

Annual Report
Academic Year 2003/2004

IAM-04-006

August, 2004

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1 Institute of Computer Science and Applied Mathematics (IAM)

1.1 Address

Neubrückstrasse 10, CH-3012 Bern, Switzerland
Telephone: +41 31 631 86 81, Telefax: +41 31 631 32 62
www: <http://www.iam.unibe.ch>

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

Dr. Florian Baumgartner; Prof. Dr. Hanspeter Bieri; Prof. Dr. Torsten Braun;
Prof. Dr. Horst Bunke; Dr. Aurelio Cortesi; Prof. Dr. Stéphane Ducasse;
Prof. Dr. Gerhard Jäger; Prof. Dr. Oscar Nierstrasz; Dr. Geoffrey Ostrin; M.
Scheidegger; PD Dr. Thomas Strahm; Dr. Thomas Studer.

Director

Prof. Dr. Oscar Nierstrasz.

Administration

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

Library

Rosa Di Matteo; Gudrun Heim; Katrin Wegmüller.

Technical staff

Roland Balmer; Peppo Brambilla.

Scientific staff

Dr. Joël Adler; Lorenz Ammon; Gabriela Arévalo; Roland Balmer; Dr. Florian Baumgartner; Alexandre Bergel; Roman Bertolami; Peppo Brambilla; Dr. Kai Brännler; Thomas Buchberger; Theo Burri; Juan Carlos Cruz; Marc Danzeisen; Marcus Denker; Ruy de Oliveira; Marcus Gaelli; Tudor Girba; Orla Greevy; Simon Günter; Marc Heissenbüttel; Christophe Irniger; Michel Krebs; Mathis Kretz; Dr. Urs-Martin Künzi; Michele Lanza; Dr. Bertrand Le Saux; Marcus Liwiki; Marcin Michalak; Michel Neuhaus; Dr. Geoffrey Ostrin; Laura Ponisio; Dieter Probst; Matthias Rieger; Philippe Robert; Vincenzo Salipante; Nathanael Schärli; Matthias Scheidegger; Andreas Schlapbach; Marc-Alain Steinemann; David Steiner; Dr. Thomas Studer; Jeremy Tammik; Tamas Varga; Thomas Wenger; Attila Weyland; Marc Wirz; Dr. Roel Wuyts; Matthias Zimmermann.

2 Teaching Activities

2.1 Courses for Major and Minor in Computer Science

Winter Semester 2003/2004

- 1st Semester

Einführung in die Informatik (H. Bieri, 3 ECTS)

Übungen zu Einführung in die Informatik (H. Bieri, 1.5 ECTS)

Grundlagen der technischen Informatik (T. Braun, 3 ECTS)

Übungen zu Grundlagen der technischen Informatik (T. Braun, 1.5 ECTS)

Programmierung 1 (Th. Strahm, 3 ECTS)

Übungen zu Programmierung 1 (Th. Strahm, 1.5 ECTS)

- 3rd Semester

Automaten und formale Sprachen (H. Bunke, 3 ECTS)

Übungen zu Automaten und formale Sprachen (H. Bunke, 1.5 ECTS)

Datenbanken (K. Stoffel, 3 ECTS)

Übungen zu Datenbanken (K. Stoffel, 1.5 ECTS)

Einführung in Software Engineering (O. Nierstrasz, 3 ECTS)

Übungen zu Einführung in Software Engineering (O. Nierstrasz, 1.5 ECTS)

- 5th Semester

Künstliche Intelligenz (H. Bunke, 3 ECTS)

Übungen zu Künstliche Intelligenz (H. Bunke, 1.5 ECTS)

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

Übungen zu 3D-Grafik (H. Bieri, 1.5 ECTS)

Logik und Informatik (Th. Strahm, 3 ECTS)
Übungen zu Logik und Informatik (Th. Strahm, 1.5 ECTS)
Computernetze (T. Braun, 3 ECTS)
Übungen zu Computernetze (T. Braun, 1.5 ECTS)

- Special Program

Mustererkennung 2 (H. Bunke 3 ECTS)
Seminar: Künstliche Intelligenz (H. Bunke, 3 ECTS)
Praktikum Computeranimation (H. Bieri, 3 ECTS)
Seminar: Computergeometrie und Grafik (H. Bieri, 3 ECTS)
Seminar: Theoretische Informatik und Logik (G. Jäger, 3 ECTS)
Seminar: Inferenz und Deduktion (G. Jäger und J. Kohlas, 3 ECTS)
Concurrent Programming (O Nierstrasz, 3 ECTS)
Interpreting Object-Oriented Models (S. Ducasse, 3 ECTS)
Seminar: Software Composition (O. Nierstrasz, 3 ECTS)
Netzwerk- und Protokollprogrammierung (F. Baumgartner, 3 ECTS)
Seminar: Rechnernetze und Verteilte Systeme (T. Braun, 3 ECTS)
Parallel Algorithms and Programming (A. Cortesi, 3ECTS)

- Service Course

Anwendungssoftware (Th. Studer, 4.5 ECTS)

Summer Semester 2004

- 2nd Semester

Datenstrukturen und Algorithmen (H. Bieri, 3 ECTS)
Übungen zu Datenstrukturen und Algorithmen (H. Bieri, 1.5 ECTS)
Programmierung 2 (O. Nierstrasz, 3 ECTS)
Übungen zu Programmierung 2 (O. Nierstrasz, 1.5 ECTS)

Rechnerarchitektur (F. Baumgartner, 3 ECTS)

Übungen zu Rechnerarchitektur (F. Baumgartner, 1.5 ECTS)

- 4th Semester

Computergrafik (H. Bieri, 3 ECTS)

Übungen zu Computergrafik (H. Bieri, 1.5 ECTS)

Einführung in die theoretische Informatik (Th. Strahm, 3 ECTS)

Übungen zu Einführung in die theoretische Informatik (Th. Strahm, 1.5 ECTS)

Praktikum in Software Engineering (O. Nierstrasz, 4.5 ECTS)

- 6th Semester

Compilerbau (H. Bunke, 3 ECTS)

Übungen zu Compilerbau (H. Bunke, 1.5 ECTS)

Grundlagen der Mustererkennung (H. Bunke, 3 ECTS)

Übungen zu Grundlagen der Mustererkennung (H. Bunke, 1.5 ECTS)

Programmiersprachen (O. Nierstrasz, 3 ECTS)

Übungen zu Programmiersprachen (O. Nierstrasz, 1.5 ECTS)

Betriebssysteme und Verteilte Systeme (M. Scheidegger, 3 ECTS)

Übungen zu Betriebssysteme und Verteilte Systeme (M. Scheidegger, 1.5 ECTS)

- Special Program

Praktikum Bildanalyse und Mustererkennung (H. Bunke, 3 ECTS)

Seminar: Künstliche Intelligenz (H. Bunke, 3 ECTS)

Digitale Bilder (H. Bieri, 3 ECTS)

Seminar: Computergeometrie und Grafik (H. Bieri, 3 ECTS)

Seminar: Theoretische Informatik und Logik (G. Jäger, 3 ECTS)

Seminar: Inferenz und Deduktion (G. Jäger und J. Kohlas, 3 ECTS)

Scheme (S. Ducasse, 3 ECTS)

Seminar: Software Composition (O. Nierstrasz, 3 ECTS)

Praktikum Computernetze (T. Braun, 3 ECTS)

Parallel Computer Architecture (A. Cortesi, 3 ECTS)

An Introduction to Set Theory (G. Ostrin, 1.5 ECTS)

- Service Course

Anwendungssoftware (Th. Studer, 4.5 ECTS)

2.2 Colloquium in Computer Science

- 21/10/2003 Dr. Leszek Lilien
Department of Computer Sciences, Purdue University
Developing Pervasive Trust Paradigm for Authentication
and Authorization
- 28/10/2003 Ozgur Ercetin
Sabanci University
Energy-Efficient Multi-Path Routing in Unreliable Wire-
less Sensor Networks
- 11/11/2003 Prof. Dr. C. A. Zehnder
ETH Zürich
Bachelor-Master-Programme im Informatikstudium –
Vorder- und Hintergründiges
- 06/01/2004 Prof. Hans-Peter A. Künzi
Department of Mathematics and Applied Mathematics,
University of Cape Town
Ramsey Theory and Some of Its Applications
- 20/01/2004 Gilad Bracha
Sun Microsystems
Adding Generics to the Java(tm) Programming Language
- 03/02/2004 Shriram Krishnamurthi
Brown University
Automated Modular Verification in Product-Line Systems
- 27/04/2004 Robert Stärk
Computer Science Department, ETH Zürich
Formal Specification, Validation and Verification of Sys-
tems with Abstract State Machines

- 11/05/2004 Prof. Dr. Ulrich Ultes-Nitsche
Departement für Informatik, Universität Freiburg
Traceability of Design Patterns for Automatic Verification of Finite-state Systems – Linear-time Temporal Logic Model-Checking
- 28/06/2004 Michel Pahud
Microsoft Research, Learning Sciences and Technology
The Innovative Learning Initiative

2.3 Students

- Major Subject Students: 247
- Minor Subject Students: 186
- PhD Candidates: 28

2.4 Degrees and Examinations

- PhD: 2
- Diploma: 22
- Major Subject Examinations: 49 (Diplom 1. Teil: 27, Propädeutische Hauptfachprüfung: 22, 2160 ECTS)
- Completion of Minor Studies: 34 (60E: 9, 45E: 7, 36E: 2, 31E: 1, 30E: 2, 18E: 11, 13E: 1, 24 Stunden-Programm: 1, 1265 ECTS)
- Semester Examinations Winter Semester 2003/2004: 594 (2673 ECTS)
- Semester Examinations Summer Semester 2004: 517 (2326.5 ECTS)

3 Research Group on Computational Geometry and Graphics

3.1 Personnel

| | | |
|--------------------------|--------------------|---|
| Head: | Prof. Dr. H. Bieri | Tel.: +41 31 631 8670 email: bieri@iam.unibe.ch |
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| | Th. Buchberger | Tel.: +41 31 631 4864 email: buchberg@iam.unibe.ch |
| | Ph. Robert | Tel.: +41 31 631 4679 email: robert@iam.unibe.ch |
| | Th. Wenger | Tel.: +41 31 631 4990 email: wenger@iam.unibe.ch |

3.2 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

Subdivision Surfaces in Real-Time Character Animation

Commercial 3D animation software packages like Maya, Softimage XSI or Lightwave have broad and mature support for character animation. But all of them can't be used directly in real-time applications such as computer games or real-time simulations.

This project investigates various aspects of real-time character animation for computer games:

- Level-of-detail techniques to achieve scalability.
- Real-time computation requiring efficient algorithms (time-complexity $O(n \log n)$ or better).
- Rendering on common triangle based 3D hardware. This hardware favors polygon based techniques like progressive meshes or subdivision surfaces.
- Integration into game engines.

The goal of this research project is to design and implement a scalable system that supports real-time character animation in 3D computer games.

Three main techniques are used and compared against each other:

- Discrete level-of-detail.
- Mesh simplification (e.g. quadric error metrics or progressive meshes).
- Subdivision surfaces.

Research staff: Ch. Ammann

Collaboration on Scene Graph Based 3D Models

Professional 3D modeling applications like Alia Maya or discrete 3ds max offer only limited support for a team of designers to work on a 3D model collaboratively. There is even less support for managing revisions and variants or different representations of designs. 3D models are often made up of thousands of objects in a scene graph (DAG) that is stored in one single file. Therefore commercial group authoring tools and revision control systems cannot provide a solution as they generally work file based and/or are specialized to text documents only and thus cannot take advantage of the DAG structure of 3D models.

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. A simple configuration management implements some intensional versioning aspects on top of the extensional versioning.

Support for collaboration between different 3D modeling applications is provided by heterogeneous 3D scenes that integrate the applications different representations of 3D models. When working with such a scene in an application, models stored in a representation unknown to that application are transparently replaced by proxy models in a supported representation. Those proxy models can be automatically derived by converters from the models in their original representations. For collaboration purposes, the proxy models do not need to be perfect copies but more or less accurate approximations to the original models they stand for, thus only rather simple converters have to be written or bought. The heterogeneous scene is supposed to be rendered with a common external renderer supported by all applications involved such as RenderMan or Mental Ray.

Research staff: L. Ammon

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

Albert Einstein exhibition

The Historical Museum of Bern will hold a special exhibition about Albert Einstein in 2005 to celebrate the centenary of the Theory of Relativity and its discovery in Bern. This exhibition will feature in particular a virtual ride with a bicycle through the city of Bern along the route from Einstein's home to his

place of work. Depending on the pedalling speed a relativistic visualization will be shown simulating riding at almost speed of light.

As a project partner the research group will provide the 3-dimensional computer model of the relevant part of the city of Bern. Multiple student projects are involved in contributing to this project, including

- “A generic house model for buildings of the city of Bern” which allows the quick generation of 3-dimensional house models depending on some input parameters
- “Fusion of roof data and cadastral ground plans” which helps integrating photogrammetrically acquired roof data into the city model
- several models of important buildings which are modelled in detail by hand

Research staff: Th. Buchberger, K. Rollé, M. Zaugg, J. Marbach, Ch. Gutmann, A. Polyansky, K. Tran, H. Bieri

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.

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

Interactive Ray Tracing

This research project investigates algorithms, data structures and implementation techniques which have to be adopted in order to design and implement an interactive ray tracing system. Our main focus thereby lies on aspects which are of particular importance to single system image (SSI) computer based solutions, as opposed to the more common cluster-based approaches. Among these are e.g. efficient memory management and cache usage, clever computation optimizations using the SIMD programming model and general purpose computations on the GPU (GPGPU). We furthermore look into the usage of non-trivial rendering primitives in our interactive ray tracer, such as

e.g. implicit surfaces. Part of this effort is the development of a ray tracing based graphics library named RGL, which enables us to compare important facets of our interactive ray tracing system to traditional, z-buffer based renderers such as OpenGL.

Research staff: Ph. C.D. Robert

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. A lot of standalone tools and mesh libraries with a specialized focus are available today. But currently there doesn't exist any 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. 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 generation, mesh simplification, mesh subdivision, and signal processing with meshes will be implemented. The mesh data structures and algorithms will offer extensions targeting especially at didactic use cases, like e.g. visualization and documentation. Several typical JMesh-based prototype applications will 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 should be useful to application developers too.

Research staff: Th. Wenger

Reconstruction of a Classical Animation Short

Many classical animations which were done in the past were drawn (2D) or made out of clay figures (3D). Some of them have significant lack of quality in terms of footage. Others look to be quite stiff in their motion. The main goal of this diploma project is to reconstruct an animation short with today's 3D graphics capabilities and to reduce these drawbacks. Being a typical example, the animation short "Pat & Mat: Apple" by Lubomír Beneš and Vladimír Jiránek from the year 1985 has been chosen. The reconstruction process goes through five stages:

- Modelling: Characters (Pat & Mat) are constructed using subdivision surfaces while other objects are constructed with NURBS or polygon meshes.
- Animation: Characters in the original animation short are animated by the stop motion technique. Stop motion frames translate directly into key frames in the timeline of the animation software. In-between frames will be automatically computed, which results in smoother animation of the characters.
- Texturing: Because of the original animation’s poor VHS footage quality, textures have to be reproduced from other sources as they can’t be extracted from the original movie material.
- Lighting: Positions and intensities of light sources will be estimated by analyzing the shadows being cast by objects in the scene.
- Rendering: For the reconstruction of the animation short, camera positions will be adopted from the original scene.

At the end, it will be possible to experiment with other camera positions to see what an effect this would have on a viewer. To fulfil all the needs of this rather complex process, the software package by Alias—Wavefront Maya is used.

Research staff: D. Bukovac

Digital Tapestry Reconstruction

The Bernese Historical Museum owns a famous collection of Burgundian tapestry (15th century). This tapestry is in a surprisingly good condition, however it has been repaired several times and most of its colors have badly changed and in particular faded.

This image processing project tries to digitally refresh some of this tapestry. As normally the colors of the back face are much better conserved, one approach does refreshing mainly by copying corresponding pixels from the back to the front face. Another approach works only with the front face and tries to replace the color of the pixels by their “original” colors using ancient color descriptions and other sources.

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

Real-Time Fluid Flow Rendering

Previous research efforts have shown that realistic fluid-flow rendering can be achieved in real-time in 2D. This project aims at implementing a real-time fluid flow renderer in 3D, based on the well-known Navier-Stokes equations and variations thereof. The required performance for real-time usage will be obtained exploiting coherence (SIMD programming) as well as using the GPU as stream based coprocessor (GPGPU). The focus of this work is on smoke visualization.

Research staff: D. Schweri, Ph. Robert

3.3 Diploma Theses

- Oliver Aeberhard: Echtzeit-Simulation der Zuschauersicht am Beispiel des Stadttheaters Bern
- Christian M. Ammann: Implementation von Computerspielen unter Verwendung von Subdivision Surfaces
- Rudolf Blattner: Evaluations-Tool zur Rekonstruktion von Gebäuden aufgrund von Fragmenten
- Michel Bruhin: 3D-Rekonstruktion von Figuren in Gemäldezyklen am Beispiel von Niklaus Manuels Totentanz
- Marc Hugli: Level of Detail in 3D Games

3.4 Further Activities

- Project artcampus: “Art History 1200 - 2002” of the Swiss Virtual Campus. Project partner: H. Bieri
- Project “Albert Einstein Exhibition” of the Historisches Museum Bern. Project partner: H. Bieri
- Reviewing for the journal The Visual Computer: L. Ammon, H. Bieri
- Reviewing for WSCG 2004: L. Ammon, H. Bieri
- Professor election committee at the University of Neuchâtel: H. Bieri
- Professor election committee at the Swiss Federal Institute of Technology, Zurich: H. Bieri

3.5 Publications

- M. Kallmann, H. Bieri, D. Thalmann: Fully Dynamic Constrained Delaunay Triangulations. In G. Brunnett, B. Hamann, H. Müller, L. Linsen (Eds.): Geometric Modelling for Scientific Visualization, 241-257, Springer 2003
- C. Glauser, H. Bieri: From Road Maps to 3D-Scenes: A Reconstruction System. In S.N. Spencer, M. Zimanyi (Eds.): Proceedings of the 19th Spring Conference on Computer Graphics, 263 - 272, ACM Press 2003
- X. Jiang, H. Bieri: 3D Imaging and Applications. In D.D. Zhang, M. Kamel, G. Baciú (Eds.): Integrated Image and Graphics Technologies, 331 - 349, Kluwer Academic Publishers, 2004
- Ph. C.D. Robert, D. Schweri: GPU-Based Ray - Triangle Intersection Testing. Technical Report IAM-04-004, August 2004
- In UNIPRESS 119, 31-43, December 2003:
 - P. Jezler: Erzählfhilfen beim Gang durch die Ausstellung
 - H. Bieri, L. Ammon, Th. Buchberger: Rekonstruktion der Vergangenheit
 - O. Aeberhard, D. Niedermann: Burgunder Tapissereien in neuem Licht
 - D. Kilchhofer: Animation des Originalzustands
 - M. Bruhin, T. Huber: Der animierte Tod
 - O. Burkert, M. Kozary, D. Schulte: Die Burgerstube im Licht von Krieg und Frieden

3.6 Applications

- Implementations for the project artcampus: “Art History 1200 - 2000” (Prof. O. Bätschmann, Dr. Ch. Bracht) of Swiss Virtual Campus: K. Rollé, R. Hürzeler
- Implementations for the Institute of Art History (Dr. T. Weddigen): R. Angeli, Ph. Holzmann
- Animations for the Historisches Museum Bern (P. Jezler, director): M. Bruhin, O. Burkert, T. Huber, M. Kozary, S. Schär

4 Research Group on Computer Networks and Distributed Systems

4.1 Personnel

| | | |
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| Head: | Prof. Dr. T. Braun | Tel.: +41 31 631 4994 email: braun@iam.unibe.ch |
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| | R. de Oliveira* | Tel.: +41 31 631 3328 email: oliveira@iam.unibe.ch |
| | M. Scheidegger* | Tel.: +41 31 631 8692 email: mscheid@iam.unibe.ch |
| | T. Spreng* (15.12.03-01.06.04) | email: spreng@iam.unibe.ch |
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| | A. Weyland* | Tel.: +41 31 631 8648 email: weyland@iam.unibe.ch |
| | S. Zimmerli * (31.01.03-30.06.04) | email: szimmer@iam.unibe.ch |
| Guests: | Prof. Dr. B. Bhargava | Purdue University 24.11.03 – 08.12.03 |
| | Dr. I. Khalil | Osaka University 24.11.03 – 01.12.03 |

* with financial support from a third party

** external Ph.D. student

4.2 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 lately with the advent of mobile ad-hoc, peer-to-peer, and sensor networks. Yet, many of the fundamental questions remain to be solved. NCCR-MICS is composed of eleven research projects, and the RVS group of the University of Berne is participating in the individual project “Self-Organizing Networking Mechanisms” (IP4), which aims at investigating the main networking issues in ad-hoc networks in a broad sense. Specifically, the RVS research group is doing research on two topics: Routing and TCP in mobile ad-hoc networks.

In the area of routing the focus is on the topic of position-based and energy conserving routing for sensor and vehicular ad-hoc networks. Most of today’s routing protocols for mobile ad hoc networks are not well-suited for large and highly mobile ad-hoc networks like sensor networks and vehicular ad-hoc networks. They are primarily focusing on rather small networks, where the number of nodes is up to several hundreds and have little mobility. Hence, these constraints have to be overcome when designing a routing protocol for this environment. Position information available at each node is the key enabler for a new class of protocols, called position-based routing protocols, which exploit location information to enhance routing. We propose the BLR (Beacon-Less Routing) protocol that avoids periodic beacon broadcast. It is state-less in the sense that nodes do not need to store information about the neighborhood. BLR was implemented in a realistic network simulator. Results from simulations indicate that BLR provides superior performance under various network conditions compared to other position-based routing protocols that use beacons. Especially in scenarios with mobility the performance of BLR remains basically unaffected by the movement of the nodes. Thus, BLR provides efficient and robust routing in highly dynamic mobile ad-hoc networks and is also more scalable as it causes almost no routing overhead.

In the area of transport protocols, we investigate techniques for improving TCP performance on an end-to-end basis. One problem of TCP in such environments is its inability to distinguish losses induced by the lossy wireless channel from the ones due to network congestion. Traditional TCP decreases its sending rate sharply when packet losses occur in order to reduce the

network load. But this could be just the wrong approach if the packet loss occurred due to the wireless medium. We have proposed and evaluated a fuzzy logic engine for performing packet loss discrimination in short multihop networks in terms of number of hops between sender and receiver. Simulation evaluations showed that this technique provides effective discrimination in such scenarios, and its response time is satisfactory in most cases. Another main problem is that TCP requires acknowledgments for its transmitted data packets (segments), which is costly in the shared wireless medium in place. We are currently working on a dynamic adaptive acknowledgment strategy to minimize the number of transmissions and retransmissions in the shared transmission medium. The key idea is to minimize the number of unnecessary transmissions (via minimization of ACKs), which may provide not only better bandwidth utilization but also lower energy consumption.

Research staff: Marc Heissenbüttel, Ruy de Oliveira, David Jörg, Thomas Staub. MICS Internship Students: Thomas Bernoulli, Cécile Grivaz, Till Bobot, Markus Wälchli, Isabel Steiner

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

Virtual Internet and Telecommunications Laboratory of Switzerland (VITELS)

VITELS (<http://vitels.unibe.ch>) is part of the 1st series of the Swiss Virtual Campus (SVC) projects and will continue within the SVC consolidation program until June 2006. The goal was to develop an e-learning course in English language that provides theory and practical hands-on exercises in the area of telecommunications / computer networks with real network hardware for third year computer science students. Actually, VITELS consists of nine modules, five designed and maintained by University of Bern. University of Bern now operates also some modules of other partners.

We developed the course infrastructure further and connected VITELS to the Swiss authentication and authorization infrastructure (AAI) implementation, together with the developed AAI portal. Ongoing work consists in maintaining the running modules.

The course is operational and has been used in lectures. We are in the process of moving the modules to recently delivered hardware. During the consolidation, tasks like didactical and technical updates are planned. A first action is the adaptation of the WebCT CE course implementation to the WebCT Vista implementation operated by Edutech.

The RVS group was granted the Microsoft Research Curriculum Request for Proposal Award to develop a distance learning course module in the area of Internet Security.

Research staff: Marc-Alain Steinemann, Attila Weyland, Stefan Zimmerli, Thomas Spreng, Christine Rosenberger, Florian Baumgartner, Roland Balmer

Financial support: Bundesamt für Bildung und Wissenschaft (BBW), Virtual Campus Switzerland Project No. 991043, and University of Bern

Authentication and Authorization Infrastructure (AAI) Portal

An Authentication and Authorization Infrastructure (AAI, <http://www.switch.ch/aai/>) consists of systems that simplify the mobility of network services users. In Switzerland, SWITCH started establishing an AAI for universities and related organizations. Student's data remain at the respective university, called home organization, as well as the authentication process. Resource providers that connect to the AAI, such as universities and related organizations, receive authenticated users on their resources.

A disadvantage of an AAI is that resources must be adapted to it. In many cases this is not possible, for example when the resource code is not open source. In other cases it might be too expensive to adapt a single resource to the AAI.

The AAI portal that has been developed is located between the core AAI and the resource provider. The AAI portal simplifies the process of connecting non-AAI-enabled resources to the AAI and adds interesting features for students and resource users.

We have successfully finished this mandate and handed over the architecture documentation and the code to SWITCH. The source code is available at <http://aai-portal.sourceforge.net/>.

Research staff: Marc-Alain Steinemann, Thomas Spreng, Karl Guggisberg, Attila Weyland, Calogero Butera

Financial support: Virtual Campus Switzerland Mandate

Advanced Architecture for Inter-Domain Quality-of-Service Monitoring, Modeling, and Visualization (InterMON)

InterMON (<http://www.ist-intermon.org>) was an EU-IST project with 12 participants from several European countries within the 5th Framework Program of the EU. It aimed to develop an architecture for monitoring, modeling, simulation and visualization of inter-domain quality of service. University of Bern was leading work package 5, which was concerned with developing efficient modeling and simulation techniques to support scalable simulation of large inter-networks.

The main focus of the work package 5 during this final phase of the project was on the integration of the various tools in the Intermon simulation toolkit with the global architecture, and on evaluation of these tools. The deliverable “Evaluation of Inter-Domain QoS Modeling, Simulation and Optimization” describes the evaluation work. Contributions to several other deliverables have also been made, see Intermon deliverables at technical reports section. The “hybrid simulation” concept developed by the University of Bern achieves scalability by combining analytical models for network domain clouds (usually autonomous systems) and inter-domain links with classical packet-based simulation techniques. A mechanism to integrate these analytical models into the packet-based ns-2 simulator has been implemented. The resulting hybrid simulator and its integration into the Intermon architecture have been successfully tested and evaluated using two testbed networks, located at Salzburg Research and the University of Bern, respectively.

Research staff: Florian Baumgartner, Matthias Scheidegger

Financial support: EU project IST-2001-34123, Bundesamt für Bildung und Wissenschaft (BBW) Nr. 01.0551

eXperience Based Admission Control (XBAC)

End system based Admission Control (EAC) is a concept where applications first measure the available bandwidth before starting the real data transmission (e.g. video streaming). If the measurement indicates insufficient quality of service, the end system does not admit the transmission to proceed. The EAC approach has several disadvantages, especially the relatively long measurement phase (in the order of seconds) and the waste of resources during the measurement phase.

The XBAC project aims to establish an infrastructure of special servers, which both allow applications in close proximity of a server to share their experience regarding quality of service. The servers provide a “measurement service” for applications. This aggregation of experience and measurement data may result in better QoS predictions, shorter probing intervals, and a significant reduction in measurement overhead on the network. To further improve predictions the XBAC servers can exchange information using a peer-to-peer network.

Research staff: Matthias Scheidegger

Financial support: Swiss National Foundation Project No. 200021-101679/1

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 as well as transparent charging and accounting methods, which take into account the specific attributes of wireless networks and the requirements of diversified services. A wide range of accounting, charging and pricing schemes have been analyzed.

Our research focuses on cooperation and accounting strategies in multi-hop cellular networks. With multi-hop cellular networks the coverage area can be increased and the installation costs for the provider can be reduced. However, the individual customers play an important role in such networks and their participation must be encouraged.

We proposed a scheme called CASHnet (Cooperation and Accounting Strategy in Hybrid Networks), which makes cooperation a rewarding alternative, but allows selfishness at the same time. We took a highly decentralized approach for the accounting as well as for the security architecture. Accounting is done on the device and authentication is based on public key cryptography. We implemented CASHnet in ns2 and made extensive evaluations regarding network liveness and overall throughput. Currently we are working on the comparison of our scheme with other cooperation schemes, on possible improvements of CASHnet and on the implementation of a prototype using SmartCards.

Research staff: Attila Weyland and Thomas Staub

Financial support: Swiss National Foundation Project No. 2100-057077. 99/2 and 20-68086.02/1

QoS Support for the Internet based on Intelligent Network Elements (QuINE)

The QuINE project made use of intelligent network elements providing more flexible network management mechanisms allowing the network provider to offer additional services. In particular, QoS support based on Differentiated Services and various multicast mechanisms should be provided.

A Java based central policy server approach was implemented using COPS (Common Open Policy Service) for the communication inside the network. The security of an earlier version of the software was improved in order to detect situations in which two different users submit the same authentication information.

Evaluations have shown that a central instance for policy control can represent a bottleneck in terms of performance. Thus, a new concept for flexible service establishment has been developed. In this concept, most of the configuration decisions are done inside the network by active components. Only the decisions that need a global network view are performed by a central entity. The concept addresses security as well, by controlling the authenticity of the information and the authorization of the user.

Another activity within the Quine project has been the further extension of the Virtual Router platform as well as the development and implementation of a Java based Active Router (JVAR) with a special focus on video processing and signaling. The systems allow to react on network events, either by signaling event occurrence to a central management station, or by automatically triggering certain actions to cope with the new situation. Standard services like adaptation of video coding, automatic configuration of encryption and compression mechanisms have been implemented. The system is able to establish tunnels dynamically and therefore allows to route traffic on specific paths through the network. Besides load balancing this mechanism also allows to create security services like splitting of a single data stream and transporting its parts along different paths. This prevents suspicious nodes to monitor the complete data flow and, combined with proper coding, increases security with low overhead. The implementation is very flexible and provides a set of standard services as well as a framework for service creation. The framework especially enforces the implementation of proof classes for each new service, which allows to test new elements before installing them into the network, and therefore increasing the stability of the whole system.

The JVAR system has been implemented and can be used without significant modifications on top of Virtual Routers as well as on standard Linux routers. A simple interface between the active elements and the router allows the quick adaptation to different router platforms. Since the performance of Java is rather limited, only certain transcoding tasks may be accomplished within the JVAR itself, while for more complex tasks external, native libraries have to be used, which are supported by the JVAR platform. Especially on a Virtual Router infrastructure with multiple routers and JVARs on a single host, the performance is of course an issue, since the computer has not only to cope with the load of Virtual Routers and their communication, but also with resource consumption of the active elements. However, even a scenario with multiple active routers is sufficient for small experiments, low packet rates or if the scenario is mainly used for monitoring and management tasks, which create less processing load.

Research staff: Florian Baumgartner, Roland Balmer, Marc Brogle, Dragan Milic

Financial support: Swiss National Foundation Project No. 2000-06624.01/1

Cellular Assisted Heterogeneous Networking (CAHN)

Existing radio technologies like wireless LAN, Bluetooth, GPRS or Ultra Wide Band (UWB) allow communication between different mobile devices like mobile phones, PDAs or laptops. These wireless technologies require appropriate configuration to work in a desired manner. Too often, more than a basic know-how about the technology itself is required to understand the different settings needed to interconnect devices. With the CAHN approach, this configuration is performed automatically and transparently for the user. The bandwidth limitation of nowadays cellular networks like GSM/GPRS is a big disadvantage in the competition against broadband wireless radio technologies such as wireless LAN, Bluetooth or UWB, which are much more appropriate for fast data transfer. But on the other hand, the cellular networks benefit from the high coverage and the “always on” characteristics. The paging of a mobile device that is attached to the cellular network is a common functionality. Therefore, the cellular network is very well meeting the requirements of a signaling plane. Taking these facts into account, a framework for Cellular Assisted Heterogeneous Networking has been developed, where the cellular network serves as the signaling plane for wireless broadband data channels.

The implementation of a prototype was done for the communication establishment based on CAHN for Bluetooth and WLAN spontaneous networking. The implementation offers a GUI where users can invite peers to join a private peer to peer connection. The connection setup is then done automatically based on SMS communication. Three patents covering the main aspects of such an implementation have been submitted and are pending. The adaptations required on the CAHN protocol to cope with other signaling channels like Unstructured Supplementary Service Data (USSD) or IP based communication were designed and will be implemented, as well as support for heterogeneous data links between involved nodes. Therefore, the next release of the prototype will offer a faster and more flexible platform for setting up and maintaining heterogeneous spontaneous networks among mobile or fixed nodes. Integration of Mobile IP based communication is also in progress.

Research staff: Marc Danzeisen, Isabel Steiner, Simon Winiker, Ehsan Maghsoudi

Financial support: Swisscom Innovations AG

Multimedia Transmission in Mobile Ad-hoc Networks

Efficient transmission of real-time data such as audio and video is a challenging task, in particular in mobile ad-hoc networks. After performing the initial research investigating the related work in this field, we identified hybrid (wired/wireless) networks to be a very promising area. The work focussed on improvements of the handover and delivery time in hybrid networks. We have developed an architecture which allows the node to keep the same IP address even if the Internet access point has changed. This approach saves time needed for Mobile IP handover. The developed architecture can also be used for improving communication by using wired shortcuts in the ad-hoc network. Next research work will continue investigating possibilities given by the hybrid (wired/wireless) network as well as decreasing the handover time between wireless nodes in order to improve multimedia transmission quality.

Research staff: Marcin Michalak

Peer-to-Peer Networks for Mobile and Multicast Communications

Peer-to-Peer Networks are not only becoming important for applications as file sharing, but derived mechanisms can also be useful for supporting different communication scenarios.

First, we investigated Application Level Multicast as a promising approach to overcome the deployment problems of IP level multicast. Application level multicast is typically supported by peer-to-peer or overlay networks. We have developed a mechanism that allows selecting a particular multicast delivery tree out of a set of n alternative multicast delivery trees, which might be established on top of an overlay network. The set of alternative multicast trees consists of the default multicast tree and up to $n-1$ backup multicast trees. Each backup multicast tree is characterized by the fact that exactly one link of the default multicast tree is replaced by a backup link from the set of available links. The so-called backup multicast tree algorithm can calculate this set of trees with a complexity of $O(m \log n)$. The backup multicast tree algorithm is the basis for the reduced multicast tree algorithm that can calculate a tree, which results from the default multicast tree by removing a particular node and by replacing the links of the removed node. Explicit multicast tree selection can also be useful to support the case of leaving nodes in secure application level multicast communications.

Another investigated problem is the minimization of authentication delays when mobile users roam across different wireless networks. The basic idea is to avoid exchanging security information between networks visited by a roaming user and the user's home authentication, authorization, and accounting (AAA) server that is typically located in the home network possibly far away from the visited network. Instead, the authentication of a roaming user shall be supported by an AAA server in the visited network. We propose that the AAA server that is responsible for authorization in a newly visited network locates the AAA server in the previously visited network and retrieves the required security information from that AAA server. The AAA servers can be organized in a peer-to-peer manner and peer-to-peer mechanisms can be applied for searching and transferring security information between them. Several mechanisms for locating the previously responsible AAA server have been evaluated by simulations. Performance measurements also show the rather low performance overhead of application level forwarding used in peer-to-peer networks.

Research staff: Torsten Braun

Financial support: Institut National de Recherche en Informatique et en Automatique, Sophia-Antipolis, France

TCP in Sensor Networks

Although new application-specific routing and transport protocols are required in sensor network, the Transmission Control Protocol (TCP) should also be supported by sensor nodes, since TCP might be required for controlling and managing sensor nodes. As an example, new code might have to be downloaded from a base station in a reliable way. Recent work shows that TCP can be implemented efficiently on sensor nodes without consuming too much CPU and memory resources. Another issue is to minimize the energy consumption in such a network when a TCP connection is established between a sensor node and a base station via several intermediate sensor nodes. A promising approach is to cache TCP segments inside the sensor network in order to avoid end-to-end retransmissions. We are currently working on improvements of this concept by allowing not only the nodes along the path to cache segments but also nodes in the direct neighborhood of the path, which might have received forwarded TCP segments too. A simulation model has been implemented in Omnet++ which will serve as a basis for future performance analysis. Other related issues are the development of a backpressure scheme to avoid useless transmissions by a sender into the sensor network in case of congestion and error situations as well as adapting header compressions schemes to sensor networks.

Research staff: Torsten Braun

Financial support: Swedish Institute of Computer Science, Kista, Sweden

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. For example, the MICS and InterMON projects use the CPU power of the machines to run specialized simulators, with focus on node mobility and large inter-domain topologies, respectively. The InterMON project further uses the testbed for its CVS, FTP and mailing list archive servers, as well as for parts

of the web site. Two systems have also been connected to the so called global controller of the InterMON project. An educational lab network for students' training is also connected to the testbed. The whole testbed is IPv6-enabled and is connected to the 6bone via SWITCH.

Research staff: All members of the RVS research group

4.3 Diploma Theses

- Dragan Milic: Java Policy Server, May 2004
- Simon Winiker: Integration of Cellular Assisted Heterogeneous Networking and Bluetooth Service Discovery Protocol, May 2004
- Calogero Butera: Accounting and Information Exchange Services on a Resource Management Portal, May 2004
- Silvia Stattenberger: HTTP-Servererweiterung zur dynamischen Anpassung der Übertragungsrate, April 2004
- Marc Brogle: JVAR: Java Virtual Active Routing, April 2004
- Christine Rosenberger: Theory and Hands-on Exercises for E-Learning on Distributed Systems, January 2004

4.4 Further Activities

Memberships

- Editorial Board of Elsevier's Computer Communications Journal (Torsten Braun)
- Editorial board of Informatik Spektrum / Springer-Verlag (Torsten Braun)
- Swiss Representative of COST 290 Action "Traffic and QoS Management in Wireless Multimedia Networks" (Torsten Braun)
- SWITCH Stiftungsrat (Torsten Braun)
- SWITCH Stiftungsratsausschuss (Torsten Braun)
- SWITCH Tariff Working Group (Torsten Braun)

- SPEEDUP Society Committee (Torsten Braun)
- Kuratorium Fritz-Kutter-Fonds (Torsten Braun)
- Ph.D. Jury at University of Grenoble (Torsten Braun)
- Ph.D. Jury at University of Nice (Torsten Braun)
- Expert for Diploma Exams at Fachhochschule Bern (Torsten Braun)
- Steering Committee member of the Swiss IPv6 Task Force (Torsten Braun)
- Core team member of the Swiss IPv6 Task Force (Florian Baumgartner)
- SWITCH Projektausschuss (steering committee) “e-Academia / Authentifizierungs- und Autorisierungs-Infrastruktur (AAI): Pilot-Phase” (Marc-Alain Steinemann)

Conference Program Committees

- Workshop on Challenges of Mobility, part of 18th World Computer Congress WCC 2004, Toulouse, France, August 22-27, 2004 (Torsten Braun)
- NETWORKS 2004, Vienna, Austria, June 13-16, 2004 (Torsten Braun)
- Third International IFIP-TC6 Networking Conference, Athens, Greece, May 9-14, 2004 (Torsten Braun)
- 13th IEEE Workshop on Local and Metropolitan Area Networks (LAN-MAN 2004), San Francisco Bay Area, USA, April 25-28, 2004 (Torsten Braun)
- IEEE Workshop on High Performance Switching and Routing (HPSR 2004), Phoenix, Arizona, USA, April 18-21, 2004 (Torsten Braun)
- Workshop on End-to-End Service Differentiation (EESD 2004), Phoenix, Arizona, USA, April 5, 2004 (Torsten Braun)
- International Conference on Wired/Wireless Internet Communications (WWIC 2004), Frankfurt (Oder), Germany, February 04-06, 2004 (Torsten Braun)

- International Conference on Next Generation Teletraffic and Wired/Wireless Advanced Networking (NEW2AN'04), St.Petersburg, Russia, February 02-06, 2004 (Torsten Braun)
- IEEE Consumer Communications and Networking Conference, Las Vegas, Nevada, USA, January 5-8, 2004 (Torsten Braun)
- International Workshop on Multimedia Interactive Protocols and Systems, Napoli, Italy, November 18-21, 2003 (Torsten Braun)
- The 28th Annual IEEE Conference on Local Computer Networks (LCN), Bonn/Königswinter, Germany, October 20-24, 2003 (Torsten Braun)
- Workshop on High-Speed Local Networks (HSLN) as part of the IEEE LCN conference, Bonn/Königswinter, Germany, October 21, 2003 (Torsten Braun)
- 14th IFIP/IEEE International Workshop on Distributed Systems: Operations & Management (DSOM'03), Heidelberg, Germany, October 20-22, 2003 (Torsten Braun)
- Workshop on Quality of Future Internet Services (QoFIS), Stockholm, Sweden, October 1-3, 2003 (Torsten Braun)
- Third International Workshop on Internet Charging and QoS Technology (ICQT 2003), Munich, Germany, September 16-19, 2003 (Torsten Braun)

Reviewing Activities

- Schweizerischer Nationalfonds (SNF) (Torsten Braun)
- Hong Kong Research Grant Council (Torsten Braun)
- International Conference on Communications (ICC 2004) (Torsten Braun)
- Journal of Network and Systems Management (Torsten Braun)
- Elsevier's Computer Networks Journal (Torsten Braun)
- IEEE Journal on Selected Areas in Communications (JSAC) (Torsten Braun)
- Kluwer Academic Publications (Torsten Braun)

- Elsevier's Journal on Simulation Practice and Theory (Torsten Braun)
- University of Armed Forces München (Torsten Braun)
- Purdue University (Torsten Braun)

Invited Talks and Tutorials

- Torsten Braun: A Beacon-Less Routing Mechanism for Wireless Multi-Hop Networks, Swedish Institute of Computer Science (SICS), Kist/Stockholm, Sweden, August 24, 2004
- Marc Heissenbüttel: Beacon-Less Routing as a Possibility to Enhance Position-Based Routing, The MICS (Mobile Information and Communication Systems) Annual Workshop 2004, Zürich, Switzerland, July 06, 2004
- Torsten Braun: Network Emulation, Internet Nouvelle Generation (ING), Obernai, France, June 15, 2004
- Marc Danzeisen: SESAM Von einer Diplomarbeit zum Produkt, Technologietransfer von der Forschung in die Wirtschaft, Forum Bern, Bern, May 25, 2004
- Torsten Braun: Peer-to-Peer Networks for Mobile Communications and Multicast Support, INRIA, Sophia-Antipolis, France, May 5, 2004
- Torsten Braun: A Beacon-Less Routing Mechanism for Mobile Ad-Hoc Networks, Eurecom, Sophia-Antipolis, France, May 3, 2004
- Ruy de Oliveira: Packet Loss Discrimination in Ad Hoc Networks, Purdue University, West Lafayette, USA, March 31, 2004
- Marc Danzeisen: P2P Systems and Applications Seminar, Schloss Dagstuhl, Germany, March 7-10, 2004
- Ruy de Oliveira: An End-to-end Approach for Improving TCP Performance in Ad Hoc Networks, EPFL, Lausanne, Switzerland, January 29, 2004
- Torsten Braun: Broadband Multimedia Applications, Università della Svizzera Italiana, Lugano, Switzerland, January 27, 2004

- Torsten Braun: End-to-End Mechanisms for QoS Support in Wireless Networks, COST 279 Mid-Term Workshop, Rome, Italy, January 22, 2004
- Torsten Braun: Authentication and Authorization in the Internet, Schweizer Informatiktag, Bern, Switzerland, October 17, 2003
- Torsten Braun: Next Generation Internet Protocols for Optical Network Environments, SPIE ITCOM, Orlando, USA, September 11, 2003

Organized Events

Schweizer Informatiktag The RVS Group hosted the Swiss informatics day 2003 (Schweizer Informatiktag) on behalf of the Swiss Computer Science Society (SI). The event aimed at bringing together the Swiss community involved with Computer Science related topics. It provided room for topical presentations and meaningful discussions on current and future trends on informatics in Switzerland.

Vitels Information Day and Telematiktag Bern University of Bern is the leading house of the Virtual Internet and Telecommunications Laboratory of Switzerland (VITELS). This event was promoted by the RVS Group to show VITELS' development process, its constructivist concept and how well established the course has been. VITELS demonstrations were also presented in the Telematiktag Bern event, where the main functionalities of the system were exhibited.

Institutional Research Cooperation

The RVS group maintains an effective collaboration with the RAID laboratory at Purdue University in the United States. RAID belongs to the Department of Computer Science of that University, and focuses on research involving various topics within computer networking field. As part of such a collaboration, the RVS group hosted Prof. Dr. Bharat Bhargava of Purdue University in a technical visit of two weeks on December 2003.

Prof. Dr. Torsten Braun spent his sabbatical in summer semester 2004 at INRIA (Institut National de Recherche en Informatique et en Automatique) Sophia Antipolis (February 09 to May 08) and SICS (Swedish Institute of Computer Science) Kista/Stockholm (July 26 to October 17).

4.5 Publications

Publications submitted in the academic year 2003/2004 and appearing in 2004/2005 or later are not listed

Reviewed Journal and Conference Papers

- Marc Heissenbüttel, Torsten Braun, Thomas Bernoulli, and Markus Wälchli: BLR: Beacon-Less Routing Algorithm for Mobile Ad-Hoc Networks, Elsevier's Computer Communications Journal, vol. 27, no. 11, July 2004, ISSN 0140-3664, pp. 1076-1086
- Attila Weyland, Thomas Staub, and Torsten Braun: Liveliness Evaluation of a Cooperation and Accounting Strategy in Hybrid Networks, 4th Workshop on Applications and Services in Wireless Networks (ASWN 2004), Boston, MA, USA, August 8-11, 2004
- Roland Balmer and Torsten Braun: Resource Control and Authentication for a Video Streaming Service in a DiffServ/IP Multicast Network, 3rd Conference on Security and Network Architectures (SAR04), La Londe, Cote d'Azur (France) June 21-25, 2004, pp. 359-368
- Matthias Scheidegger, Florian Baumgartner, and Torsten Braun: Simulating Large-Scale networks with Analytical Models, Analytical and Stochastic Modelling Techniques and Applications (ASMTA2004), 18th European Simulation Multiconference, (ESM 2004), Magdeburg, Germany, June 13-16, 2004, ISBN 3-936150-38-9, pp. 13-16
- Attila Weyland and Torsten Braun: Cooperation and Accounting Strategy for Multi-hop Cellular Networks, 13th IEEE Workshop on Local and Metropolitan Area Networks (LANMAN 2004), Mill Valley, CA, USA, April 25-28, 2004, pp. 193-198
- Attila Weyland and Torsten Braun: CASHnet - Cooperation and Accounting Strategy for Hybrid Networks, 2nd Workshop on Modeling and Optimization in Mobile, Ad Hoc and Wireless Networks (WiOpt 2004), Cambridge, UK, March 24-26, 2004, pp. 423-424
- Florian Baumgartner, Matthias Scheidegger, and Torsten Braun: Simulating Router- and Domain Characteristics, International Workshop on Inter-Domain Performance and Simulations (IPS2004), Budapest, Hungary, March 21-22, 2004, ISBN 963-421-592-0, pp. 139-145

- Ruy de Oliveira and Torsten Braun: A Delay-based Approach Using Fuzzy Logic to Improve TCP Error Detection in Ad Hoc Networks, IEEE Wireless Communications and Networking Conference (WCNC 2004), Atlanta, USA, April 21-25, 2004, ISBN 0-7803-8344-3, pp. 1666–1671
- Maurizio Bartoli, Florian Baumgartner, Christof Brandauer, Torsten Braun, Sandor Kardos, Fabrizio Orlandi, Matthias Scheidegger, and Jörn Seger: The Intermon Simulation Framework, International Workshop on Inter-Domain Performance and Simulations (IPS2004), BudaPest, Hungary, March 21-22, 2004, ISBN 963-421-592-0, pp. 130–138
- Erich Bircher and Torsten Braun: An Agent-Based Architecture for Service Discovery and Negotiations in Wireless Networks, 2nd International Conference on Wired/Wireless Internet Communications (WWIC 2004), Frankfurt (Oder), Germany, February 04-06, 2004, ISBN 3-540-20954-9, pp. 295–306
- Ruy de Oliveira and Torsten Braun: A Fuzzy Logic Engine to Assist TCP Error Detection in Wireless Mobile Ad Hoc Networks, Next Generation Teletraffic and Wired/Wireless Advanced Networking (NEW2AN), St. Petersburg, Russia, February 02-06, 2004, ISBN 952-15-1132-X, pp. 32–37
- Stefan Egger and Torsten Braun: Multicast for Small Conferences A Scalable Multicast Mechanism Based on IPv6, IEEE Communications Magazine, Vol. 42 Issue 1, January 2004, ISSN 0163-6804, pp. 121-126
- Marc Danzeisen, Torsten Braun, Daniel Rodellar, and Simon Winiker: Heterogeneous network establishment assisted by cellular operators, Fifth IFIP TC6 International Conference on Mobile and Wireless Communications Networks (MWCN'03), October 27-29, 2003, Singapore, ISBN 981-238-686-6, pp. 265–269
- Stefan Egger and Torsten Braun: Performance Evaluation of Multicast for Small Conferences, Fifth International Workshop on Networked Group Communications (NGC'03), September 16-19, 2003, Munich, Germany, ISBN 3-540-20051-7, pp. 226–233

- Torsten Braun and Marc-Alain Steinemann: The Virtual Internet and Telecommunications Laboratory of Switzerland, Workshop on Networking Education: How to Educate the Educators? (NetEd), In conjunction with ACM SIGCOMM 2003, August 25-29, 2003, Karlsruhe, Germany, pp. 02–03
- Florian Baumgartner, Torsten Braun, Eveline Kurt, and Attila Weyland: Virtual Routers: A Tool for Networking Research and Education, ACM Computer Communication Review, Vol. 33 Issue 3, July 2003, ISSN 0146-4833, pp. 127–135
- Stefan Zimmerli, Marc-Alain Steinemann, and Torsten Braun: Resource Management Portal for Laboratories Using Real Devices on the Internet, Computer Communications Review Vol. 33 Issue 3, July 2003, ISSN 0146-4833, pp. 145–151
- Günther Stattenberger and Torsten Braun: Performance of a Bandwidth Broker for DiffServ Networks. In K. Irmscher and K-P. Fhnrich, (eds.): Tagungsband der 13. ITG/GI-Fachtagung Kommunikation in Verteilten Systemen (KiVS), Leipzig, Germany, February 25-28, 2003. Springer Verlag, ISBN 3-540-00365-7, pp. 93-104

Magazine Papers

- Marc Danzeisen and Torsten Braun: BLR: Mit dem Laptop ins Netz, UNIPRESS Forschung und Wissenschaft an der Universität Bern, no. 121, June 2004, pp. 37-39
- Marc Danzeisen, Daniel Rodellar, Simon Winiker, Torsten Braun: Heterogeneous Networking facilitated by cellular Networks, COMTEC 03/04, March/April 2004, ISSN 1420-3715, pp. 18-21
- Torsten Braun, Marc-Alain Steinemann, and Attila Weyland: VITELS - an e-Learning Course on Computer Networks and Distributed Systems, SWITCHjournal, pages 2003(2):32-35, November 2003

Technical Reports

- Matthias Scheidegger et al.: Evaluation of Inter-Domain QoS Modeling, Simulation and Optimization, Intermon Deliverable 19, April 2004
- Ilka Miloucheva, Ulrich Hofmann, Matthias Scheidegger et al.: Final Project Report, Intermon Deliverable 17, April 2004

- Carsten Schmall, Elisa Boschi, Florian Baumgartner, Matthias Scheidegger et al.: Final Architecture Specification, Intermon Deliverable 15, April 2004
- Ali Nassri, Florian Baumgartner et al.: Exploitation and Business Plan, Intermon Deliverable 14, March 2004
- Andreas Kock, Matthias Scheidegger et al.: Integration Report, Intermon Deliverable 16, October 2003
- Ruy de Oliveira, Torsten Braun: A Dynamic Adaptive Acknowledgment Strategy for TCP over Multihop Wireless Networks, Technical Report, IAM-04-005, July 2004.
- Marc-Alain Steinemann, Thomas Spreng, Aljoscha Bachmayer, Torsten Braun, Christoph Graf. Martin Guggisberg: Authentication and Authorization Infrastructure: Portal Architecture and Prototype Implementation, Technical Report, IAM-03-012, December 2003
- Thomas Staub: Performance Comparison of MANET Routing Protocols in Ad-hoc and Hybrid Networks, Computer Science Project, University of Bern, February 2004
- Thomas Spreng: IP Security Module for VITELS, Computer Science Project, University of Bern, November 2003
- Dragan Milic: Delaytester für Linux, Computer Science Project, University of Bern, April 2003
- Torsten Braun, Georg Carle, Uli Ultes-Nitsche, Florian Baumgartner, Matthias Scheidegger, Ruy de Oliveira, Attila Weyland, Marcin Michalak, Klaus Wehrle, Marc Danzeisen, Marc-Alain Steinemann: Klausurtagung of the RVS Group at Pochtenalp, August 26-30, 2003, Technical Report, IAM-03-011, September 2003

Patents

- Marc Danzeisen, Michael Schädler: Verfahren und System für mobile IP-Nodes in heterogenen Netzwerken, patent application, July, 2004

4.6 Awards

Microsoft Research Curriculum Request for Proposal Award

The Computer Networks and Distributed Systems research group as part of the Institute of Computer Science and Applied Mathematics at the University of Bern has been granted a Microsoft Research Curriculum Request for Proposal Award for the development of a distance learning course module in the area of Internet Security.

Fritz-Kutter Award 2002/2003

The dissertation Dynamic Service Provisioning in IP Networks received the prestigious Fritz-Kutter award for the best practice oriented Ph.D. thesis in Computer Science in whole Switzerland during the academic year 2002/2003. The thesis was written by Ibrahim Khalil and supervised by Prof. Dr. Torsten Braun.

5 Research Group on Computer Vision and Artificial Intelligence

5.1 Personnel

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| Guests: | Prof. X. Jiang | University of Münster, Germany March – April 2004 |
| | Prof. A. Kandel | University of South Florida, Tampa, USA June – July 2004 |
| | A. Serrau | University of Cagliari, Italy October – December 2003 |

* with financial support from a third party

5.2 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.

Research staff: R. Bertolami, S. Günter, M. Liwicki, A. Schlapbach, T. Varga, M. Zimmermann

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 adaptation of concepts and techniques based on vector representations to the domain of graphs, and special classes of graphs that allow matching with polynomial complexity.

Research staff: Ch. Irniger, Dr. B. Le Saux, M. Neuhaus

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 search

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 investigate various approaches to writer identification and verification.

Research staff: M. Neuhaus, A. Schlapbach

5.3 Diploma Theses

- Käser, Ch.: Clustering von Schreibern anhand ihres Schreibstils
- Jud, D.: Learning Discrete Edit Costs for Graph Matching
- Gabriel, G.: Abbildung struktureller Daten in den euklidischen Raum durch multidimensionale Skalierung
- Brunner, F.: Lexikon-Reduktion bei der Handschrifterkennung
- Bertolami, R.: Rejection Strategies in Handwriting Recognition Systems

5.4 PhD Theses

- Zimmermann, M.: Offline Handwriting Recognition and grammar based Syntax Analysis
- Günter, S.: Multiple Classifier Systems in Offline Cursive Handwriting Recognition

5.5 Further Activities

Editorial Boards

- Editor-in-Chief of Electronic Letters on Computer Vision and Image Analysis (H. Bunke)
- Member of the editorial board of the International Journal of Pattern Recognition and Artificial Intelligence (H. Bunke)

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

Membership in Committees

- Co-chair of Track 2 on “Pattern Recognition and Neural Networks” with associated theme “Document Analysis” of the 17th Int. Conf. on Pattern Recognition, Cambridge, UK, August 22 - 26, 2004 (H. Bunke)
- Program Committee member “5th Int. Workshop on Multiple Classifier Systems”, Cagliari, Sardinia, June 9 - 11, 2004 (H. Bunke)
- Program Committee member “10th Int. Workshop on Structural and Syntactic Pattern Recognition”, Lisbon, Portugal, August 18 - 20, 2004 (H. Bunke)

Activities in National NCCR

- Head of individual project “Multimodal Access and Contents Protection” of the NCCR Project IM2 (Interactive Multimodal Information Management Systems) (H. Bunke)

5.6 Publications

Books and Special Issues of Journals

- Last, M., Kandel, A., Bunke, H. (eds.): Artificial Intelligence Methods in Software Testing, World Scientific, 2004
- Last M., Kandel, A., Bunke, H. (Eds.): Data Mining in Time Series Databases, World Scientific, 2004
- H. Bunke, T. Caelli (eds.): Graph Matching in Pattern Recognition and Machine Vision, Special Issue of Int. Journal of Pattern Recognition and Art. Intelligence, Vol. 18, No. 3, 2004

Journal Publications

- Vinciarelli, A., Bengio, S., Bunke, H.: Offline recognition of unconstrained handwritten texts using HMMs and statistical language models, *IEEE Trans. PAMI* 26, 709 - 720
- Schenker, A., Last, M., Bunke, H., Kandel, A.: Classification of web documents using graph matching, *Int. Journal of Pattern Recognition and Art. Intelligence*, Vol. 18, No. 3, 2004, 475 - 496
- Dickinson, P.J., Kraetzl, M., Bunke, H., Neuhaus, M. and Dadej, A.: Similarity measures for hierarchical representations of graphs with unique node labels, *Int. Journal of Pattern Recognition and Art. Intelligence*, Vol. 18, No. 3, 2004, 425 - 442
- Günter, S., Bunke, H.: Optimization of weights in a multiple classifier handwritten word recognition system using a genetic algorithm, *Electronic Letters of Computer Vision and Image Analysis, ELCVIA*, Vol 3, No 1, 2004, 25 - 44
- Jiang, X., Abegglen, K., Bunke, H., Csirik, J.: Dynamic computation of generalised median strings, *Pattern Analysis and Applications* 6, 2003, 185 - 193
- Günter, S., Bunke, H.: Feature selection algorithms for the generation of multiple classifier systems and their application to handwritten word recognition, *Pattern Recognition Letters* 25, 2004, 1323 - 1336, 2004
- Günter, S., Bunke, H.: HMM-based handwritten word recognition: on the optimization of the number of states, training iterations and Gaussian components, *Pattern Recognition* 37, 2004, 2069 - 2079

Refereed Conference Proceedings and Edited Books

- Guidobaldi, C., Bunke, H., Vento, M.: Weighted minimum common supergraph for cluster representation, *Proc. IEEE Int. Conf. on Image Processing, Barcelona, 2002*, Vol. II, 25 - 28
- Schenker, A., Bunke, H., Last, M., Kandel, A.: Building graph-based classifier ensembles by random node selection, in Roli, F., Kittler, J., Windeatt, T. (eds.): *Multiple Classifier Systems, Proc. 5th Int. Workshop, MCS 2004*, Springer Verlag, LNCS 3077, 2004, 214 - 222

- Günter, S., Bunke, H.: Ensembles of classifiers derived from multiple prototypes and their application to handwriting recognition, in Roli, F., Kittler, J., Windeatt, T. (eds.): Multiple Classifier Systems, Proc. 5th Int. Workshop, MCS 2004, Springer Verlag, LNCS 3077, 2004, 314 - 323
- Günter, S., Bunke, H.: Fast feature selection in an HMM-based multiple classifier system for handwriting recognition, in Michaelis, B., Krell, G. (eds.): DAGM 2003, Springer LNCS 2781, 2003, 289 - 296
- Günter, S., Bunke, H.: Off-line cursive handwriting recognition - on the influence of training set and vocabulary size in multiple classifier systems, Proc. of the 11th Conf. of the Int. Graphonomics Society, 2003, 196 - 199
- Varga, T., Bunke, H.: Effects of training set expansion in handwriting recognition using synthetic data, Proc. of the 11th Conf. of the Int. Graphonomics Society, 2003, 200 - 203
- Schenker, A., Last, M., Bunke, H., Kandel, A.: Clustering of web documents using a graph model, in Antonacopoulos, A., Hu, J. (eds.): Web Document Analysis: Challenges and Opportunities, World Scientific, 2003, 3 - 18
- Bunke, H., Kraetzel, M.: Classification and detection of abnormal events in time series of graphs, in Last M., Kandel, A., Bunke, H. (Eds.): Data Mining in Time Series Databases, World Scientific, 2004, 127 - 148
- Jiang, X., Bunke, H., Csirik, J.: Median strings: a review, in Last M., Kandel, A., Bunke, H. (Eds.): Data Mining in Time Series Databases, World Scientific, 2004, 173 - 192
- Zimmermann, M., Bunke, H.: Optimizing the integration of a statistical language model in HMM based offline handwritten text recognition, Proc. 17th Int. Conf. on Pattern Recognition, Cambridge, 2004
- Schlapbach, A., Bunke, H.: Off-line handwriting identification using HMM based recognizers, Proc. 17th Int. Conf. on Pattern Recognition, Cambridge, 2004
- Varga, T., Bunke, H.: Off-line handwritten textline recognition using a mixture of natural and synthetic training data, Proc. 17th Int. Conf. on Pattern Recognition, Cambridge, 2004

- Neuhaus, M., Bunke, H.: A probabilistic approach to learning costs for graph edit distance, Proc. 17th Int. Conf. on Pattern Recognition, Cambridge, 2004
- Irniger, Ch., Bunke, H.: Graph database filtering using decision trees, Proc. 17th Int. Conf. on Pattern Recognition, Cambridge, 2004
- Günter, S., Bunke, H.: An evaluation of ensemble methods in handwritten word recognition based on feature selection, Proc. 17th Int. Conf. on Pattern Recognition, Cambridge, 2004
- Zimmermann, M., Bertolami, R., Bunke, H.: Rejection strategies for offline handwritten sentence recognition, Proc. 17th Int. Conf. on Pattern Recognition, Cambridge, 2004
- Schenker, A., Last, M., Bunke, H., Kandel, A.: Comparison of algorithms for web document clustering using graph representations of data, Proc. IAPR Workshop on Structural and Syntactic Pattern Recognition, Lisbon, 2004
- Günter, S., Bunke, H.: Evaluation of classical and novel ensemble methods for handwritten word recognition, Proc. IAPR Workshop on Structural and Syntactic Pattern Recognition, Lisbon, 2004
- Irniger, Ch., Bunke, H.: Decision tree structures for graph database filtering, Proc. IAPR Workshop on Structural and Syntactic Pattern Recognition, Lisbon, 2004
- Pekalska, E., Duin, B., Günter, S., Bunke, H.: On not making dissimilarities Euclidean, in Proc. IAPR Workshop on Structural and Syntactic Pattern Recognition, Lisbon, 2004
- Neuhaus, M., Bunke, H.: An error-tolerant approximate matching algorithm for attributed planar graphs and its application to fingerprint classification, Proc. IAPR Workshop on Structural and Syntactic Pattern Recognition, Lisbon, 2004
- Bunke, H., Dickinson, P., Kraetzl, M.: Matching sequences of graphs with applications in computer network analysis, Proc. 8th World Multi-Conference on Systemics, Cybernetics and Informatics, Orlando, 2004, 270 - 275

Unrefereed Papers and Technical Reports

- Günter, S.: Vergleich von Erkennungsmethoden, IAM TR-001, 2004

6 Research Group on Theoretical Computer Science and Logic

6.1 Personnel

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6.2 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).

Keywords: Proofs as computations, formulas as types, polymorphism, flexible typing, explicit and constructive mathematics, universes of types, theories of types and names, functional programming, distributed computing.

Research staff: All members of the research group

Algebraic and Logical Aspects of Knowledge Processing

In this project we try to shed new light on various formalisms (type-theoretic, set-theoretic, explicit, intensional, non-well-founded, ...) for representing declarative and procedural knowledge and on new questions concerning the logical analysis of abstract computations and computable knowledge.

The formalisms that interest us range over a wide spectrum: classical and admissible higher set theory; frameworks with a constructive and computational meaning; and theories relating to feasible computations.

A crucial aspect of our work deals with establishing exact proof-theoretic and complexity-theoretic bounds for the systems and approaches involved. In this context, we deal with higher reflection principles, higher order and non-monotone inductive definability as well as the design and proof theory of feasible theories with flexible typing and the systematic study of strong tiered formalisms.

Keywords: Algebraic and logical knowledge representation, explicit mathematics, type theories, subsystems of set theory and second order arithmetic,

proof theory, higher type recursion theory, abstract computations, constructivity

Research staff: K. Brännler, T. Burri, G. Jäger, D. Probst, V. Salipante, Th. Strahm, M. Wirz

Financial support: Swiss National Science Foundation

Inference and Deduction: an Approach Integrating Logic and Probability

In collaboration with: Prof. Dr. J. Kohlas, University of Freiburg.

Inference and deduction play an important role in many formal and semi-formal approaches to information and knowledge. Information and knowledge, on the other hand, are concepts which are mostly used in computer science in an intuitive understanding, although there exist some fragments of a formal theory of information: information theory in the sense of Shannon, algorithmic information theory, logic of information or information flow, logic of knowledge. Each of these fragments addresses a particular aspect of the concept of information and knowledge. We plan to study further aspects of information and knowledge. These include:

- Algebraic aspects of information arising from the operations of aggregation (combination) and focusing of information.
- Modelling of structures of compatible questions or domains and the relation of information and its measures relative to particular questions or domains.
- Uncertain nature of information, the corresponding inference problems, with particular attention to statistical information.
- Dynamic nature of information and knowledge, including the passage from information to knowledge and reasoning about knowledge.

These issues will be studied in their own right, but also with the goal to establish links between them and existing fragments of a theory of information. This should be a step towards an integrated theory of information. In particular, Shannon's information measure based on entropy will be generalized in order to represent various forms of information such as constraints on possible choices or probability distributions on the possible choices.

Keywords: inference, deduction, logic, probability, reasoning under uncertainty, probabilistic argumentation, computational logic, nonmonotonic reasoning

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

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.

Keywords: Integration of reasoning and information storage in one system, metadata management, user management, dynamic description logics, automated user support.

Research staff: T. Burri, G. Jäger, Th. Studer

Financial support: Swiss National Science Foundation

ViLoLa - a Virtual Logic Laboratory

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

ViLoLa is a virtual logic laboratory centered around some basic and advanced logic-oriented modules. Starting off from the fact that logic is a crucial basis for many scientific disciplines, it addresses students with various backgrounds (e.g. computer science, mathematics, philosophy, electrical engineering etc.). ViLoLa intends to provide theoretical knowledge as well as the ability to make use of this knowledge for the solution of practically relevant examples. Keywords: Classical propositional logic, formal languages and automata, computability and complexity theory, logics for computer science, logic and uncertainty, structures for algebraic logic, state transition systems and concurrency, logic and philosophy.

Research staff: J. Adler, G. Jäger, M. Krebs, U.-M. Künzi

Financial support: Swiss Virtual Campus

6.3 Diploma Theses

- Theo Burri: Weak König’s Lemma and Extensional Equality

6.4 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 Committees

- President of the Swiss Society for Logic and Philosophy of Science (G. Jäger)
- Member of the Scientific Council of the European Association for Computer Science Logic (G. Jäger)
- Swiss representative of the COST Action 274 “Theory and Applications of Relational Structures as Knowledge Instruments” (G. Jäger)
- Member of the Council of the Association for Symbolic Logic (G. Jäger)
- PC Member of the Logic Colloquium 2005 (G. Jäger)
- Expert for “Maturitätsprüfungen Mathematik” (G. Jäger, Th. Strahm, Th. Studer)
- Secretary of the Swiss Society for Logic and Philosophy of Science (Th. Strahm)

Bern University

- Dean of the Science Faculty (G. Jäger)

6.5 Publications

- L. Alberucci and G. Jäger: About cut elimination for logics of common knowledge, *Annals of Pure and Applied Logic*, to appear
- L. Alberucci and V. Salipante: On modal μ -calculus and non-well founded set theory, *Journal of Philosophical Logic*, to appear
- K. Brünnler: *Deep Inference and Symmetry in Classical Proofs*, Logos Verlag, Berlin, 2004
- K. Brünnler and A. Guglielmi: A First Order System with Finite Choice of Premises, in Hendricks et al. (Eds.), *First Order Logic Revisited*, to appear
- G. Jäger: An intensional fixed point theory over first order arithmetic, *Annals of Pure and Applied Logic* 128, 2004
- G. Jäger and D. Probst: Iterating Σ -operations in admissible set theory without foundation: a further aspect of metapredicative Mahlo, to appear
- G. Jäger and D. Probst: A variation of a theme of Schütte, *Mathematical Logic Quarterly* 50, 2004
- G. Jäger and Th. Strahm: Reflections on reflections in explicit mathematics, submitted
- G.E. Ostrin and S.S. Wainer: Elementary arithmetic, *Annals of Pure and Applied Logic*, to appear
- D. Probst: The proof-theoretic analysis of transfinitely iterated quasi least fixed points, submitted
- D. Probst: On the relationship between fixed points and iteration in admissible set theory without foundation, *Archive for Mathematical Logic*, to appear
- K. Stoffel and Th. Studer: Canonical Databases and Certain Answers under Key Constraints, submitted
- Th. Strahm: Theories with self-application and computational complexity, *Information and Computation* 185, 2003
- Th. Strahm: A proof-theoretic characterization of the basic feasible functionals, submitted

- Th. Studer: Explicit Mathematics: Power Types and Overloading, Annals of Pure and Applied Logic, to appear

7 Research Group on Software Composition

7.1 Personnel

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*financial support from a third party

**external PhD student

***visitor

7.2 Research Projects

Tools and Techniques for Decomposing and Composing Software

This project addresses the problem of how to organize and structure software systems in such a way that they can be easily adapted to changing requirements. We focus on (1) tools and techniques for extracting architectural artifacts, *i.e.*, for *decomposing* software, and (2) mechanisms and language features for flexibly constructing software from parts, *i.e.*, for *composing* software. The key results in the first year include (1) techniques for extracting behavioural dependencies in legacy software using Concept Analysis, and for visualizing and understanding run-time structures, and (2) the development of innovative programming language features for building object-oriented software from fine-grained units of reuse (*traits*), for specifying extensions to existing software bases in a local context (*Classboxes*), and specifying applications as compositions of components (*Piccola*).

This project is carried out under close collaboration with *RECAST: Evolution of Object-Oriented Applications* (SNF Project No. 620-066077). Whereas RECAST concentrates more generally on modeling of object-oriented software, program understanding and software evolution, this project focuses on technical issues related to object-oriented languages and language design.

Research staff: All members of the research group.

Duration: Oct. 2002 - Sept. 2004

Financial support: Swiss National Science Foundation, project no. 2000-067855.02

For further details, please consult:

<http://www.iam.unibe.ch/~scg/Research/SNF02/>

RECAST: Evolution of Object-Oriented Applications

This research project is about reengineering object-oriented applications. Reengineering such applications not only entails the usual complex problems related to software maintenance, *i.e.*, program understanding, program analysis, and program transformation, but also brings special difficulties related to: (1) the complexity introduced by late binding, dynamic typing, and incremental definition specific to object-oriented programming, and (2) the complexity related to the new way of software development (multiple parallel

versions, frameworks, and products lines). Based on our research experience, this research project is structured in three non-orthogonal directions: (a) reengineering, (b) analysis of versions, and (c) migration of object-oriented applications towards components.

We are currently working on the identification of changes and their predictability. For that purpose we are building a new meta-model dedicated to evolution analysis. We investigate the characterization of packages to support the modularization of object-oriented applications. We are also working on the identification of features using dynamic analysis.

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>

Traits in C#

Traits offer a simple compositional model for building classes from groups of methods and a small amount of glue code. This project will investigate how to apply traits to statically typed programming languages, in particular C#. The first experiments with Traits have been carried out with Smalltalk, a dynamically-typed language. Traits have proven to dramatically improve code reuse, while avoiding the fragility problems introduced by other approaches to sharing code, such as mixins and multiple inheritance. The goal of this project is to introduce traits into C# as a representative of statically typed languages

Research staff: S. Ducasse, O. Nierstrasz, N. Schaerli, R., Wuyts.

Duration: March 2004 - Sept. 2005

Financial support: Microsoft

For further details, please consult:

<http://www.iam.unibe.ch/~scg/Research/Rotor/TraitsInRotor4.html>

7.3 Diploma Theses

- Tobias Aebi. Extracting architectural information using different levels of collaboration. Diploma thesis, University of Bern, September 2003.
- Frank Buchli. Detecting software patterns using formal concept analysis. Diploma thesis, University of Bern, September 2003.
- Michael Freidig. Trace based object-oriented application testing. Diploma thesis, University of Bern, January 2004.
- Daniel Rațiu. Time-based detection strategies. Master's thesis, Faculty of Automatics and Computer Science, "Politehnica" University of Timișoara, September 2003. Supervised by Tudor Gîrba and defended at Politehnica University of Timisoara, Romania.
- David Vogel. Management and security of collaborative web environments. Diploma thesis, University of Bern, June 2004.

7.4 Further Activities

Editorial Boards

Oscar Nierstrasz:

- Software and Systems Modeling (Springer Verlag)

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 (Board member)

- ESEC, the European Software Engineering Conference (Member of Steering Committee)
- NSERC GCS 330 – Natural Sciences and Engineering Research Council of Canada, Member of the Grant Selection Committee for Computing & Information Sciences (subgroup A)

Stéphane Ducasse:

- CHOOSE – Swiss group for Object-Oriented Systems and Environments (Executive Board member)
- ESUG (European Smalltalk User Group, Member of Steering Committee)
- SSUG (Swiss Smalltalk User Group, Member of Steering Committee)

Program Committees

Oscar Nierstrasz:

- PC Member of ECOOP 2004 (European Conference for Object-Oriented Programming – Oslo, Norway, June 14-19, 2004)
- PC Member of the Euromicro CBSE Track (30th Euromicro – Rennes, France, Sept 3, 2004)
- PC Member of IWPSE 2004 (International Workshop on Principles of Software Evolution – Kyoto, Japan, Sept. 6-7, 2004)

Stéphane Ducasse:

- PC member of ESUG 2004 (European Smalltalk User Group Conference – Bled, Slovenia, 6-10 September, 2004)
- PC member of LMO 2004 (Languages et Modèles à Objets – Lille, 17-18 March 2004, France)
- PC member of UML 2004 (7th International Conference on the Unified Modeling Language – October 10-15, 2004, Lisbon, Portugal)
- PC member of JFDLPA (Journée Francophone sur le Développement de Logiciels Par Aspects, 14th September 2004)

Reviewing Activities

Oscar Nierstrasz:

- Swiss National Science Foundation,
- Elsevier Journal of Systems and Software,
- Information & Software Technology,
- ACTA Informatica,
- ACM Transactions on Software Engineering and Methodology (TOSEM)

Stéphane Ducasse:

- ACM Transactions on Software Engineering (TSE)
- Journal of Software Evolution and Maintenance (SEM)

Invited Talks and Tutorials

- Oscar Nierstrasz and Stéphane Ducasse, Tutorial speakers at OOP 2004 (“Object-Oriented Reengineering Patterns” tutorial – Munich, Germany, Jan 23, 2004)
- Oscar Nierstrasz, Invited Speaker at SI-SE 2004 (Components – The Future of Software Engineering? – University of Zurich, March 18-19, 2004)
- Oscar Nierstrasz, Keynote speaker at CBSE7 (International Symposium on Component-Based Software Engineering – Edinburgh, Scotland, May 24-25, 2004)

Hosted events

- CHOOSE presentation by Franz Achermann: Naked Objects – U Bern, Oct 8, 2003
- CHOOSE Forum tutorial by Angelika Langer: New Features in the Java 2 Standard Edition 1.5 – Kursaal Bern, Nov 3, 2003
- SSUG/CHOOSE Tutorial by Josph Pelrine: SCRUM: A Methodology to Keep the Team Going – U Bern, Oct 14, 2003
- LOTS (Let’s Open the Source) Kickoff event – U Bern, Oct 24, 2003

7.5 Publications

Journal Papers

- Stéphane Ducasse and Sander Tichelaar. Dimensions of reengineering environment infrastructures. *International Journal on Software Maintenance: Research and Practice*, 15(5):345–373, October 2003.
- Michele Lanza and Stéphane Ducasse. Polymetric views — a lightweight visual approach to reverse engineering. *IEEE Transactions on Software Engineering*, 29(9):782–795, September 2003.
- Oscar Nierstrasz and Stéphane Ducasse. Moose — a language-independent reengineering environment. *ERCIM News*, 58:24–25, July 2004.
- Nathanael Schärli and Andrew P. Black. A browser for incremental programming. *Computer Languages, Systems and Structures*, 30:79–95, 2004.
- Roel Wuyts and Stéphane Ducasse. Unanticipated integration of development tools using the classification model. *Journal of Computer Languages, Systems and Structures*, 30(1-2):63–77, 2004. Special issue: Smalltalk Language.

Conference/Workshop Papers

- Gabriela Arévalo, Stéphane Ducasse, and Oscar Nierstrasz. Understanding classes using X-Ray views. In *Proceedings of 2nd International Workshop on MASPEGHI 2003 (ASE 2003)*, pages 9–18. CRIM - University of Montreal (Canada), October 2003.
- Gabriela Arévalo, Stéphane Ducasse, and Oscar Nierstrasz. X-Ray views: Understanding the internals of classes. In *Proceedings of ASE 2003 (Automated Software Engineering)*, pages 267–270. IEEE Computer Society, October 2003. Short paper.
- Stéphane Ducasse, Michael Freidig, and Roel Wuyts. Logic and trace-based object-oriented application testing. In *Fifth International Workshop on Object-Oriented Reengineering (WOOR 2004)*, 2004.
- Stéphane Ducasse, Michele Lanza, and Roland Bertuli. High-level polymetric views of condensed run-time information. In *Proceedings of CSMR 2004 (Conference on Software Maintenance and Reengineering)*, pages 309 – 318, 2004.

- Stéphane Ducasse and Roel Wuyts. Supporting objects as an anthropomorphic view at computation or why Smalltalk for teaching objects? In *Proceedings of the Ecoop'02 International Educator Symposium*, 2002.
- Thomas Genßler, Oscar Nierstrasz, and Bastiaan Schönhage. Components for embedded software — the PECOS approach. In *Proc. International Conference on Compilers, Architectures and Synthesis for Embedded Systems*, 2002.
- Tudor Gîrba and Michele Lanza. Visualizing and characterizing the evolution of class hierarchies. In *Fifth International Workshop on Object-Oriented Reengineering (WOOR 2004)*, 2004.
- Michele Lanza. Program visualization support for highly iterative development environments. In *Proceedings of VisSoft 2003 (International Workshop on Visualizing Software for Understanding and Analysis)*, pages 62 – 67. IEEE CS Press, 2003.
- Philippe Mougín and Stéphane Ducasse. OOPAL: Integrating array programming in object-oriented programming. In *Proceedings OOPSLA 2003 (International Conference on Object-Oriented Programming Systems, Languages and Applications)*, pages 65–77, October 2003.
- Oscar Nierstrasz. Putting change at the center of the software process. In I. Crnkovic, J.A. Stafford, H.W. Schmidt, and K. Wallnau, editors, *CBSE 2004*, volume 3054 of *LNCS*, pages 1–4. Springer-Verlag, 2004. Extended abstract of an invited talk.
- Oscar Nierstrasz. Software evolution as the key to productivity. In A. Knapp M. Wirsing and S. Balsamo, editors, *Radical Innovations of Software and Systems Engineering in the Future*, volume 2941 of *LNCS*, pages 274–282. Springer-Verlag, 2004.
- Oscar Nierstrasz and Franz Achermann. A calculus for modeling software components. In S. Graf F. S. De Boer, M. M. Bonsangue and W-P. de Roever, editors, *FMCO 2002 Proceedings*, volume 2852 of *LNCS*, pages 339–360. Springer-Verlag, 2003.
- Daniel Rațiu, Stéphane Ducasse, Tudor Gîrba, and Radu Marinescu. Using history information to improve design flaws detection. In *Proceedings of CSMR 2004 (European Conference on Software Maintenance and Reengineering)*, pages 223–232, 2004.

- Nathanael Schärli, Stéphane Ducasse, Oscar Nierstrasz, and Roel Wuyts. Composable encapsulation policies. In *Proceedings ECOOP 2004 (European Conference on Object-Oriented Programming)*, LNCS 3086, pages 248–274. Springer Verlag, June 2004.

Technical Reports

- Alexandre Bergel, Stéphane Ducasse, Oscar Nierstrasz, and Roel Wuyts. Classboxes: Controlling visibility of class extensions. Technical Report IAM-04-003, Institut für Informatik, Universität Bern, Switzerland, June 2004.
- Thomas Bühler. MooseGager, a software metrics tool based on Moose. Informatikprojekt, University of Bern, October 2003.
- Markus Kobel. VisClim – visualisation of climatological data. Informatikprojekt, University of Berne, January 2004.
- Adrian Lienhard. Mewa: Meta-level architecture for generic web-application construction. Informatikprojekt, University of Bern, November 2003.
- Baltisar Oswald and Silvan Auer. CASYMS. Informatikprojekt, University of Bern, August 2003.
- Lukas Renggli. Smallwiki: Collaborative content management. Informatikprojekt, University of Bern, 2003.
- Daria Spescha. Software composition styles: Mixins for Piccola. Informatikprojekt, University of Bern, March 2004.
- Christoph Wyssseier. CCJun – polymetric views in three-dimensional space. Informatikprojekt, University of Berne, June 2004.
- Reto Zurbuchen. Stroke datenbank. Informatikprojekt, University of Bern, August 2003.

Miscellaneous

- Wolfgang Demeuter, Stéphane Ducasse, Theo D’hondt, and Ole Lehrmann Madsen. Report of the ecoop’03 workshop on object-oriented language engineering in post-java era, 2003.
- Serge Demeyer, Stéphane Ducasse, Kim Mens, Adrian Trifu, and Rakesh Vasa. Report of the ecoop’03 workshop on object-oriented reengineering, 2003.

7.6 Awards

The Ph.D. thesis of Michele Lanza, “Object-Oriented Reverse Engineering – Coarse-grained, Fine-grained, and Evolutionary Software Visualization”, won the prestigious Denert-Stiftung Prize for Software Engineering for 2003. The award was presented October 1, 2003 at the *Informatik 2003* conference in Frankfurt.

8 Administration

University:

- H. Bieri: Member of Weiterbildungskommission
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)
- H. Bunke: Member of Wahlvorbereitungsausschuss Vizerektor
- G. Jäger: Member of the Senat

Faculty:

- T. Braun: Member of Evaluationskommission
- G. Jäger: Dean of Science Faculty

Institute:

- H. Bieri: Prüfungsleiter
- O. Nierstrasz: Director of IAM
- T. Braun: Deputy Director of IAM