr. Aurelio Cortesi; Prof. Dr. Rolf Haenni; PD Dr. L. Halbeisen; Dr. Ch.
Irniger; Prof. Dr. Gerhard Jäger; Prof. Dr. Oscar Nierstrasz; Dr. G. Ostrin;
Dr. D. Probst; PD Dr. Thomas Strahm; PD Dr. Thomas Studer.

Director

Prof. Dr. Oscar Nierstrasz.

Administration

Ruth Bestgen; Bettina Choffat; Sabine Gerber; Therese Schmid; Susanne
Thüler.

Library

Gudrun Heim; Katrin Wegmüller.

Technical staff

Peppo Brambilla; Dragan Milic.

Scientific staff

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2 Teaching Activities

2.1 Courses for Major and Minor in Computer Science

Winter Semester 2005/2006

- Bachelor 1st Semester

Einführung in die Informatik (H. Bieri, 5 ECTS)

Programmierung 1 (Th. Strahm, 5 ECTS)

Grundlagen der technischen Informatik (Th. Studer, 5 ECTS)

- Bachelor 3rd Semester

Information und Logik (Prof. G. Jäger, 5 ECTS)

Einführung in Software Engineering (O. Nierstrasz, 5 ECTS)

Computernetze (T. Braun, 5 ECTS)

- Bachelor 5th Semester

Künstliche Intelligenz (Ch. Irniger, 5 ECTS)

Mensch Maschine Schnittstelle (Th. Strahm, 5 ECTS)

- Master's Courses and Seminars

Blockveranstaltung Bern und Freiburg: Inferenz und Deduktion (G. Jäger, J. Kohlas, 5 ECTS)

Blockveranstaltung: Parallel Computer Architecture (A. Cortesi, 5 ECTS)

3D-Grafik (H. Bieri, 5 ECTS)

Concurrent Programming (O. Nierstrasz, 5 ECTS)

Digitale Bilder (H. Bieri, 5 ECTS)

Einführung in die Kryptographie (R. Haenni Sola, 5 ECTS)

Multimediakommunikation (T. Braun, 5 ECTS)

Strukturelle Beweistheorie (G. Jäger, 5 ECTS)

Seminar: Computergeometrie und Grafik (H. Bieri, 5 ECTS)

Seminar: Mengensysteme (G. Jäger, 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)

- Service Course

Anwendungssoftware (Th. Studer, 3 ECTS)

Summer Semester 2006

- Bachelor 2nd Semester

Datenstrukturen und Algorithmen (H. Bieri, 5 ECTS)

Datenbanken (L. Halbeisen, 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

- Seminar: Künstliche Intelligenz (H. Bunke, 5 ECTS)
- Seminar: Computergeometrie und Grafik (H. Bieri, 5 ECTS)
- Seminar: Software Composition (O. Nierstrasz, 5 ECTS)
- Seminar: Rechnernetze und Verteilte Systeme (T. Braun, 5 ECTS)

- Master's Courses

- Blockveranstaltung Bern und Freiburg: Inferenz und Deduktion (G. Jäger und J. Kohlas, 5 ECTS)
- Blockveranstaltung: Parallel Algorithms and Programming (A. Cortesi, 5 ECTS)
- 3D Rekonstruktion (H. Bieri, 5 ECTS)
- Intelligente Spiele (R. Haenni Sola, 5 ECTS)
- Komplexitätstheorie (Th. Strahm, 5 ECTS)
- Mobilkommunikation (T. Braun, 5 ECTS)
- Mustererkennung 2 (H. Bunke, 5 ECTS)
- Praktikum Computeranimation (H. Bieri, 5 ECTS)
- Programmiersprachen (O. Nierstrasz, 5 ECTS)
- Smalltalk (O. Nierstrasz, S. Ducasse, 5 ECTS)
- Seminar: Theoretische Information und Logik (Th. Strahm and Th. Studer, 5 ECTS)
- Seminar: Computergeometrie und Grafik (H. Bieri, 5 ECTS)
- Seminar: "Coordinated Attack" und verwandte Probleme (D. Probst and G. Ostrin, 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)

- Service Course

Anwendungssoftware (Th. Strahm, 3 ECTS)

2.2 Colloquium in Computer Science

- 17/02/2006 Dr. Thiemo Voigt
Swedish Institute of Computer Science, Kista, Sweden
Contiki, Protothreads and the Contiki Network Simulator
Cooja
- 04/04/2006 Wolfgang Henggeler
Technologietransferstelle der Universität Bern (Unitectra)
Schutz und Verwertung von Computerprogrammen
- 23/05/2006 Prof. Dr. Thomas Vetter
Universität Basel, Departement Informatik
Gesichtserkennung, eine Herausforderung an Mensch
und Maschine
- 15/06/2006 Prof. Dr. Gunnar Karlsson
KTH Stockholm
Wireless Content Distribution
- 27/06/2006 Prof. Brian Hendersen-Sellers
CHOOSE-Talk
- 30/06/2006 Prof. Houari Sahraoui
University of Montreal, Canada
Visual Detection of Design Anomalies and Evolution phe-
nomena in OO Programs

2.3 Students

- Major Subject Students: WS 05/06: 245, SS 2006: 228
- Minor Subject Students: WS 05/06: 177, SS 2006: 170
- PhD Candidates: WS 05/06: 29, SS 2006: 26

2.4 Degrees and Examinations

- PhD: 10

- Diploma: 9
- Master: 10
- Bachelor: 2
- Propädeutische Hauptfachprüfung: 28
- Completion of Minor Studies: 22 (60E: 6, 50E: 1, 45E: 1, 40E: 1, 36E: 1, 30E: 6, 25E: 1, 15E: 3, 13E: 2, 807 ECTS)
- Semester Examinations Winter Semester 2005/2006: 643 (3034 ECTS)
- Semester Examinations Summer Semester 2006: 553 (2611 ECTS)

3 Research Group on Computational Geometry and Graphics

3.1 Personnel

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	M. Hugli	Tel.: +41 31 631 3321 email: hugli@iam.unibe.ch
	Ph. Robert	Tel.: +41 31 631 4679 email: robert@iam.unibe.ch
	S. Schär	Tel.: +41 31 631 8955 email: schaer@iam.unibe.ch
	Th. Wenger	Tel.: +41 31 631 4990 email: wenger@iam.unibe.ch
Guest:	Prof. X. Jiang	University of Münster, Germany July 2006

3.2 Overview

The research group CGG (computational geometry and graphics) focuses on geometry on the computer and its applications to computer graphics, image processing and computer vision. The group is mainly interested in applications that require techniques from several of those fields and are of practical relevance, for instance in history, art history and archaeology. Its three main areas of interest are the following:

Polyhedra in d dimensions

Since approx. 1975, a promising new kind of polyhedra - the so-called Nef polyhedra - have been developed at this institute. Nef polyhedra are dimension independent and therefore especially interesting for applications

where the dimension of the underlying space is higher than 3. A typical example are configuration spaces. Ongoing work extends the theory of Nef polyhedra and implements the kernel of a modeling system based on them.

Reconstruction of geometric objects

Museums, exhibitions and research projects in history, archaeology, etc. need virtual reconstructions of many kinds of 2D and 3D objects. The existing data are extremely varied, and so have to be the corresponding reconstruction techniques. Several projects deal with such reconstructions, and they typically try to combine some of the most promising techniques, to generalize them and to base them on sound theoretical fundamentals.

Frameworks for graphics applications

A number of independent frameworks are developed, e.g. for interactive ray tracing, 3D games, 3D city models and scene graphs for generic 3D applications. Each such framework is extended with implementations of different comparable techniques, and one main purpose consists in building “intelligent” dispatchers capable to select the most promising technique in view of the requirements and characteristics of a given application.

3.3 Research Projects

D-Dimensional General Polyhedra

These polyhedra, now called “Nef polyhedra”, are those subsets of the d -dimensional Euclidean space that can be obtained by applying a finite number of Boolean set operations to a finite number of linear halfspaces. The project extends the theory of Nef polyhedra, develops and analyses convenient data structures and lays the foundation of an object-oriented implementation of the kernel of a solid modeler for working with Nef polyhedra.

Research staff: H. Bieri, W. Nef, J. Tammik

Anatomy of 3D Real-Time Game Engines

This research project investigates various aspects of 3D real-time game engines for next generation platforms:

- Multi resolution geometry (eg. subdivision surfaces)
- GPU shader techniques (per pixel lighting, parallax mapping, etc.)
- Character animation
- Integration of high level languages (scripting)
- Content pipeline (asset creation, data export, light mapping, etc.)
- Middleware integration

3D computer games require efficient data structures and algorithms. Important factors are:

- Memory access patterns (data locality and dependency)
- Branching (both conditional and unconditional)

The goal of this research project is to design and implement a reference 3D real-time game engine prototype that has all major features to build a state-of-the-art 3D real-time computer game.

Research staff: Ch. Ammann

Collaboration on Scene Graph Based 3D Models

Professional 3D modeling applications like Alias Maya or discreet 3ds max offer only limited support for a team of artists to work on a 3D model collaboratively. There is even less support for efficiently managing revisions and variants or different representations of designs. Commercial group authoring tools and revision control systems cannot provide a solution as they generally work file based and/or are specialized on text documents only. But 3D models are often stored in binary files in a proprietary format assembling thousands of objects in a complex structure called the scene graph (DAG).

This project provides support for collaboration on scene graph based 3D models by means of a specialized repository that implements extensional

version control for DAG structured 3D data avoiding pitfalls like version proliferation. Collaboration is based on an optimistic locking scheme combining a check-in/-out mechanism with automatic merging of consistent changes to a 3D model. A revision history keeps track of who made when what changes to a model and also provides information about a models alternatives and different representations.

The scene graph repository stores 3D models in an attributed scene graph that has been designed to hold scene graphs of different 3D applications without loss of information. Attributed scene graphs also reflect dependencies between nodes in order to track the effects of changes to nodes through the scene graph. This allows to reliably detect inconsistent collaborative changes and identify unexpected side effects possibly not taken into account by the modelers. In addition, a GUI helps to track down such unwanted side effects of collaborative changes visually by directing modelers to the critical points in a scene and by isolating changes and their side effects.

An XML schema defines the attributed scene graph model formally and allows to export/import such scene graphs to/from XML files. Typically, check-out/-in and export/import operations are implemented in plug-ins for 3D applications.

Research staff: L. Ammon, A. Rüttimann

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: Th. Buchberger

Practical Reconstruction of 3D Objects

Many museums own a large number of precious 3D objects. Digital 3D reconstructions of such objects can be very useful. To replace originals by copies is advantageous in many cases, not only for security reasons. Other applications consist in building animations which include such reconstructions.

This project examines and compares known reconstruction methods with many different applications, and tries to adapt and improve them for the given special situation.

A major motivation for this project is to convert a big classical model of the city of Bern around 1800 to a digital model and then to generalize the procedure. There exist many valuable classical city models, and their conversion to digital models offers a large number of interesting new applications.

An important technique to be examined will be Photogrammetry, especially by applying the software products Photomodeler by EOS Systems and Imagemodeler by REALVIZ. Photogrammetry will be combined with the classical "CAD approach" as well with laserscanning in order to arrive at a comprehensive and flexible combined approach to reconstruct 3D objects of good - but not too high - quality in reasonable time and at limited costs.

Research staff: M. Hugli, J. Marbach, H. Bieri

Interactive Ray Tracing

This research project investigates algorithms, data structures and rendering techniques which have to be adopted in order to design and implement a scalable and interactive ray tracing system. Our main focus lies on aspects which are of particular importance to single system image (SSI) multi-GPU and multi-CPU computer based solutions. Among these are

- general purpose computations on graphics hardware (GPGPU)
- frameless rendering image-space based rendering optimisations
- scalable rendering techniques
- efficient memory management and cache usage
- computation optimizations using the SIMD programming model

Part of this effort is the development of a ray tracing based graphics library and a prototype application, which enables us to research various aspects of interactive ray tracing systems.

Additionally, we are studying the usage of algebraic surfaces as rendering primitives for interactive ray tracing - e.g., quadrics and superquadrics.

Research staff: Ph. Robert, S. Schoepke, Ch. Gerber

JMesh: A Mesh Library in Java

Polygonal meshes are very popular in 3D graphics and thus the topic of many ongoing research projects all over the world. Many standalone tools and mesh libraries with a specialized focus are available today. But currently there exists no comprehensive software basis in Java that supports and integrates the different research approaches to meshes.

This project intends to build JMesh, a uniform but flexible framework to experiment with different kinds of mesh data structures (e.g. halfedge, corner table, etc.) and algorithms.

A basic mesh abstraction layer is defined, that unifies several mesh representations. Different implementation techniques and new language features and extensions of Java (e.g. generic classes, aspect oriented programming) are analyzed and evaluated for their benefit in this context. The most important basic algorithms for mesh reconstruction, mesh generation, mesh simplification, mesh subdivision, and signal processing with meshes are being implemented. The mesh data structures and algorithms offer specific extensions targeting at didactic use cases like e.g. visualization and documentation. Several typical JMesh-based prototype applications investigate the extensibility, efficiency, and reliability of the framework.

Although typical target application areas for JMesh come from research and didactics in computer graphics, JMesh is useful to application developers too.

Research staff: Th. Wenger, Ch. Aymon, A. Kobel

Designing a Tool to Simulate Stage Settings in a Reconstructed Theatre Location

Realisations of theatrical productions require the coordination of various involved parties, like in-house technicians as well as external light design-

ers and directors, all with their own way of working and different levels of knowledge about the locality's technical equipment and the requirements of the production. Currently the exchange of certain documents of the planning stage, like building and lighting plans between the in-house staff and the external crew, is most often done by sending back and forth printed or electronic CAD drawings. These vary in terms of quality as well as content from one theatre to the other. The aim of this project is to simplify the way of exchanging that information by providing a tool that allows the in-house staff to build an easy reconstruction of the theatre's interior and the external crew to simulate the different stage settings of their production by means of these models.

Research staff: M. Suchy, H. Bieri, A. Kotte

Computer Reconstruction of Human Faces and Heads

The reconstruction of complex organic shapes, such as the human head, is a tedious and long-lasting process that has been a task exclusively performed manually. There has been a lot of research recently on simplifying and automating this process. These research activities have led to a wide variety of different approaches to the reconstruction of human faces and heads. This project examines the advantages and disadvantages of those approaches in detail.

Some of the reconstruction techniques are used to get first hand experiences in the creation of human faces and heads. Furthermore, the experiences gained are used to model a part of the staff of the Institute of Computer Science in order to enhance a former project that only consisted in the virtual reconstruction of some of the institute's premises. Another part of the present project deals with the animation of the head and face meshes.

Research staff: J. Rothen

2D to 3D Conversion of Videos Based on Motion Layers

The 2D to 3D conversion of arbitrary videos is still a challenging task. Various algorithms exist to gain 3D data from uncalibrated 2D videos, each subjected to particular restrictions. Amongst others, dynamical scenes cause problems, especially if they contain multiple independently moving objects (IMO).

On the other hand, segmentation and depth ordering of IMO's can be achieved through motion layer segmentation. Furthermore, an exact reconstruction of the 3D scene is not necessary to gain a satisfactory visual 3D effect. Thus, in this project, we analyze the restrictions of the different algorithms used for motion segmentation and study their applicability to arbitrary videos as well as the possibility to use motion layer segmentation for the 2D to 3D conversion of videos. For this purpose, we implement a test environment, define test cases and perform quality ratings of the visual 3D effect.

Research staff: S. Schär, X. Jiang, H. Bieri

3.4 Diploma Theses

- Daniel Schulte: Partikelsysteme und autonomes Verhalten in Computeranimationen
- Mark Hinnen: Computervisualisierung von nicht realisierten Bauprojekten
- Philipp Holzmann: Gallery Assistant - Ein Tool für die Planung und Visualisierung von Gemäldeausstellungen

3.5 Bachelor's Thesis

- Roland Bärtschi: Desktop-Publishing für ein Buch über Musikinformatik

3.6 Further Activities

- Organization of a series of lectures "Farbe und Farben" for the Collegium generale at the University of Bern, April - June, 2006 (H. Bieri)
- Member of the Program Committee of ISVC 2006 (H. Bieri)
- Reviewing for WSCG 2006 (L. Ammon, H. Bieri)
- 3D-Scanning for the Hochschule der Künste Bern (M. Hugli)

3.7 Publications

- P. Bhaniramka, Ph. Robert, S. Eilemann: OpenGL Multipipe SDK: A Toolkit for Scalable Parallel Rendering. In Proceedings of IEEE Visualization 2005, 119 – 126, 2005
- S. Schär, H. Bieri, X. Jiang: Digital Restoration of Medieval Tapestries. In Proceedings of VAST 2005 - 6th International Symposium on Virtual Reality, Archeology and Intelligent Cultural Heritage, 143 - 150, 160, 2005
- L. Ammon, H. Bieri: Collaboration on scene graph based 3D data. In Proceedings of GRAPP 2006 - 1st International Conference on Computer Graphics Theory and Applications, 259 - 266, 2006
- A. Breyer, X. Jiang, A. Rüttsche, H. Bieri, T. Oexl, A. Baumann, D. Mojon: Influence of the Pulfrich phenomenon on driving performance. To appear in Graefe's Archive for Clinical and Experimental Ophthalmology

4 Research Group on Computer Networks and Distributed Systems

4.1 Personnel

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* with financial support from a third party

[†] external Ph.D. student

4.2 Overview

The research group for Computer Networks and Distributed Systems (Rechnernetze und Verteilte Systeme, RVS) is active 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 studying how such services with high demands on the quality of communication systems and networks can be supported. In the past, we developed scalable simulation tools to support planning and operation of global IP networks. Nowadays, 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 such 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 (e.g. for direct communication between vehicles) and so-called mesh networks, which form low cost alternatives for the network access by end users. 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 resulted from recent research projects. We are develop-

ing new methods and tools to support learners and teachers in e-learning environments. In particular, we aim to support practical experiments, mobile learning, and support for groups of learners.

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. NCCR-MICS is composed of more than twenty research projects distributed over four clusters. The research project of the RVS group of the University of Berne is called “Distributed event detection and localization architecture for wireless sensor networks” (IP4), which aims at designing and implementing a distributed event detection, event localization, and data aggregation framework. It includes efficient and reliable signaling protocols as well as mechanisms to dynamically reprogram sensor network applications.

In the last year we developed our first approach of a fully distributed event localization scheme. The scheme consists of two algorithms: The distributed election-winner notification algorithm (DENA) determines the closest sensor node to an event and notifies all other nodes about that winner. The intensity-based localization algorithm (ILA) provides a signal independent position estimation of the event and is executed at the winner node. In order to support efficient data dissemination, we additionally proposed an adaptation of our dynamic delayed broadcast protocol (DDB) to tailor this approach to sensor networks with limited resources. Additionally, we investigated the applicability of the ILA by implementing it on Embedded Sensor Board (ESB) nodes from FU Berlin and running tests in multiple real world scenarios. The results of these tests indicate that lightweight localization and tracking is possible even with the cheap and inaccurate passive infrared (PIR) modules of the ESB sensor nodes used in our implementation. Work in progress adapts the ILA and DENA algorithms to object tracking.

Furthermore, we did a first basic implementation of a virtual backbone algorithm supporting our event localization framework. The goal of this work is on energy efficiency as well as adaptability to network constraints such

as connectivity, node mobility, energy distributions, etc. Another work was the implementation and evaluation of two MAC protocols, namely LMAC and TEEM, on ESBs. We got a number of insights concerning the implementation of a theoretical concept on real sensor hardware with all its limitations.

Research staff: Markus Wälchli, Thomas Bernoulli, Reto Zurbuchen, Michael Meer, Markus Anwander, Samuel Bissig, Torsten Braun

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

Mobile IP Telephony (MIPTel)

The MIPTel project aims to develop and support mobile telephony applications over IP networks. Providers are in great need of scalable, extensible, flexible and transparent charging and accounting methods, which take into account the specific attributes of wireless networks and requirements of diversified services. A wide range of accounting, charging and pricing schemes have been analyzed.

We found that the increasing user mobility requires a new approach to the existing charging and accounting concepts. While the users demand for increased service coverage, the providers aim for low infrastructure costs. Multi-hop cellular networks are a promising concept, which suits both needs. It combines the advantages of two worlds: the dynamics of mobile ad hoc networks and the reliability of wired networks. Mobile ad hoc networks are spontaneously created by interconnecting nodes operated by individual users. In order for the network to function, the nodes are required to participate in the packet transmission process, in particular they must forward packets transmitted by other nodes. This behavior is also known as cooperation among nodes. How to ensure the cooperation in civilian networks in the absence of a single authority is a challenging research question, which we tried to answer in this project. The project has been successfully completed with the PhD thesis of Attila Weyland, which presents the cooperation and accounting strategy for hybrid wireless networks called CASHnet.

CASHnet introduces charges and rewards to the packet transmission process using a hybrid accounting architecture. The charging and rewarding is done decentralized on the nodes and the refill of the virtual currency

account is done at service stations operated by a provider. It uses separate accounts for charging as well as rewarding and the exchange of the virtual currencies requires the help of the provider. Compared to fully decentralized accounting schemes like Nuglet, CASHnet ensures a constant cash flow and keeps the provider in control of it. Unlike completely centralized accounting schemes, CASHnet does not put additional signaling load on the links toward the base stations. It also allows cost sharing between sender and receiver located in different multi-hop cellular networks. Further, CASHnet supports the provider in the network planning process. We implemented and evaluated CASHnet in the network simulator ns-2 and developed and tested a prototype implementation of CASHnet under Linux.

We see the main contribution in the specification, development and evaluation of a complete cooperation and accounting architecture, which has several unique features: It retains as much flexibility as possible of the multi-hop communication paradigm through its hybrid accounting and decentralized security architecture. It keeps the provider in control of the cash flow through its two virtual currencies and accounts. It also ensures the security of the accounting mechanisms through non-repudiation.

Research staff: Attila Weyland, Carolin Latze

Financial support: Swiss National Foundation Project No. 2100-057077.99/2 and 20-68086.02/1

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 networks, measuring the communication delay between all overlay participants does not scale. To still be able 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 the 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 ERON project we try to improve one of the most precise coordinates-based communication delay prediction system – GNP. In GNP the coordinates of a communication partner are calculated by measuring the communication delay to a fixed set of other communication partners (so called landmarks) and by performing multilateration. The coordinates of the landmarks are calculated by minimizing the sum of the square distances between measured and calculated coordinates. Since GNP uses a very general but slow function minimization, it is very computation-intensive especially with the increasing number of dimensions and landmarks.

We try to improve the GNP system by explicitly calculating the maximum number of dimensions that are needed to represent the coordinates of the landmarks and also to provide a good starting point for the function minimization. We also consider using other iterative function minimization algorithms such as Gauss-Newton-Iterative method. Another goal of our research is to exploit the statistical properties of the measured delays (mean, variance) to improve the predictions.

After improving the GNP system we are planning to develop an routing protocol, based on the greedy spatial routing. The goal is to have the routing protocol, which should be near-optimal compared to the routing in the network on which the overlay network bases.

Research staff: Dragan Milic

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

End-to-end Quality of service support over heterogeneous networks (EuQoS)

The *EuQoS* project (<http://www.euqos.org>) aims to resolve outstanding design issues presently associated with the delivery of end to end Quality of Service across heterogeneous networks. With the help of EuQoS these issues should be solved and the infrastructures should be upgraded so that new applications can be supported by the Internet and new service packages can be offered by operators, ISPs and other service providers.

Our research group is involved in the work packages WP1, WP3, WP5 and WP6.

WP1 (Business Model and System Design) aims to define an architecture for different aspects of the EuQoS system. Support for QoS in IP multicast is difficult to achieve due to the lack of wide deployment of IP multicast in the Internet and it seems that this will probably not change in the near future, even with the adoption of IPv6. Our research focuses on providing transparent support for application level multicast on end systems. This enables multicast communication across the Internet using only unicast communication offering QoS support.

WP3 (Implementation of the EuQoS System) delivers the proposed applications and services according to the architectures defined in WP1. We developed a transparent multicast facility known as "Multicast Middleware," which is based on a virtual network interface (TAP) and is implemented mostly using Java (version 5.0) to support different operating systems. The Multicast Middleware aims to be independent of the underlying QoS mechanisms. It will either use the EuQoS QoS signaling (introduced with the EuQoS project) or the measurement-based multicast to bridge gaps where no (EuQoS) QoS is offered by the underlying network. The overlay network is constructed using a Scribe/Pastry implementation called Freepastry.

WP5 (EuQoS Pan European trials) builds a testbed environment in which the developed prototypes and applications can be tested and evaluated. Different heterogeneous networks (WLAN, UMTS, LAN, xDSL, etc.) are interconnected in a full mesh among the partners. Our testbed represents a high speed gigabit-LAN-based network, which is interconnected by GRE tunnels to twelve other testbeds belonging to other EuQoS consortium partners involved in WP5. It is directly connected to the university's border router through a 1 Gbit/s network link.

WP6 (Dissemination, Standards and Training) focuses on delivering the project results to the public. This shall be achieved by four activities, namely development of training material, delivery of training, standardization contributions, as well as dissemination by demonstrations and publications. In addition to leading and managing the whole work package, our main contributions address the training activities. Within this context, a course focusing on QoS related topics is being developed for students and industrial learners. The goal of the course is also to raise the familiarity with QoS technologies for next generation networks and applications. The course is based on distance learning technologies and consists of seven QoS related modules. We have developed the didactical concept of the e-learning course and are coordinating its implementation. In particular,

we have developed the course modules “Applications’ QoS demands” and “Implementing protocols on network simulators.” For the latter module we are currently also developing a tool for the visualization and animation of simulator trace files. Now we are implementing a new module on “Multicast in EuQoS system.” We are also participating in the development of the “EuQoS overview” module, where we mainly focus on the illustration of the content (animation and graphics). We are further developing and providing the course management system and the authentication & authorization framework required for the various module exercises.

Research staff: Thomas Bernoulli, Marc Brogle, Dragan Milic, Matthias Scheidegger, Thomas Staub, Marc-Alain Steinemann, Gerald Wagenknecht, Markus Wulff, Jana Krähenbühl, Torsten Braun

Financial support: EU project IST-2003-004503

Virtual Internet and Telecommunications Laboratory of Switzerland (VITELS)

VITELS, a first series Swiss Virtual Campus (SVC) project has been funded within the SVC consolidation program. The VITELS goal has been to develop an e-learning course in English language that provides theory and practical hands-on exercises in the area of telecommunications and computer networks with real network hardware for computer science students. Currently, VITELS consists of eight modules, six designed and maintained by University of Bern, one by University of Neuchâtel, and one by University of Fribourg. The course is fully operational and has been productively used in different regular courses on the Bachelor level at the Universities of Bern (in the “Computer Networks” lecture), Fribourg, and Neuchâtel.

In the reporting period several VITELS related activities have been performed. The “VITELS Didactic and Design Guide” has been updated to include detailed instructions on the use of WebCT in order to ease the work of developers of new modules and maintainers of existing ones. New modules have been agreed on with the University of Tübingen and Jyväskylä University of Applied Sciences. In the reporting period we have also continued the development of an improved course management system with student profiles and a much more flexible hands-on session reservation system. Upgrades to new versions of the Shibboleth based authentication and authorization infrastructure have been performed.

Research staff: Thomas Staub, Thomas Bernoulli, Daniel Frey, Marc-Alain Steinemann, Reto Gantenbein, Torsten Braun

Financial support: Staatssekretariat für Bildung und Forschung (SBF), Virtual Campus Switzerland Project No. 991043, and University of Bern

Operating Systems Laboratory (OSLab)

The Operating System Laboratory, OSLab, is an online course that will teach students about principles of operating systems using a constructivist approach and problem-oriented learning. OSLab focuses on the hands-on training experience of the students and will complement existing lectures. The course is modularly structured. Each module covers a topic and is self-contained. A teacher can select modules according to his need and easily add new modules to the course.

During this project we will create seven e-learning modules covering the topics of process scheduling, inter-process communication, memory management, file systems, distributed file systems, security as well as device drivers and input/output.

So far we have specified the theory and hands-on part of all seven modules in form of extended abstracts. In addition, we identified three main types of hands-on sessions and specified their requirements (OS-independent Programming, OS-dependent Programming and OS-dependent Configuration). We also published two guidelines, one for module authors, and one for course authors. This separation of roles allows module authors to focus on their tasks. These guides contain the experiences from our previously conducted E-Learning activities. Further, we developed administrative scripts for automatic user account creation and removal to be used for interactive theory as well as OS-dependent programming hands-on sessions. Last, we improved the FFGF (file framework generator & formatter) to support the generation of initialization modules and enabled both standalone use as well as interaction with the GCED (Guided Content Editor). Currently, we are investigating the possibility of automatic evaluation of the student's hands-on performance and are implementing the file systems module.

Research staff: Attila Weyland, Markus Wulff, Gerald Wagenknecht, Matthias Scheidegger, Torsten Braun

Financial support: Staatssekretariat für Bildung und Forschung (SBF), Programm Virtueller Campus Schweiz, Project No. P-4-019, and University of Bern

Graphical Editor for the Production of E-Learning Content

Among the results of the VITELS project is a didactics guide for laboratory-based e-learning courses, and a text-based tool for creating content according to these guidelines. This tool converts several HTML sources to the formats of the WebCT CE and Vista platforms. However, the usability of this tool is restricted by its non-graphical interface, especially if the user is not a computer expert. The goal of this project was therefore to implement a graphical editor for e-learning content.

During the project we have implemented an editor based on the multi-platform Java framework, which ensures that the editor runs on several platforms including Microsoft Windows, Mac OS X, and UNIX. Furthermore, it is implemented based on freely distributable components to avoid licensing problems. Besides its graphical HTML editing capabilities the editor has several special features: The creator of a course can predefine a course structure that will be enforced by the editor, and which can be browsed for easy access to different parts of the document. Furthermore, a small part of the editing window displays the relevant didactical guidelines for the section currently being edited. Formatting of content is done using the original tool. This ensures compatibility with already created content.

Research staff: Matthias Scheidegger, Marc-Alain Steinemann

Financial support: University of Bern, VC-Kleinprojekt

eXperience Based Admission Control (XBAC)

The XBAC project aimed to create an overlay network architecture that provides a distance estimation service to user applications. Before an application opens a connection to a remote endpoint it can ask for a prediction of the quality of service to this destination. Depending of the prediction it can then decide to proceed with connection setup or to back off. Moreover, peer-to-peer networks can use the service to optimally configure their topology and also to adapt to later changes in quality of service.

The XBAC architecture is based on the idea of creating groups of endpoints that are close to each other in the physical network topology. While communicating these endpoints gather measurement data, which they distribute to the other endpoints in their cluster. Thereby they create a common pool of network measurements, termed the group's *experience*. Using this experience, the group can give robust answers to QoS prediction requests. In contrast to other approaches, XBAC can detect clusters of remote nodes and groups based on end-to-end measurements, which leads to better scalability and enables inclusion of non-cooperative nodes into the system.

Based on the architecture defined in the XBAC project we have designed and developed a prototype for experimental deployment on PlanetLab. We have also defined test cases to estimate the scalability of the implementation in terms of CPU, memory, and bandwidth usage. Furthermore, evaluation of several possible variants of the joining-node procedure has allowed us to select the optimal one.

Research staff: Matthias Scheidegger, Ben Zahler

Wireless Mesh Networks

Today, various wireless network technologies are deployed in isolated networks. In order to interconnect these networks and thereby enhance the overall coverage a new key technology called wireless mesh networks (WMNs) has appeared. The wireless nodes of WMNs establish peer-to-peer connections with each other and form an ad hoc network without the presence of any additional infrastructure. In order to exploit WMNs for IP telephony and video conference applications we investigate the possibilities of path diversity and multi-stream coding. The characteristics of multiple paths are usually largely uncorrelated, i.e., the delay, jitter, and loss rate of the paths differ a lot from each other. Compared to a single path, multiple uncorrelated paths provide redundancy in the transmission, which we expect to improve the quality of the transmission. We investigate new algorithms for mapping coding and paths according to network conditions. Moreover, different existing multi-path routing protocols are being implemented in simulators (Omnet++, ns2). Some of the protocols will be implemented in Linux. They are planned to be integrated in our embedded Linux for WMNs.

An important aspect for the deployment of a real WMN testbed is the secure remote management of WMNs. The individual nodes have to be eas-

ily managed by a central unit. This includes possibilities of rapidly changing the system software, routing protocols and radio parameters. Further, configuration errors as well as system software bugs have to be corrected without the need of physical access to the nodes. During the project an embedded Linux distribution is being developed including a management solution with different fallback behaviors in case of errors. Our physical nodes are low priced embedded x86 based systems from PC Engines GmbH.

Besides the work on a real WMN testbed we have begun to evaluate the possibilities of a virtual mesh network running real Linux software. Our research focuses on a solution using XEN to virtualize the mesh nodes and interconnecting them by an emulation framework.

Research staff: Thomas Staub, Alican Geycasar, Stefan Ott, Michael Lustenberger, Daniel Balsiger

Power Saving in Wireless Ad Hoc Networks

Power saving mechanisms in wireless ad hoc network nodes mainly switch off the transmission and reception hardware for a maximum amount of time and turn it on again periodically for a given interval. Many approaches aim to synchronize the state changes of the nodes in the network through distributed beacon generation and introduce mechanisms where nodes synchronously wake up at designated points of time to exchange announcements about pending traffic. However, synchronization is difficult to achieve, in particular in wireless ad hoc networks. We developed, evaluated, and improved a power saving approach based on asynchronous wake-up patterns and wake-up announcements integrated with Ad-hoc On-demand Distance Vector (AODV) protocol. Significant improvements of the connectivity under low wake ratios can be achieved by carefully designed forwarding strategies of AODV route request messages.

Research staff: Philipp Hurni and Torsten Braun

Testbed for Mobile and Internet Communications

The RVS research group maintains its own testbed network for various purposes. One part of 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.

Another part of the network 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. Furthermore, a significant part of EuQoS project's testbed is located within the RVS testbed. It is a Gigabit LAN environment of 10 machines for pan-european trials, and it is connected via IP tunnels to 11 partners' sites. The available CPU power is used by three network traffic measuring points. 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 two PlanetLab nodes in our testbed network.

Research staff: All members of the RVS research group

4.4 Ph.D. Theses

- Attila Weyland: Cooperation and Accounting in Multi-Hop Cellular Networks, November, 2005
- Marc Danzeisen: Cellular Assisted Heterogeneous Networking, February, 2006

4.5 Diploma Theses

- Carolin Latze: Linux Implementation of a Cooperation and Accounting Strategy for Multihop Cellular Networks, February, 2006
- Tobias Roth: Beacon-Less Routing: An Implementation for GNU/Linux, December, 2005
- Thomas Spreng: Authentication and Authorization for Mobile Internet Users, February, 2006
- Isabel Steiner: Synergy of Ad-Hoc and Infrastructure Based Networking, April, 2006

4.6 Bachelor Theses and Computer Science Projects

- Tobias Roth: Client Based Auto-Configuration in Heterogeneous Networks, August, 2005
- David Wittwer: Einsatz von GPS-Empfängern zur Bestimmung von One-Way-Delays in einem Netzwerk, February, 2006
- Philipp Hurni: Simulation and Evaluation of Unsynchronized Power Saving Mechanisms in Wireless Ad hoc Networks, March, 2006
- Samuel Bissig: Office Monitoring with Sensor Networks, April 2006

4.7 Further Activities

Memberships

- Editorial Board of Elsevier's Computer Communications Journal (Torsten Braun)
- Editorial Board of Informatik Spektrum / Springer-Verlag (Torsten Braun)
- Editorial Board of Journal of Internet Engineering (Editor in Chief, Torsten Braun)
- Erweitertes Leitungsgremium Fachgruppe "Kommunikation und Verteilte Systeme," Gesellschaft für Informatik (Torsten Braun)
- Management Board of EU IST project EuQoS (Torsten Braun)
- Swiss Representative, Management Committee Member, and Working Group Chair of COST 290 Action "Traffic and QoS Management in Wireless Multimedia Networks" (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)

Conference Program Committees

- 14th IEEE Workshop on Local and Metropolitan Area Networks, Chania, Crete, Greece, 18–21 September 2005 (Torsten Braun)
- 3. Deutscher Workshop über Mobile Ad-Hoc Netzwerke (WMAN 2005), in conjunction with GI-Jahrestagung 2005, Bonn, September 21, 2005 (Torsten Braun)
- 30th IEEE Conference on Local Computer Networks, Sydney, November 15–17, 2005 (Torsten Braun)
- 3rd Annual Conference on Wireless On demand Network Systems and Services (WONS), Les Ménuires, France, January 18–20, 2006 (Torsten Braun)
- 5th International Conference on Ad-Hoc Networks & Wireless, Ottawa, August 17–19, 2006 (Torsten Braun)
- IEEE Consumer Communications and Networking Conference 2006 (CCNC 2006), January 7–10, 2006, Las Vegas (Torsten Braun)
- 4th International Workshop on Internet Performance, Simulation, Monitoring and Measurement (IPS-MoMe 2006), Salzburg, February 27–28, 2006 (Torsten Braun)
- 4th International Conference on Wired/Wireless Internet Communications (WWIC), Bern, May 10–12, 2006 (Torsten Braun, General Co-Chair; Ruth Bestgen, Thomas Bernoulli, Marc Brogle, Organizing Committee)
- 5th IFIP-TC6 Networking Conference, Coimbra, Portugal, May 15–19, 2006 (Torsten Braun)
- International Workshop: Towards the QoS Internet (To-QoS'2006), Coimbra, Portugal, May 19, 2006, held in conjunction with 2006 IFIP Networking Conference (Torsten Braun)
- 6th International Workshop on Applications and Services in Wireless Networks, Berlin, May 29–31, 2006 (Torsten Braun)
- 6th International Conference on Next Generation Teletraffic and Wired/Wireless Advanced Networking (NEW2AN), St.Petersburg, May 29–June 2, 2006 (Torsten Braun)

- 5th Conference on Security and Network Architectures (SAR 2006), Seignosse-Landes, France, June 6–9, 2006 (Torsten Braun)
- IEEE 2006 Workshop on High Performance Switching and Routing, Poznan, Poland, June 7–9, 2006 (Torsten Braun)
- 2006 IEEE International Conference on Communications (ICC 2006), Istanbul, June 11–15, 2006 (Torsten Braun)
- ACM Workshop on Real-World Wireless Sensor Networks (REAL-WSN), in conjunction with ACM MobiSys 2006, Uppsala, Sweden, June 19, 2006 (Torsten Braun)
- First workshop on advanced EXPerimental activities ON WIRELESS networks and systems (EXPONWIRELESS 2006), affiliated with IEEE WOWMOM 2006, Niagara-Falls, June 26–29, 2006 (Torsten Braun)
- 5th International Workshop on Advanced Internet Charging and QoS Technologies (ICQT'06), St Malo, France, June 27, 2006 (Torsten Braun)
- 32nd Euromicro Conference, Track on “Multimedia & Telecommunications: Dependable Adaptive Systems,” Cavtat/Dubrovnik, Croatia, August 29–September 1, 2006 (Torsten Braun)

Reviewing Activities

- Research Council of Norway (Torsten Braun)
- VINNOVA (Swedish Governmental Agency for Innovation Systems) (Torsten Braun)
- Swiss National Science Foundation (Torsten Braun)
- RMIT University, Melbourne (Torsten Braun)
- Review Team für Fachbereiche Informatik und Scientific Computing an der Universität Salzburg (Torsten Braun)
- Elsevier Computer Networks Journal (Torsten Braun)
- Elsevier Ad Hoc Networks Journal (Thomas Staub, Torsten Braun)
- IEEE Network Magazine (Torsten Braun, Attila Weyland)

- IEEE Transactions on Mobile Computing (Torsten Braun)
- IEEE Infocom (Torsten Braun)
- IEEE Communications Magazine (Torsten Braun, Attila Weyland)
- ACM Transactions on Multimedia Computing Communications and Applications (Torsten Braun)
- Wiley International Journal of Communication Systems Springer Wireless Networks (Torsten Braun)
- Reviewer for The Handbook of Computer Networks, Wiley (Torsten Braun)

Invited Talks and Tutorials

- Torsten Braun: Entstehung und Funktionsweise des Internets, Collegium Generale “Virtuelle Welten? Die Realität des Internets”, University of Bern, November 2, 2005
- Torsten Braun: Multimediale Dienste als Resultat der Konvergenz von Telekommunikation und Informatik, 12. Elite Telecom Tagung 2005, Bern, November 3, 2005
- Torsten Braun: Fernüberwachung von industriellen Anlagen über Sensor Internet, Heidelberger Innovationsforum, November 30, 2005
- Torsten Braun: Wireless Sensor Networks: A Systems View, Las Vegas, Tutorial at IEEE Consumer Communications and Networking Conference (CCNC), Las Vegas, January 8, 2006
- Torsten Braun: Optimized Stateless Broadcasting in Wireless Multi-hop Networks, 5th COST 290 meeting, February 9–10, 2006, Delft, The Netherlands
- Dragan Milic: Utilizing P2P Overlay Multicast using standard IP-Multicast Applications, Dagstuhl Seminar 06131 (Peer-to-Peer Systems and Applications), Dagstuhl, Germany, March 27, 2006
- Torsten Braun: Broadcasting and Reliable Transport in Wireless Multi-hop Networks, NEC Colloquium, April 13, 2006, Heidelberg

- Thomas Bernoulli: Experimental Lifetime Evaluation for MAC Protocols on Real Sensor Hardware, Workshop on Distributed Systems and Networks, held in conjunction with WWIC 2006, Bern, May 9, 2006
- Torsten Braun: Computer Networks and Distributed Systems Research @ University of Bern, Workshop on Distributed Systems and Networks, held in conjunction with WWIC 2006, Bern, May 9, 2006
- Torsten Braun: Telematiknetze, Kaderkurs Telematik, Bundesamt für Bevölkerungsschutz, Schwarzenburg, Switzerland, November 29, 2005; April 25, 2006; May 30, 2006
- Thomas Staub: Réseaux de communications, cours de cadres pour chefs de la télématique, Office fédéral de la protection de la population, Schwarzenburg, Switzerland, May 30, 2006
- Torsten Braun: The EuQoS project, Terena ENGINE workshop, Prague, June 1, 2006

Organized Events

Torsten Braun has been scientific chair of the MICS Scientific conference 2005 held from September 21–23 at Löwenberg / Murten (Switzerland). The RVS group hosted the the 6th COST 290 management committee meeting on May 9–10, 2006 as well as the 4th International Conference on Wired/Wireless Internet Communications (WWIC) on May 10–12, 2006.

Awards

Marc Heissenbüttel received the award from the GI/ITG Fachgruppe “Kommunikation und Verteilte Systeme” (KuVS) for his Ph.D. thesis on “Routing and Broadcasting in Ad-Hoc Networks.” This award is given each year to outstanding Ph.D. theses in the area of Communication Networks and Distributed Systems.

4.8 Publications

Publications submitted in the academic year 2005/2006 and appearing in 2006/2007 or later are not listed.

Books and Book Chapters

- Torsten Braun, Georg Carle, Sonia Fahmy, Yevgeni Koucheryavy (Editors): Proceedings of the Wired/Wireless Internet Communications, WWIC 2006, Bern, Switzerland, Springer Verlag, ISBN 3-540-34023-8, May 10 - 12, 2006

Reviewed Journal and Conference Papers

- Marc Heissenbüttel, Torsten Braun, David Jörg, Thomas Huber: A Framework for Routing in Large Ad-Hoc Networks with Irregular Topologies, 4th Annual Mediterranean Ad Hoc Networking Workshop, Île de Porquerolles, France, June 21–24, 2005, ISBN 0-387-31171-8, pp. 119–128, Springer Boston
- Thiemo Voigt, Adam Dunkels, Torsten Braun: On-demand Construction of Non-interfering Multiple Paths in Wireless Sensor Networks, 2nd Workshop on Sensor Networks at Informatik 2005, 35. Jahrestagung der Gesellschaft für Informatik, Bonn, Germany, September 21, 2005, ISBN 3-88579-397-0, pp. 150–154, GI LNI
- Dragan Milic, Marc Brogle, Torsten Braun: Video Broadcasting using Overlay Multicast, Seventh IEEE International Symposium on Multimedia (ISM 2005), Irvine, California, USA, December 12–14, 2005, ISBN 0-7695-2489-3, pp. 515–522, IEEE Computer Society Press
- Marc Heissenbüttel, Torsten Braun, David Jörg, Thomas Huber: A Framework for Routing in Large Ad-hoc Networks with Irregular Topologies, Ad Hoc & Sensor Wireless Networks, Vol. 2, Nr. 2, January 1, 2006, ISSN 1551-9899 (print) / 1552-0633 (on-line), pp. 1–24, Old City Publishing
- Marc Danzeisen, Torsten Braun, Marc Heissenbüttel, Isabel Steiner: Simulations on Heterogeneous Networking with CAHN, IEEE Consumer Communications and Networking Conference, Las Vegas, USA, January 08–10, 2006, ISBN 1-4244-0085-6, pp. 923–927, IEEE
- Markus Wälchli, Matthias Scheidegger, Torsten Braun: Intensity-based Event Localization in Wireless Sensor Networks, Third Annual Conference on Wireless On demand Network Systems and Services (WONS), Les Ménuires, France, January 18–20, 2006, pp. 41–49

- Torsten Braun, Vijay Arya, Thierry Turletti: Explicit Routing in Multicast Overlay Networks, *Computer Communications*, Issue 12, Vol. 29, August 4, 2006, ISSN 0140-3664, pp. 2201-2216, Elsevier
- Marc Heissenbüttel, Torsten Braun, Markus Wälchli, Thomas Bernoulli: Optimized Stateless Broadcasting in Wireless Multi-hop Networks, *IEEE Infocom*, Barcelona, Spain, March 23–29, 2006, ISBN 1-4244-0222-0, IEEE
- Marc Danzeisen, Torsten Braun, Daniel Rodellar, Simon Winiker: Heterogeneous Communications Enabled by Cellular Operators, *IEEE Vehicular Technology Magazine*, Vol. 1, No. 1, March 2006, ISSN 1556-6072, pp. 23–30, IEEE
- Marc Danzeisen, Torsten Braun, Isabel Steiner, Marc Heissenbüttel: On the Potential of Heterogeneous Networks, 4th International Conference on Wired/Wireless Internet Communications, Bern, Switzerland, May 10–12, 2006, ISBN 3-540-34023-8, pp. 84–95, Springer LNCS 3970
- Philipp Hurni, Torsten Braun, Laura Marie Feeney: Simulation and Evaluation of Unsynchronized Power Saving Mechanisms in Wireless Sensor Networks, 4th International Conference on Wired/Wireless Internet Communications, Bern, Switzerland, May 10–12, 2006, ISBN 3-540-34023-8, pp. 311–324, Springer LNCS 3970
- Thomas Spreng, Torsten Braun, Marc Steinemann, Attila Weyland: Implementation of an Authentication and Authorization Architecture for Mobile Internet Users, 6th International Workshop on Applications and Services in Wireless Networks (ASWN'06), Berlin, Germany, May 29–31, 2006, ISBN 3-8167-7111-4, pp. 207–213
- Matthias Scheidegger, Torsten Braun, Florian Baumgartner: Endpoint Cluster Identification for End-to-End Distance Estimation, *IEEE International Conference on Communications*, Istanbul, Turkey, June 11–15, 2006, ISBN 1-4244-0355-3, IEEE
- Markus Wälchli, Samuel Bissig, Torsten Braun: Intensity-based Object Localization and Tracking with Wireless Sensors, *ACM Workshop on Real-World Wireless Sensor Networks (REALWSN'06)*, Uppsala, Sweden, June 19, 2006, ISBN 1-59593-431-6, pp. 61–65, ACM Press

- Thomas Staub, Thomas Bernoulli, Markus Anwander, Markus Wälchli, Torsten Braun: Experimental Lifetime Evaluation for MAC Protocols on Real Sensor Hardware, ACM Workshop on Real-World Wireless Sensor Networks (REALWSN'06), Uppsala, Sweden, June 19, 2006, ISBN 1-59593-431-6, pp. 25–29, ACM Press
- Aurelius Baier, Thomas Bernoulli, Torsten Braun, Christoph Graf, Ulrich Ultes-Nitsche: Case Study of the Usage of an Authentication and Authorization Infrastructure (AAI) in an E-learning Project, Proceedings of the ISSA 2006 from Insight to Foresight Conference, Sandton, Gauteng, South Africa, July 5–7, 2006, ISBN 1-86854-636-5
- Markus Wälchli, Torsten Braun: Receiver-based CDS Algorithm for Wireless Networks, 5. GI/ITG KuVS Fachgespräch Drahtlose Sensornetze, Stuttgart, Germany, July 17–18, 2006, pp. 69–73
- Attila Weyland, Thomas Staub, Torsten Braun: Comparison of Motivation-based Cooperation Mechanisms for Hybrid Wireless Networks. *Computer Communications*, Vol. 29, Issues 13–14, August 21, 2006, ISSN 0140-3664, pp. 2661–2670, Elsevier
- Torsten Braun, Georg Carle, Yevgeni Koucheryavy, Vassilis Tsoulos: Editorial – Wired/Wireless Internet Communications, *Computer Communications*, Vol. 29, Issues 13–14, August 21, 2006, ISSN 0140-3664, pp. 2599–2600, Elsevier

Magazine Papers

- Torsten Braun: Geschichte und Entwicklung des Internets, *Unipress* 127/2005, December 1, 2005, pp. 5–6
- Torsten Braun: Geschichte und Entwicklung des Internets, *SWITCHjournal*, June, 2006, ISSN 1422-5662, pp. 6–8

Technical Reports

- Laurent Dairaine, Emmanuel Lochin, Thomas Staub et al.: First version of standardization documents, EuQoS Deliverable D6.1.2, CEC Deliverable Number 004503/NICTA/DS/D6.1.2/A, September 2, 2005

- Pascal Le Guern, Marc Brogle, Dragan Milic et al.: Connectivity and performance tests report for local and pan-European (across GÉANT) testbed design for the Trial, EuQoS Deliverable D5.1.2, CEC Deliverable Number 004503/FTRD/DS/D5.1.2/A3, February 6, 2006
- Pascal Le Guern, Marc Brogle, Dragan Milic et al.: First individual based EuQoS System test report, EuQoS Deliverable D5.1.3, CEC Deliverable Number 004503/FTRD/DS/D5.1.3/A2, February 6, 2006
- Thomas Staub, Thomas Bernoulli et al.: Description of complete pilot course implementation and course teaching / learning platform including evaluation report from pilot course delivery, EuQoS Deliverable D6.1.3, CEC Deliverable Number 004503/UoB/DS/D6.1.3/A1, February 6, 2006
- Martin Potts, Thomas Staub, Marc-Alain Steinemann et al.: Plan for using and disseminating knowledge, including description of dissemination activities (e.g., demonstrations, publications), EuQoS Deliverable D6.1.5, CEC Deliverable Number 004503/Martel/DS/6.1.5/A1, February 6, 2006
- Pascal Le Guern, Marc Brogle, Dragan Milic et al.: Testbed integration test plan, EuQoS Deliverable D5.1.4, CEC Deliverable Number 004503/FTRD/DS/D5.1.4/A1, April 13, 2006
- Pascal Le Guern, Marc Brogle, Dragan Milic et al.: Trial report, EuQoS Deliverable D5.1.5, CEC Deliverable Number 004503/FTRD/DS/D5.1.5/A1, April 26, 2006
- Mark Günther, Martin Potts, Marc Brogle, Thomas Staub et al.: Report on raising public participation and awareness, EuQoS Deliverable D6.1.6, CEC Deliverable Number 004503/Telscom/DS/6.1.6/A1, April 30, 2006
- Attila Weyland, Torsten Braun: OSLab Course Author Guide, Technical Report IAM-06-003, July, 2006
- Attila Weyland, Torsten Braun: OSLab Module Author Guide, Technical Report IAM-06-004, July, 2006

5 Research Group on Computer Vision and Artificial Intelligence

5.1 Personnel

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	V. Kilchherr	Tel: +41 31 631 33 23 email: kilchher@iam.unibe.ch
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	B. Spillmann*	Tel: +41 31 631 49 87 email: spillman@iam.unibe.ch (until 31.07.2006)
	Dr. T. Varga*	Tel: +41 31 631 33 27 email: varga@iam.unibe.ch (until 31.03.2006)
	Guests:	Prof. A. Kandel
Prof. X. Jiang		University of Münster, Germany June 2006

* 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. Another field of activities is biometric person identification where the focus is on writer identification, using on-line and off-line data. Last but not least, we are working in the field of structural pattern recognition, where we aim at developing methods to extend and improve current algorithms for string and graph matching.

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 recognition 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. Recently, also the problem of writer identification has been studied. Furthermore, multiple classifier systems and their application to handwriting recognition are under investigation. Part of these activities are carried out in the Swiss NCCR project "Interactive Multimodal Information Management Systems".

Research staff: R. Bertolami, V. Kilchherr, M. Liwicki, A. Schlapbach, T. Varga

Graph Matching Algorithms and Applications

Graphs are a flexible and powerful representation mechanism that has been successfully applied in computer vision, pattern recognition and related areas. When graphs are used to represent objects of a particular domain, the recognition problem turns into the task of graph matching. In this project we study a variety of issues, including efficient algorithms for graph matching, the adaption of concepts and techniques based on vector representations to the domain of graphs, and special classes of graphs that allow matching with polynomial complexity. Recently, we have also investigated the problem of ontology matching.

Research Staff: Ch. Irniger, M. Neuhaus, B. Spillmann

Biometric Person Authentication Using Fingerprints and Handwriting

Fingerprint analysis is one of the most reliable and most widely accepted biometric techniques for person identification. Most automatic fingerprint identification systems use a procedure for the extraction of characteristic features followed by a feature matching algorithm. In this project we study the application of structural pattern recognition methods, in particular attributed graph matching, to the problem of fingerprint classification and identification. Our main objective includes the development of efficient fingerprint recognition algorithms based on the ridge line structures occurring in fingerprints.

Handwriting is believed to be unique to one writer. Writer identification is the task of determining the author of a sample of handwriting from a set of writers. Writer verification is the task of deciding whether or not a handwritten text has been written by a certain writer. In this project we investigate various approaches to writer identification and verification, including Hidden Markov and Gaussian Mixture Models.

Part of these activities are carried out in the Swiss NCCR project “Interactive Multimodal Information Management Systems”.

Research staff: M. Neuhaus, A. Schlapbach

5.4 Ph.D. Theses

- Varga, T.: Off-line cursive handwriting recognition using synthetic training data (January 2006)
- Neuhaus, M.: Bridging the gap between graph edit distance and kernel machines (June 2006)

5.5 Diploma and Master’s Theses

- Halter, B.: Kombination von Erkennern für handgeschriebene Textzeilen (Januar 2006)
- Mugglin, M.: Tutorial für die Handschrifterkennung (März 2006)
- Angeli, R.: Ein Perturbationsansatz zur Erkennung handgeschriebener Textzeilen (März 2006)

5.6 Bachelor's Theses and Computer Science Projects

- Zumkehr, P.: Writer Identification Using Greedy Learning of Gaussian Mixture Models (Februar 2006)
- Gerber, S.: Graphextraktion mittels Delaunay-Triangulation (Mai 2006)
- Kälin, B.: StrCombo - Kombination von Handschriftenerkennern (Mai 2006)
- Spycher, O.: Writer Identification using Directional Features from Edges of Handwritten Images (August 2006)

5.7 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 the International Journal on Document Analysis and Recognition
- Member of the editorial board of Pattern Analysis and Applications
- Member of the editorial board of Acta Cybernetica
- Editor-in-chief of the book series Machine Perception and Artificial Intelligence by World Scientific Publ., Singapore

Membership in Committees (H. Bunke)

- Program Committee member "13th International Conference on Image Analysis and Processing (ICIAP)", Cagliari, Sardinia, September 6 - 8, 2005

- Organizing Committee member “IEEE International Conference on Systems, Man, and Cybernetics, Special Session on Ensemble Methods for Extreme Environments”, Big Island, Hawaii, October 10 - 12, 2005
- Program Committee member “1st International Symposium on Brain, Vision and Artificial Intelligence”, Naples, Italy, October 19 - 21, 2005
- Program Committee member “10th Iberoamerican Congress on Pattern recognition”, Havana, Cuba, November 15 - 18, 2005
- Advisory Committee member “1st International Conference on Pattern Recognition and Machine Intelligence (PReMI)”, Kolkata, India, December 18 - 22, 2005
- Program Committee member “International Conference on Biometric Authentication”, Hong Kong, January 5 - 7, 2006
- Workshop Co-Chair “7th IAPR Workshop on Document Analysis Systems (DAS)”, Nelson, New Zealand, February 13 - 15, 2006
- Program Committee member “21th Annual ACM Symposium on Applied Computing”, Dijon, France, April 23 - 27, 2006
- Program Committee member “6th Industrial Conference on Data Mining (ICDM)”, Leipzig, Germany, July 14 - 15, 2006
- Program Committee member “18th International Conference on Pattern Recognition”, Hong Kong, August 20 - 24, 2006
- Program Committee member “2nd Workshop on Artificial Neural Networks in Pattern Recognition (ANNPR)”, Castle Reisenburg, Günzburg, Germany, August 31 - September 2, 2006

Activities in National NCCR (H. Bunke)

- Head of individual project “Multimodal Access and Contents Protection” of the NCCR Project IM2 (Interactive Multimodal Information Management Systems) (until end of 2005)

Additional Activities (H. Bunke)

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

5.8 Publications

Books and Special Issues of Journals

- Bunke, H., Spitz, L.A. (eds.): Document Analysis Systems VII, Proc. 7th Int. Workshop DAS 2006, Nelson, New Zealand, Springer, LNCS 3872, 2006

Journal Publications

- Ding, Z., Bunke, H., Schneider, M., Kandel, A.: Fuzzy timed Petri net – definitions, properties and applications, *Mathematical and Computer Modelling* 41, 2005, 345 - 360
- Zimmermann, M., Chappelier, J.-C., Bunke, H.: Offline grammar-based recognition of handwritten sentences, *IEEE Trans. Pattern Analysis and Machine Intelligence*, Vol. 18, No. 5, May 2006, 818 - 821
- Bunke, H., Dickinson, P., Irniger, Ch., Kraetzl, M.: Recovery of missing information in graph sequences by means of reference pattern matching and decision tree learning, *Pattern Recognition* 39, 2006, 573 - 586
- Ding, Z., Bunke, H., Kipersztok, O., Schneider, M., Kandel, A.: Fuzzy timed Petri net – analysis and implementation, *Mathematical and Computer Modelling* 43, 2006, 385 - 400
- Jiang, X., Marti, C., Irniger, Ch., Bunke, H.: Distance measures for image segmentation evaluation, *EURASIP Journal on Applied Signal Processing*, Volume 2006, Article ID 35909, 2006, 1 - 10
- Neuhaus, M., Bunke, H.: Edit distance based kernel functions for structural pattern classification, *Pattern Recognition* 39, 2006, 1852 - 1863

Refereed Conference Proceedings and Edited Books

- Neuhaus, M., Bunke, H.: Graph-based multiple classifier systems – a data level fusion approach, in Roli, F., Vitulano, S. (eds.): Image Analysis and Processing – ICIAP 2005, Springer Verlag, Lecture Notes in Computer Science, Vol. 3617, 2005, 479 - 486
- Bunke, H., Dickinson, P., Kraetzl, M.: Theoretical and algorithmic framework for hypergraph matching, in Roli, F., Vitulano, S. (eds.): Image Analysis and Processing – ICIAP 2005, Springer Verlag, Lecture Notes in Computer Science, Vol. 3617, 2005, 463 - 470
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- Bertolami, R., Bunke, H.: Ensemble methods for handwritten text line recognition systems, Proc. 2005 IEEE Int. Conf. on Systems, Man and Cybernetics, Waikoloa, Hawaii, 2334 - 2339
- Liwicki, M., Schlapbach, A., Bunke, H., Bengio, S., Mariethoz, J., Richiardi, J.: Writer identification for smart meeting room systems, in Bunke, H., Spitz, L.A. (eds.): Document Analysis Systems VII, Proc. 7th Int. Workshop DAS 2006, Nelson, New Zealand, Springer, LNCS 3872, 2006, 186 - 195
- Bunke, H., Dickinson, P., Humm, A., Irniger, Ch., Kraetzl, M.: Computer network monitoring and abnormal event detection using graph matching and multidimensional scaling, in Perner P. (Ed.): Advances in Data Mining, Proc. 6th Industrial Conference on Data Mining, ICDM, Leipzig Germany, July 2006, Springer Verlag, LNAI 4065, 2006, 576 - 590
- Bertolami, R., Bunke, H.: Diversity analysis for ensembles of word sequence recognisers, Proc. Joint IAPR Workshops on Structural and Syntactic Pattern Recognition and Statistical Techniques in Pattern Recognition, Hong Kong, 2006, 677 - 686

- Le Saux, B., Bunke, H.: Combining SVM and graph matching in a Bayesian multiple classifier system for image content recognition, Proc. Joint IAPR Workshops on Structural and Syntactic Pattern Recognition and Statistical Techniques in Pattern Recognition, Hong Kong, 2006, 696 - 704
- Spillmann, B., Neuhaus, M., Bunke, H., Pekalska, E., Duin, B.: Transforming strings to vector spaces using prototype selection, Proc. Joint IAPR Workshops on Structural and Syntactic Pattern Recognition and Statistical Techniques in Pattern Recognition, Hong Kong, 2006, 287 - 296
- Neuhaus, M., Riesen, K., Bunke, H.: Fast suboptimal algorithms for the computation of graph edit distance, Proc. Joint IAPR Workshops on Structural and Syntactic Pattern Recognition and Statistical Techniques in Pattern Recognition, Hong Kong, 2006, 163 - 172
- Neuhaus, M., Bunke, H.: A random walk kernel derived from graph edit distance, Proc. Joint IAPR Workshops on Structural and Syntactic Pattern Recognition and Statistical Techniques in Pattern Recognition, Hong Kong, 2006, 191 - 199
- Pekalska, E., Harol A., Duin, R.P.W., Spillmann, B., Bunke, H.: Non-Euclidean or non-metric measures can be informative, Proc. Joint IAPR Workshops on Structural and Syntactic Pattern Recognition and Statistical Techniques in Pattern Recognition, Hong Kong, 2006, 871 - 880
- Bertolami, R., Bunke, H.: Early feature stream integration versus decision level combination in a multiple classifier system for text line recognition, Proc. 18th Int. Conference on Pattern Recognition, Hong Kong, Vol. 2, 2006, 845 - 848
- Liwicki, M., Scherz, M., Bunke, H.: Word segmentation of on-line handwritten text lines, Proc. 18th Int. Conference on Pattern Recognition, Hong Kong, Vol. 2, 2006, 929 - 933
- Schlapbach, A., Bunke, H.: Off-line writer identification using Gaussian mixture models, Proc. 18th Int. Conference on Pattern Recognition, Hong Kong, Vol. 3, 2006, 992 - 995
- Neuhaus, M., Bunke, H.: A convolution kernel for error-tolerant graph matching, Proc. 18th Int. Conference on Pattern Recognition, Hong Kong, Vol. 4, 2006, 220 - 223

- Spillmann, B., Neuhaus, M., Bunke, H.: Multiple classifier systems for embedded string patterns, Proc. 2nd Int. Workshop on Artificial Neural Networks in Pattern Recognition, Reisenburg Castle, Germany, 2006, 177 - 187

Unrefereed Papers and Technical Reports

- Basu, M., Bunke, H., Del Bimbo, A.: Guest editor's introduction to the special section on syntactic and structural pattern recognition, IEEE Trans. PAMI, Vol. 27, No. 7, 2005, 1009 - 1012

6 Research Group on Theoretical Computer Science and Logic

6.1 Personnel

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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

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

Algebraic and Logical Aspects of Knowledge Representation

We are mainly interested in the logical analysis of formalisms for representing and dealing with mathematical and computational knowledge. We

employ and set up conceptual frameworks, in particular, theories relating classical mathematics with constructive mathematics and feasible mathematics, thereby always emphasizing the computational properties and complexities of our formalisms.

The formal settings of interest include intensional and extensional set theories, theories of inductive definitions, systems of explicit mathematics, substructural proof and type systems, as well as modal and fixed point logics.

We continue to use proof theory as our main tool for analyzing the constructive and computational content of various formalisms and we aim at further exploiting the proofs as computations paradigm. Theories of explicit mathematics will be one of our central formalism to address the various themes of this project.

In the first part of our project we will focus on:

- the analysis of general, least and largest fixed points of complex inductive definitions,
- higher reflection and higher order functionals.

Our research aims in the second part of the project are centered around the general relation between extensionality and intensionality. In particular, we are interested in:

- the full intersection axiom in explicit mathematics,
- set theories without extensionality and/or foundation,
- proof systems with weakened structural properties.

Finally, our research concerning feasible and (sub-)recursive proof and type systems can be structured as follows:

- a proof-theoretic approach to feasible functionals of higher types,
- the setting up of feasible systems of types and names à la Feferman,
- investigations into deep inference and the calculus of structures.

Research staff: K. Brünnler, G. Jäger, R. McKinley, N. Nussbaum (until 31.7.06), D. Probst, V. Salipante (until 31.12.05), Th. Strahm

Financial support: Swiss National Science Foundation

Inference and Deduction

We study in this project further aspects of information and knowledge. These include:

1. Algebraic aspects of information arising from the operations of aggregation (combination) and focusing of information.
2. Modeling of structures of compatible questions or domains and the relation of information and its measures relative to particular questions or domains.
3. Uncertain nature of information, the corresponding inference problems, with particular attention to statistical information.
4. Dynamic nature of information and knowledge, including the passage from information to knowledge and reasoning about knowledge.
5. Proof theory of modal μ -calculus.

These issues will be studied in their own right, but also with the goal to establish links between the fragments and existing fragments of a theory of information. This should be a step towards an integrated theory of information.

The relative nature of information and its measure with respect to particular questions is emphasized. The algebraic aspects of information are studied in the perspective of important practical systems such as relational databases, constraint systems and probability networks. Information and its algebraic structure is also considered in relation to general abstract structures such as contexts, classifications or Chu spaces. The combinatorial nature of information arising from their algebraic structure will be carried over to uncertain information. Frameworks for knowledge representation (including common knowledge) and knowledge accumulation, updates and belief revision will be developed. The dynamical aspects of information and knowledge and their explicit logical treatment will play an important role.

This is a common project of the theoretical computer science groups of the Universities of Fribourg and Berne. Both groups have a specific background: Fribourg in the domain of the algebraic structure of information (valuation and information algebras), and additionally in probabilistic modeling, in particular probabilistic argumentation systems, Berne in the field of mathematical and computational logic. The alternative, but complementary backgrounds have proven fruitful in the past and will be profitable for the project proposed here.

Research staff: P. Brambilla, G. Jäger, M. Kretz, D. Steiner, R. Wehbe

Financial support: Swiss National Science Foundation

Dynamic Ontologies

In collaboration with: Prof. Dr. K. Stoffel, University of Neuchâtel

Over the last decade, ontologies have moved beyond academic domains such as knowledge representation, philosophy, or library science. They became a cornerstone in support of interoperability for facilitation of knowledge management and configuration. This development triggered a lot of interesting research questions. One of the fundamental questions is how to extend the simple logical inference system into real multi-user systems that are able to deal with the dynamic aspects of ontologies in such an environment. The goal of the dynamic ontologies project is to formally analyze, specify and implement a prototype of a complex ontology management system that will be able to meet the requirements imposed by modern information management systems.

Research staff: G. Jäger, Ph. Stouppa, Th. Studer

Financial support: Swiss National Science Foundation

ViLoLa - a Virtual Logic Laboratory (maintenance)

In collaboration with: Prof. Dr. G. Grasshoff, Prof. Dr. A. Hollenstein, and Prof. Dr. J. Schmid, University of Bern; Prof. Dr. Jürg Kohlas, University of Fribourg; Dr. U.-M. Künzi, Hochschule Rapperswil; Prof. Dr. J. Rolim, University of Geneva

ViLoLa provides a modular learning environment for many aspects of logic: Philosophical, mathematical and applications to computer science.

The original aims of the ViLoLa package are met, partially even surpassed. All modules have been field tested and are in regular use at this time. Tools (LWB, Logic Work Bench; AWB, Algebraic Work Bench) are continually expanded and even used in courses outside the original ViLoLa framework. Evaluation procedures are integrated into the project (project partner A. Hollenstein). It has become apparent that a module "Introduction to Set Theory" should complement the package to make it fully self-contained and independent.

Research staff: G. Jäger, U.-M. Künzi

Financial support: Swiss Virtual Campus

Logic and Information

In collaboration with: Prof. Dr. J. Schmid, University of Bern; Prof. Dr. J. Kohlas, Prof. Dr. U. Ultes-Nitsche, Prof. Dr. G. Sommaruga, University of Fribourg; Prof. Dr. K. Stoffel, University of Neuchâtel

A collaboration project within the so-called “Réseau BeNeFri” in order to enhance and support research on logic and information and the many connections between both. Focus is on

- good models for the representation and processing of information and knowledge,
- powerful deduction and inference procedures, including the relevant complexity considerations,
- concrete applications.

Research staff: R. Haenni, G. Jäger, G. Ostrin, D. Probst, Th. Strahm, Th. Studer

Financial support: Swiss University Conference (CUS)

Logics for Explicit Common Knowledge (until February 2006)

This project is complementary to the project *Inference and Deduction*, supported by the Swiss National Science Foundation. It addresses some conceptual problems in connection with the general theme of *Common Knowledge* and tries to make a genuine step forward in obtaining a better understanding of the crucial logical issues which until now have not been handled to a satisfactory degree.

More precisely, we want to set up a logical framework in which common knowledge and ways how common knowledge is obtained can be treated

- in a clear structural and proof-theoretic way, and
- with emphasis on the procedural aspects of these processes.

To achieve these aims, we want to start of from recent work of Artemov about explicit provability and proof polynomial in modal logics.

Research staff: G. Jäger, G. Ostrin

Financial support: Hasler Foundation

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. Jonczyk, R. Kohlas, M. Wachter

Financial support: Swiss National Science Foundation

Probabilistic Argumentation: a Unified Theory of Logical and Probabilistic Reasoning

Logic and probability theory have both a long history in science. They are mainly rooted in philosophy and mathematics, but are nowadays important tools in many other fields such as computer science and, in particular, artificial intelligence. Some philosophers studied the connection between logical and probabilistic reasoning, and some attempts to combine these disciplines have been made in computer science, but logic and probability

theory are still widely considered to be separate theories that are only loosely connected.

This project investigates a new perspective which shows that logical and probabilistic reasoning are no more and no less than two opposite extreme cases of one and the same universal theory of reasoning called probabilistic argumentation. The goal of the project is to further study this theory and its wide range of possible applications in different areas of uncertain reasoning.

Research staff: R. Haenni, J. Jonczyk, R. Kohlas, M. Wachter

Financial support: Leverhulme Trust and Proginet

ABEL

ABEL is modeling language and a solver for problems in the domain of uncertain reasoning. The goal of this project is to redesign ABEL and make the system compatible with the modern view and techniques of probabilistic argumentation.

Research staff: R. Haenni, J. Jonczyk, R. Kohlas, M. Wachter

Financial support: Swiss National Science Foundation

Managing Trust in Distributed Systems

In large open networks, handling trust and authenticity adequately is an important prerequisite for security. In a distributed approach, all network users are allowed to issue various types of credentials, e.g. certificates, recommendations, revocations, ratings, etc. This project investigates such a distributed approach, in which the evaluation of trust and authenticity is based on so-called credential networks. The idea is to use probabilistic argumentation as the underlying mathematical machinery. A complete framework for the specification and evaluation of credential networks has been implemented.

Research staff: R. Haenni, J. Jonczyk, R. Kohlas, M. Wachter

Financial support: Hasler Foundation

6.4 Ph.D. Theses

- D. Probst: Pseudo-Hierarchies in Admissible Set Theory without Foundation and Explicit Mathematics
- V. Salipante: On the Consistency Strength of the Strict Π_1^1 Reflection Principle

6.5 Diploma Theses

- M. Dürig: PALC: Extending ALC ABoxes with Probabilities
- J. Jonczyk: Kredientalnetze: ein allgemeines Modell für den Umgang mit Vertrauen und Authentizität in verteilten Netzwerken
- M. Wachter: Der AKS-Primtest

6.6 Bachelor's Theses and Computer Science Projects

- Jürg Krähenbühl: Goodstein Sequences: An Exploration with Elementary Arithmetic and Induction
- Patric Martin: Formalizing coordinated attack in Logic of Common Knowledge and Time
- Thomas Wüthrich: Modallogiken: Ein Vergleich zwischen CTL und PDL

6.7 Further Activities

Editorial Boards

- Member of the editorial board of Archive of Mathematical Logic (G. Jäger)
- Member of the consulting board of Dialectica (Th. Strahm)

Technical and Research Committees

- Research Council member of the Swiss National Science Foundation (G. Jäger)
- President of the Swiss Society for Logic and Philosophy of Science (G. Jäger)
- Secretary of the Swiss Society for Logic and Philosophy of Science (Th. Strahm)
- Member of the Scientific Council of the European Association for Computer Science Logic (G. Jäger)
- Member of the Council of the Association for Symbolic Logic (G. Jäger)
- Expert for “Maturitätsprüfungen Mathematik” (G. Jäger, Th. Strahm, Th. Studer)
- Program Committee member of the Colloquium Logicum 2006 (G. Jäger)
- Co-organizer of special session “Proofs and Computation”, Computability in Europe 2006 (T. Strahm)

Awards

D. Probst was awarded a Faculty Prize (Fakultätspreis der Phil.-nat. Fakultät der Universität Bern) for his Ph.D. thesis “Pseudo-Hierarchies in Admissible Set Theory without Foundation and Explicit Mathematics”.

6.8 Publications

- K. Brännler, Cut Elimination for Predicate Logic inside a Deep Inference System, *Studia Logica* 82, 2006
- K. Brännler, Deep inference and its normal form of derivations, *Second Conference on Computability in Europe, CiE 2006*, 2006
- K. Brännler, Deep Sequent Systems for Modal Logic, *Advances in Modal Logic*, to appear

- K. Brännler, Locality for Classical Logic, *Notre Dame Journal of Formal Logic*, to appear
- K. Brännler and S. Lengrand, On Two Forms of Bureaucracy in Derivations, *Structures and Deduction Workshop 2005*, 2005
- M. Dürig and Th. Studer, Extending ALC ABoxes with Probabilities, submitted
- R. Haenni, Non-Additive Degrees of Belief, to appear
- R. Haenni, Shedding New Light on Zadeh's Criticism of Dempster's Rule of Combination, *FUSION'05, 8th International Conference on Information Fusion*, 2005
- R. Haenni, Towards a Unifying Theory of Logical and Probabilistic Reasoning, *ISIPTA'05, 4th International Symposium on Imprecise Probabilities and Their Applications*, 2005
- R. Haenni, Uncover Dempster's Rule Where It Is Hidden, *FUSION'06, 9th International Conference on Information Fusion*, to appear
- R. Haenni and S. Hartmann, Modeling Partially Reliable Information Sources: a General Approach based on Dempster-Shafer Theory, *Information Fusion*, 2006
- R. Haenni, J. Jonczyk and R. Kohlas, Two-Layer Models for Managing Authenticity and Trust, *Trust in E-Services: Technologies, Practices and Challenges*, to appear
- G. Jäger, M. Kretz and Th. Studer, Cut-free axiomatizations for stratified modal fixed point logic, *Methods for Modalities 4*, 2005
- G. Jäger, M. Kretz and Th. Studer, Cut-free common knowledge, *Journal of Applied Logic*, to appear
- G. Jäger, M. Kretz and Th. Studer, Cut-free systems for the propositional modal μ -calculus, submitted
- G. Jäger and Th. Strahm, Reflections on reflections in explicit mathematics, *Annals of Pure and Applied Logic*, 2005
- J. Jonczyk, Evaluating Trust and Authenticity with CAUTION, *4th International Conference on Trust Management*, 2006

- J. Jonczyk and R. Haenni, Credential Networks: a General Model for Distributed Trust and Authenticity Management, *PST'05, 3rd Annual Conference on Privacy, Security and Trust*, 2005
- J. Jonczyk and R. Haenni, Implementing Credential Networks, *4th International Conference on Trust Management*, 2006
- D. Probst, The proof-theoretic analysis of transfinitely iterated quasi least fixed points, *Journal of Symbolic Logic*, to appear
- D. Steiner, A system for consistency preserving belief change, *ESS-LLI Workshop on Rationality and Knowledge*, to appear
- D. Steiner and Th. Strahm, On the proof theory of type two functionals based on primitive recursive operations, *Mathematical Logic Quarterly*, 2006
- K. Stoffel and Th. Studer, Provable data privacy, *Proceedings of Conference on Database and Expert Systems Applications*, 2005
- Ph. Stouppa, A Deep Inference System for the Modal Logic S5, *Studia Logica*, to appear
- Ph. Stouppa and Th. Studer, A formal model of data privacy, *Perspectives of System Informatics*, to appear
- Th. Studer, Explicit Mathematics: Power Types and Overloading, *Annals of Pure and Applied Logic*, 2005
- R. Wehbe, A Hybrid Representation of Knowledge and Belief, *Formal Approaches to Multi-Agent Systems*, to appear
- M. Wachter, Representing Boolean Functions with Propositional Directed Acyclic Graphs, *ECAI'06, Workshop 26: Inference methods based on graphical structures of knowledge*, to appear
- M. Wachter and R. Haenni, Propositional DAGs: a New Graph-Based Language for Representing Boolean Functions, *10th International Conference on Principles of Knowledge Representation and Reasoning*, 2006
- M. Wachter, R. Haenni and J. Jonczyk, Reliability and Diagnostics of Modular Systems: a New Probabilistic Approach, *18th International Workshop on Principles of Diagnosis*, 2006

7 Research Group on Software Composition

7.1 Personnel

Head:	Prof. Dr. O. Nierstrasz	Tel: +41 31 631 46 18 email: oscar@iam.unibe.ch
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	A. Kuhn*	Tel: +41 31 631 48 68 email: kuhn@iam.unibe.ch
	A. Lienhard*	Tel: +41 31 631 35 47 email: lienhard@iam.unibe.ch
	Dr. L. Ponisio*	Tel: +41 31 631 33 15 email: ponisio@iam.unibe.ch
	L. Renggli	Tel: +41 31 631 35 47 email: renggli@iam.unibe.ch

*with financial support from a third party

**external PhD student

7.2 Overview

Complex software systems must change to keep pace with changing needs and requirements. In this context, the Software Composition Group carries out research in programming language design and software reengineering with the goal of facilitating the development of flexible, open soft-

ware systems.

Language design: Languages shape the way we develop the software systems. We have developed constructs for extending and customizing existing code, and for expressing cross-cutting concerns to support code reuse. Modern programming languages and environments provide little support for the fact that the systems being built will inevitably change. That is why recently, rather than building languages that limit the impact of changes, we are investigating new paradigms that explicitly put changes in the center of the language. We are researching constructs such as first class changes and scope to enable several running versions co-existing in the same time, or to control the changing of the code at runtime via reflection.

Software reengineering: To successfully evolve software systems, we need to effectively understand them. We investigate new mining techniques and presentation means to support the understanding and detection of maintenance problems. Our focus ranges from analyzing the last version of the system to analyzing the entire versioning repository, and we consider as target artifacts source code, change logs, authorship information, dynamic information gathered by running the system, external documentation and tests. We strongly believe that tool support is mandatory in this field, and as a result, we have built over the past ten years an extensive environment for reengineering.

7.3 Research Projects

A Unified Approach to Composition and Extensibility

The goal of this project is to investigate means to support composability and extensibility in object-oriented languages, while reducing fragility with respect to unanticipated change. The work covers (i) *fine-grained composition* with *traits*, (ii) *coarse-grained composition* with *classboxes*, (iii) *analysis* of software systems with *formal concept analysis* and other techniques, (iv) *testing strategies*.

Recent progress includes the development of a prototype of Classboxes for Java, a prototype implementation of Traits for C# and a formal treatment of Traits for statically-typed languages. We have also developed ByteSurgeon, a tool for runtime bytecode transformation, that is used for a variety of reflective applications, and we have used Bytesurgeon to develop Gepetto, a system to support unanticipated reflection for Smalltalk.

Research staff: All members of the research group.

Duration: Oct. 2004 - Sept. 2006

Financial support: Swiss National Science Foundation, project no. 200020-105091/1

For further details, please consult:

<http://www.iam.unibe.ch/~scg/Research/SNF04/>

RECAST: Evolution of Object-Oriented Applications

The goal of the Recast project is to support the evolution of object-oriented applications by focusing on three main directions: reverse engineering and reengineering, versions analysis, and migration towards components.

We have built Mondrian, a new engine that allows for scripting and for fast prototyping of visualizations. Mondrian is part of our infrastructure for reverse and reengineering. We have started to investigate how symbols are spread over the system to identify implementation topics. We have analyzed how authors change the system and how they duplicate code from one another. We are also working on the identification of the relationship between features and of the relationship between authors and features.

Research staff: All members of the research group.

Duration: Oct. 2002 - Sept. 2006

Financial support: Swiss National Science Foundation, project no. 620-066077

For further details, please consult:

<http://www.iam.unibe.ch/~scg/Research/Recast/index.html>

NOREX: Network of Reengineering Expertise

NOREX is a collaborative effort between the Universities of Lugano, Timisoara, and Bern. The goal of of this joint research project is to provide a comprehensive and extensible support for complex, full-fledged reengineering activities applicable to real-world systems. Specifically, we want to address these issues by building a distributed reengineering environment which is able to make all the techniques and models defined and implemented by each of the three research teams to complement each other.

Research staff: All members of the research group.

Duration: Oct. 2005 - Sept. 2007

Financial support: Swiss National Science Foundation under SCOPES 2005-2008: Scientific Co-operation between Eastern Europe and Switzerland.

For further details, please consult:

<http://www.iam.unibe.ch/~scg/Research/NOREX/index.html>

7.4 Ph.D. Theses

- Alexandre Bergel. *Classboxes — Controlling Visibility of Class Extensions*. PhD thesis, University of Berne, November 2005.
- Juan Carlos Cruz. *A Group Based Approach for Coordinating Active Objects*. PhD thesis, University of Berne, Berne, June 2006.
- Tudor Gîrba. *Modeling History to Understand Software Evolution*. PhD thesis, University of Berne, Berne, November 2005.
- María Laura Ponisio. *Exploiting Client Usage to Manage Program Modularity*. PhD thesis, University of Berne, Berne, June 2006.

7.5 Master's Theses

- Adrian Kuhn. *Semantic clustering: Making use of linguistic information to reveal concepts in source code*. Master's thesis, University of Bern, March 2006.
- Lukas Renggli. *Magritte – meta-described web application development*. Master's thesis, University of Bern, June 2006.
- David Röthlisberger. *Geppetto: Enhancing Smalltalk's reflective capabilities with unanticipated reflection*. Master's thesis, University of Bern, January 2006.
- Mauricio Seeberger. *How developers drive software evolution*. Master's thesis, University of Bern, January 2006.
- Christoph Wyseier. *Interactive 3-D visualization of feature-traces*. Master's thesis, University of Berne, Switzerland, November 2005.

7.6 Bachelor's Theses and Computer Science Projects

- David Gurtner. Importing JSP into Moose. Bachelor's thesis, University of Bern, July 2006.
- Niklaus Haldimann. A sophisticated programming environment to cope with scoped changes. Informatikprojekt, University of Bern, December 2005.
- Rebecca Hiller. SEDEXfield — PDA Programm zur Beurteilung von Wildbächen. Bachelor's thesis, University of Bern, March 2006.
- Niklaus Jordi and Frank Wettstein. Die Entwicklung von Psystatix. Informatikprojekt, University of Bern, 2005.
- Michael Meyer. Merlin: A continuous integration tool for Visual-Works. Informatikprojekt, University of Berne, December 2005.
- Stefan Reichhart. A prototype of Traits for C#. Informatikprojekt, University of Bern, 2005.
- Florian Thalmann and Markus Gaelli. Jam Tomorrow: Collaborative music generation in Croquet using OpenAL. In *Proceedings of C5 2006 (The Fourth International Conference on Creating, Connecting and Collaborating through Computing)*, January 2006.

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)
- Software and Systems Modeling, Springer Verlag – (Associate Editor)

Stéphane Ducasse:

- RSTI (Revue des Sciences et Techniques de l'Information)

Memberships

Oscar Nierstrasz:

- CHOOSE – Swiss group for Object-Oriented Systems and Environments (President)
- SARIT – Swiss Association for Research in Information Technology (Board member)
- AITO – Association Internationale pour les Technologies Objets (Vice President)
- 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)

Stéphane Ducasse:

- ESUG – European Smalltalk User Group (President)

Program Committees

Oscar Nierstrasz:

- Program Chair of MoDELS 2006 (9th International Conference on Model Driven Engineering Languages and Systems – Genoa, Italy, Oct 1-6, 2006)
- PC Member of EVOL 2006 (International ERCIM Workshop on Software Evolution – Lilles, France, April 6-7, 2006)
- PC Member of DLS05 (Dynamic Languages Symposium at OOPSLA 2005 – San Diego, Oct 18, 2005)
- PC Member of MoDELS / UML 2005 (ACM/IEEE 8th International Conference on Model Driven Engineering Languages and Systems – Jamaica, Oct 2-7, 2005)

Stéphane Ducasse:

- PC member of IDM 2006 (Journées sur l'Inginérie Dirigée par les Modeèles – Lille, France, 27-28 June, 2006)
- PC member of CSMR 2006 (10th European Conference on Software Maintenance and Reengineering – Bari, Italy, March 22-24, 2006)
- PC member of ICPC 2006 (4th IEEE International Conference on Program Comprehension – Athens, Greece, June 14-16, 2006)
- PC member of LMO 2006 (Conférence sur les Langues et Modèles à Objets – Nîmes, France, March 22-24, 2006)
- PC member of MoDELS 2006 (9th International Conference on Model Driven Engineering Languages and Systems – Genoa, Italy, Oct 1-6, 2006)
- Organizer of International Workshop on Visualizing Software for Understanding and Analysis 2005 (Vissoft)
- PC Member of DLS05 (Dynamic Languages Symposium at OOPSLA 2005 – San Diego, Oct 18, 2005)
- International Conference on Software Maintenance (ICSM 2005)

Tudor Gîrba:

- PC Member of ESUG 2006 (The 14th International Smalltalk Conference 2006 – Prague, Czech Republic, Sep 4-8, 2006)
- PC Member of NODe 2006 Net.ObjectDays Conference – Erfurt, Germany, Sep 18-20, 2006)

Orla Greevy:

- PC Member of PCODA 2005 (1st Workshop on Program Comprehension through Dynamic Analysis – Nov 10, 2005)

Reviewing Activities

Oscar Nierstrasz:

- Swiss National Science Foundation,
- Netherlands Organisation for Scientific Research,
- Australian Research Council,

- NSERC GCS 330 – Natural Sciences and Engineering Research Council of Canada, Member of the Grant Selection Committee for Computing & Information Sciences (subgroup A)
- ACM TOPLAS

Stéphane Ducasse:

- ACM Transactions on Software Engineering (TSE)
- Journal of Software Evolution and Maintenance (SEM)
- Journal of Empirical Software Engineering
- Scientific reviewer for NWO (Nederlandse Organisatie voor Wetenschappelijk Onderzoek — Dutch National Research Council).
- Scientific reviewer for NSERC GCS 330 (Natural Sciences and Engineering Research Council of Canada, Grant Selection Committee for Computing & Information Sciences — A).
- Scientific reviewer for ANR (agence nationale de la recherche, France)

Tudor Gîrba:

- Journal of Software Maintenance and Evolution (JSME)
- Journal of Empirical Software Engineering

Invited Talks

Oscar Nierstrasz:

- Invited speaker at ESEC/FSE 2005 (European Software Engineering Conference Lisbon, Portugal, Sept. 5-9, 2005)
- Invited Speaker at GPCE'05 (Generative Programming and Component Engineering Tallinn, Estonia, Sep 29 - Oct 1, 2005)

7.8 Publications

Journal Papers

- Alexandre Bergel, Stéphane Ducasse, and Oscar Nierstrasz. Analyzing module diversity. *Journal of Universal Computer Science*, 11(10):1613–1644, November 2005. TR-LISTIC-0512.
- Marcus Denker, Stéphane Ducasse, and Éric Tanter. Runtime bytecode transformation for Smalltalk. *Journal of Computer Languages, Systems and Structures*, 32(2-3):125–139, July 2006.
- Stéphane Ducasse, Oscar Nierstrasz, and Matthias Rieger. On the effectiveness of clone detection by string matching. *International Journal on Software Maintenance and Evolution: Research and Practice*, 18(1):37–58, January 2006.
- Stéphane Ducasse, Oscar Nierstrasz, Nathanael Schärli, Roel Wuyts, and Andrew Black. Traits: A mechanism for fine-grained reuse. *ACM Transactions on Programming Languages and Systems*, 28(2):331–388, March 2006.
- Tudor Gîrba and Stéphane Ducasse. Modeling history to analyze software evolution. *International Journal on Software Maintenance: Research and Practice (JSME)*, 18:207–236, 2006.
- Kris Gybels, Roel Wuyts, Stéphane Ducasse, and Maja D’Hondt. Inter-language reflection – a conceptual model and its implementation. *Journal of Computer Languages, Systems and Structures*, 32(2-3):109–124, July 2006.
- Oscar Nierstrasz, Stéphane Ducasse, and Serge Demeyer. Objektorientierte re-engineering-muster: ein Überblick. *ObjektSpektrum*, 2005(6):46–51, 2005. German translation of “Object-oriented Reengineering Patterns — an Overview” (GPCE 05).
- Oscar Nierstrasz, Stéphane Ducasse, and Nathanael Schärli. Flattening Traits. *Journal of Object Technology*, 5(4):129–148, May 2006.

Conference Papers

- Mihai Balint, Tudor Gîrba, and Radu Marinescu. How developers copy. In *Proceedings of International Conference on Program Comprehension (ICPC 2006)*, pages 56–65, 2006.
- Alexandre Bergel and Stéphane Ducasse. Supporting unanticipated changes with Traits and Classboxes. In *Proceedings of Net.ObjectDays (NODE'05)*, pages 61–75, Erfurt, Germany, September 2005. TR-LISTIC-0514.
- Alexandre Bergel, Stéphane Ducasse, and Oscar Nierstrasz. Class-box/J: Controlling the scope of change in Java. In *Proceedings of Object-Oriented Programming, Systems, Languages, and Applications (OOPSLA'05)*, pages 177–189, New York, NY, USA, 2005. ACM Press.
- Stéphane Ducasse, Tudor Gîrba, and Roel Wuyts. Object-oriented legacy system trace-based logic testing. In *Proceedings 10th European Conference on Software Maintenance and Reengineering (CSMR 2006)*, pages 35–44. IEEE Computer Society Press, 2006.
- Stéphane Ducasse, Michele Lanza, and Laura Ponisio. Butterflies: A visual approach to characterize packages. In *Proceedings of the 11th IEEE International Software Metrics Symposium (METRICS'05)*, pages 70–77. IEEE Computer Society, 2005.
- Stéphane Ducasse, Lukas Renggli, and Roel Wuyts. SmallWiki — a meta-described collaborative content management system. In *International Symposium on Wikis (WikiSym'05)*, pages 75–82, New York, NY, USA, 2005. ACM Computer Society.
- Markus Gaelli, Michele Lanza, and Oscar Nierstrasz. Towards a taxonomy of SUnit tests. In *Proceedings of ESUG 2005 (13th International Smalltalk Conference)*, September 2005.
- Markus Gaelli, Oscar Nierstrasz, and Serge Stinckwich. Idioms for composing games with EToys. In *Proceedings of C5 2006 (The Fourth International Conference on Creating, Connecting and Collaborating through Computing)*, January 2006. To appear.
- Orla Greevy, Stéphane Ducasse, and Tudor Gîrba. Analyzing feature traces to incorporate the semantics of change in software evolution

analysis. In *Proceedings of ICSM 2005 (21th International Conference on Software Maintenance)*, pages 347–356. IEEE Computer Society Press, September 2005. TR-LISTIC-0520.

- Sunghun Kim, Thomas Zimmermann, Miryung Kim, Ahmed Hassan, Audris Mockus, Tudor Gîrba, Martin Pinzger, James Whitehead, and Andreas Zeller. TA-RE: An exchange language for mining software repositories. In *Proceedings Workshop on Mining Software Repositories (MSR 2006)*, pages 22–25, 2006.
- Adrian Kuhn, Stéphane Ducasse, and Tudor Gîrba. Enriching reverse engineering with semantic clustering. In *Proceedings of Working Conference on Reverse Engineering (WCRE 2005)*, pages 113–122, Los Alamitos CA, November 2005. IEEE Computer Society Press. TR-LISTIC-0519.
- Adrian Lienhard, Stéphane Ducasse, and Gabriela Arévalo. Identifying traits with formal concept analysis. In *Proceedings of ASE '05 (20th Conference on Automated Software Engineering)*, pages 66–75. IEEE Computer Society Press, November 2005. TR-LISTIC-0517.
- Mircea Lungu, Michele Lanza, and Tudor Gîrba. Package patterns for visual architecture recovery. In *Proceedings 10th European Conference on Software Maintenance and Reengineering (CSMR 2006)*, pages 183–192, Los Alamitos CA, 2006. IEEE Computer Society Press.
- Cristina Marinescu, Radu Marinescu, and Tudor Gîrba. Towards a simplified implementation of object-oriented design metrics. In *METRICS 2005*, pages 110–119, 2005.
- Oscar Nierstrasz, Alexandre Bergel, Marcus Denker, Stéphane Ducasse, Markus Gaelli, and Roel Wuyts. On the revival of dynamic languages. In Thomas Gschwind and Uwe Aßmann, editors, *Proceedings of Software Composition 2005*, volume 3628, pages 1–13. LNCS 3628, 2005. Invited paper.
- Oscar Nierstrasz, Stéphane Ducasse, and Serge Demeyer. Object-oriented reengineering patterns — an overview. In Michael Lowry Robert Glück, editor, *Proceedings of Generative Programming and Component Engineering (GPCE 2005)*, pages 1–9. LNCS 3676, 2005. Invited paper.

- Oscar Nierstrasz, Stéphane Ducasse, and Tudor Gîrba. The story of Moose: an agile reengineering environment. In *Proceedings of the European Software Engineering Conference (ESEC/FSE 2005)*, pages 1–10, New York NY, 2005. ACM Press. Invited paper.
- Laura Ponisio and Oscar Nierstrasz. Using context information to re-architecture a system. In *Proceedings of the 3rd IEEE Software Measurement European Forum 2006 (SMEFS'06)*, pages 91–103. IEEE Computer Society, 2006.
- Romain Robbes, Stéphane Ducasse, and Michele Lanza. Microprints: A pixel-based semantically rich visualization of methods. In *Proceedings of ESUG 2005 (13th International Smalltalk Conference)*, pages 131–157, 2005. TR-LISTIC-0518.
- Éric Tanter, Kris Gybels, Marcus Denker, and Alexandre Bergel. Context-aware aspects. In *Proceedings of the 5th International Symposium on Software Composition (SC 2006)*, LNCS, pages 229–244, Vienna, Austria, March 2006.
- Marcel Weiher and Stéphane Ducasse. High-order messaging. In *Proceedings of SDL 2005 (International Symposium on Dynamic Languages)*, pages 23–34. ACM Press, 2005. TR-LISTIC-0515.

Technical Reports

- Oscar Nierstrasz, Stéphane Ducasse, Stefan Reichhart, and Nathanael Schärli. Adding Traits to (statically typed) languages. Technical Report IAM-05-006, Institut für Informatik, Universität Bern, Switzerland, December 2005.
- Oscar Nierstrasz, Stéphane Ducasse, and Nathanael Schärli. Flattening Traits. Technical Report IAM-05-005, Institut für Informatik, Universität Bern, Switzerland, April 2005.
- Laura Ponisio and Oscar Nierstrasz. Using contextual information to assess package cohesion. Technical Report IAM-06-002, University of Berne, Institute of Applied Mathematics and Computer Sciences, 2006.

Workshop Papers

- Alexandre Bergel and Marcus Denker. Prototyping languages, related constructs and tools with Squeak. In *In Proceedings of the Workshop on Revival of Dynamic Languages (co-located with ECOOP'06)*, July 2006.
- Serge Demeyer, Filip Van Rysselberghe, Tudor Gîrba, Jacek Ratzinger, Radu Marinescu, Tom Mens, Bart Du Bois, Dirk Janssens, Stéphane Ducasse, Michele Lanza, Matthias Rieger, Harald Gall, Michel Wermelinger, and Mohammad El-Ramly. The LAN-simulation: A research and teaching example for refactoring. In *Proceedings of IWPSE 2005 (8th International Workshop on Principles of Software Evolution)*, pages 123–131, Los Alamitos CA, 2005. IEEE Computer Society Press.
- Marcus Denker and Stéphane Ducasse. Software evolution from the field: an experience report from the Squeak maintainers. In *Ercim workshop on Software Evolution*, 2006.
- Stéphane Ducasse, Michele Lanza, and Romain Robbes. Multi-level method understanding using Microprints. In *Proceedings of Vissoft 2005 (3th IEEE International Workshop on Visualizing Software for Understanding)*, September 2005.
- Markus Gaelli, Orla Greevy, and Oscar Nierstrasz. Composing unit tests. In *Proceedings of SPLiT 2006 (2nd International Workshop on Software Product Line Testing)*, September 2005.
- Tudor Gîrba, Adrian Kuhn, Mauricio Seeberger, and Stéphane Ducasse. How developers drive software evolution. In *Proceedings of International Workshop on Principles of Software Evolution (IWPSE 2005)*, pages 113–122. IEEE Computer Society Press, 2005.
- Orla Greevy and Stéphane Ducasse. Characterizing the functional roles of classes and methods by analyzing feature traces. In *Proceedings of WOOR 2005 (6th International Workshop on Object-Oriented Reengineering)*, July 2005.
- Orla Greevy, Michele Lanza, and Christoph Wyssseier. Visualizing feature interaction in 3-D. In *Proceedings of Vissoft 2005 (3th IEEE International Workshop on Visualizing Software for Understanding)*, pages 114–119, September 2005.

- Adrian Kuhn, Orla Greevy, and Tudor Gîrba. Applying semantic analysis to feature execution traces. In *Proceedings of Workshop on Program Comprehension through Dynamic Analysis (PCODA 2005)*, pages 48–53, November 2005.
- Mircea Lungu, Adrian Kuhn, Tudor Gîrba, and Michele Lanza. Interactive exploration of semantic clusters. In *3rd International Workshop on Visualizing Software for Understanding and Analysis (VIS-SOFT 2005)*, pages 95–100, 2005.
- Oscar Nierstrasz, Marcus Denker, Tudor Gîrba, and Adrian Lienhard. Analyzing, capturing and taming software change. In *In Proceedings of the Workshop on Revival of Dynamic Languages (co-located with ECOOP'06)*, July 2006.

Miscellaneous

- Stéphane Ducasse, Tudor Gîrba, and Oscar Nierstrasz. Moose: an agile reengineering environment, September 2005. Tool demo.
- Mauricio Seeberger, Adrian Kuhn, Tudor Gîrba, and Stéphane Ducasse. Chronia: Visualizing how developers change software systems, March 2006. Tool demo.

8 Administration

University:

- H. Bieri: Member of Collegium generale
- T. Braun: Member of Kommission Informatikdienste
Delegate of the University of Bern at the board of trustees
of SWITCH (Vertreter der Universität Bern im Stiftungsrat
SWITCH)

Faculty:

- T. Braun: Member of Evaluationskommission

Institute:

- H. Bieri: Prüfungsleiter
- T. Braun: Deputy Director of IAM
- H. Bunke: Member of Hauskommission Engehalde
- O. Nierstrasz: Director of IAM
- T. Strahm: Member of Bibliothekskommission Exakte
Wissenschaften
Member of Hauskommission Exakte Wissenschaften