

# Research Report 2002/03

## Research Group on Computer Networks and Distributed Systems

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### Research Projects

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

The NCCR-MICS ([www.mics.ch](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 and peer-to-peer networks on the Internet. Yet, many of the fundamental questions remain to be

solved, and applications are often only emerging now. 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 two different topics. First, a protocol architecture has been developed whose key component is inspired by the behavior of social insects like ants. Second, emphasis has been given to the aspect of power saving, which is a major concern for any mobile devices. A battery conserving and position based routing protocol has been introduced, which is able to operate without the periodical broadcast of hello messages (beacons).

In the area of TCP issues, an end-to-end approach for enhancing TCP performance in mobile ad-hoc networks has been developed. The key idea of this approach is to be independent of specific intermediate nodes' cooperation, which should not only avoid inherent security concerns posed by most existing proposals but also leverage the deployment of this approach. Specifically, this end-to-end proposal relies on round trip time measurements for inferring the internal state of the network.

### **Research Staff**

Marc Heissenbüttel, Ruy de Oliveira. Internship Students: Thomas Bernoulli, Cécile Grivaz, Till Bohbot, 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 is part of the first series of the Swiss Virtual Campus (SVC) projects. The goal is to develop an on-line 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 five modules designed and maintained by the university of Bern (4) and Fribourg (1). Four other modules might complement the course later. They are designed by the Universities of Genève and Neuchâtel as well as the Engineering School Fribourg.

Ongoing work consists in creating and implementing a course architecture that allows the participation of many institutes as course module providers and also the access to the exercise modules by many students located anywhere in the Internet. The architecture includes authentication, authorization and scheduling functions. The web-learning platform WebCT leads students through the modules offering a broad spectrum of collaboration and exercise tools with integrated assessment functions.

Further valuable experiences with similar modules stimulating the design and development of the virtual course modules have already been gained during the development and conduction of a traditional in house network laboratory course during the academic year 2002/2003.

Both modules, "IP Security" and "Simulation of IP Network Configuration" have already been used in the curriculum. "Remote Method Invocation" and "Sockets and RPC" are the two most recent modules produced by University of Bern. In addition to the course architecture and the modules, we also have developed a didactics and design guide for VITELS.

### **Research Staff**

Marc-Alain Steinemann, Attila Weyland, Stefan Zimmerli, Thomas Spreng, Christine Rosenberger, Günther Stattenberger

### **Financial Support**

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

## **Student Admission Control Infrastructure for Projects of the Swiss Virtual Campus (Authentication and Authorization Infrastructure Portal)**

Authentication and authorization infrastructures (AAI) simplify the mobility of network services users. In Switzerland, SWITCH started establishing an AAI for universities and related organizations. Student data, as well as the authentication process, remain at the respective university, called home organization. Resource providers that connect to the AAI do not need to authenticate users themselves. Users are automatically authenticated by the architecture. A disadvantage of AAI is that resources must be adapted. In many cases this is not possible, for example when the resource code is not open source. In other cases it is too expensive to adapt a single resource to the AAI. The AAI portal under development 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. The AAI portal adds interesting features for tutors. The design of the AAI portal is almost finished, the prototype is working and we started to add test resources. Currently, we are working towards an improved version and also on an interface to WebCT.

### **Research Staff**

Marc-Alain Steinemann, Thomas Spreng, Karl Guggisberg, Attila Weyland, Calogero Butera, Günther Stattenberger, Christine Rosenberger

### **Financial Support**

Schweizerische Universitätskonferenz, Mandate within the Swiss Virtual Campus Program, SWITCH Pilot 1

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

InterMON ([www.ist-intermon.org](http://www.ist-intermon.org)) is an EU-IST project with 12 participants from several European countries and is part of the 5<sup>th</sup> Framework Program of the EU. It aims to develop an architecture for monitoring, modeling, simulation and visualization of inter-domain quality of service. University of Bern

is leading work package 5, which is concerned with developing efficient modeling and simulation techniques to support scalable simulation of large inter-networks. Two deliverables, "Specification of the Modeling and Simulation Toolkit" and "Integration of the Inter-Domain Modeling and Simulation Toolkit," have been compiled, edited and delivered to the EU successfully. Moreover, contributions to the work package 3 deliverable "Enhanced InterMON Architecture" have been provided. 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. It loads models from shared object files and is even capable of loading new analytical models during a simulation run. Also, one such model, capable of simulating delay and loss behavior of multiple ISP networks at the same time, has been implemented.

### **Research Staff**

Florian Baumgartner, Matthias Scheidegger

### **Financial Support**

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

## **Mobile IP Telephony (MIPTel)**

The MIPTel project aims to develop and support mobile telephony applications over IP networks. Currently, our research focuses on charging & accounting of QoS-enabled services in wireless networks. ISPs are in great need of scalable, extensible, flexible and transparent charging and accounting methods, which take into account the specific attributes of wireless networks and requirements of diversified services. A wide range of accounting, charging and pricing schemes have been analyzed. A promising notion is the conjunction of pricing and resource control. A preliminary accounting scheme has been defined, which uses a credit point-based accounting strategy and provides incentives for cooperation among mobile users. Ongoing work includes the investigation of new cooperation schemes, the specification of the accounting architecture and the evaluation via simulations.

### **Research Staff**

Attila Weyland

### **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 makes 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 (e.g. native IP multicast and explicit multicast) should be provided.

A new concept for flexible services establishment has been developed. In this concept, most of the configuration decisions are done inside the network supported by active components. Only the decisions needing a global network view are performed by a central entity. The concept also takes care of security issues, in particular controlling the authenticity of the information and controlling the authorization of the user. Therefore, a tool has been developed and tested allowing to check the authentication of users joining a multicast service. An outcome of the experiments showed that the reallocation of the tasks in a central task is necessary.

In another activity, the virtual router system that has been designed and implemented for the evaluation of active networking concepts has been further improved and extended. In addition to the development of a well defined application programming interface several performance evaluation experiments have been performed in order to investigate the impact of distributing virtual router topologies on multiple computers. It could be shown that the additional delay caused by distribution emulation does not limit the power of the virtual router approach. Another set of experiment compared performance evaluations of Differentiated Services mechanisms using the ns-2 network simulator and the virtual routers. The experiments showed the capability of virtual routers to emulate even complex traffic conditioning systems and yielded similar results in both cases. Therefore, the current virtual router implementation is able to provide the classical multicast services and provides a framework for more advanced multicast concepts. Finally, a new active networking system is also available for Linux systems and allows to perform experiments in heterogeneous environments consisting of Linux and virtual routers. Active network capsules have been implemented allowing the dynamic establishment and configuration of tunnels by use of mobile and native code for tunnel encryption.

## **Research Staff**

Roland Balmer, Florian Baumgartner

## **Financial Support**

Swiss National Science Fondation 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 setting needed to interconnect devices. With the CAHN approach, this configuration is performed automatically and transparently for the user. Therefore, the signaling channel is separated from the actual data channel. The need for a reliable, secure signaling plane with a high coverage makes the cellular network a promising candidate for this purpose. 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 cellular aware 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 first implementation of the CAHN architecture will be realized

in the near future.

## **Research Staff**

Marc Danzeisen, Simi Winiker, Ehsan Maghsoudi

## **Financial Support**

Swisscom Innovations AG

## **Multimedia Transmission in Mobile Ad-hoc Networks**

Audio and video network services are getting more and more popular. Efficient transmission of real-time data is a challenging task, in particular in mobile ad-hoc networks. The initial research investigated the related work in this field, focusing especially on multi-path transmission. There are two basic issues in the multipath transmission: content division and routing. Content division decides how to divide data across different paths. Appropriate approaches are reference picture selection, multiple description, layered coding and video redundancy coding. Among routing algorithms a general principle is to use the maximally disjoint, i.e. independent, paths. Future work will include performance evaluation of existing solutions and investigation of other approaches to the topic.

## **Research Staff**

Marcin Michalak

## **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 are also 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

## **Diploma Theses**

- Erich Bircher: An Automated Agent-Based Marketplace for Mobile Internet Access, June 2003
- Stefan Zimmerli: Internetportal für Computernetze-Praktika, January 2003
- Marco Studer: Ein Simulations-Framework für Endpoint Admission Control, November 2002
- Stefan Egger: Performance Simulation of Multicast for Small Conferences, November 2002

## PhD Theses

- Ibrahim Khalil: Dynamic Service Provisioning in IP Networks, February, 2003
- Günther Stattenberger: Scalable Quality of Service Support for Mobile Users, February, 2002

## Further Activities

### Memberships

- SWITCH Stiftungsrat (Torsten Braun)
- SWITCH Stiftungsratsausschuss (Torsten Braun)
- SPEEDUP Society Committee (Torsten Braun)
- Kuratorium Fritz-Kutter-Fonds (Torsten Braun)
- Swiss Representative of COST 263 Action "Quality of Future Internet Services" (Torsten Braun)
- Professor election committee at University of Zürich (Torsten Braun)
- Ph.D. Jury at University of Grenoble (Torsten Braun)
- Expert for Diploma Exams at Fachhochschule Bern (Torsten Braun)
- Steering Committee member of the Swiss IPv6 Task Force (Torsten Braun)
- Member of editorial board Informatik Spektrum/Springer-Verlag (Torsten Braun)
- Program Chair of the 3<sup>rd</sup> Workshop on Applications and Services in Wireless Networks (ASWN 2003), Bern, Switzerland, July 2-4, 2003 (Torsten Braun)
- Local Arrangements Chair of the 3<sup>rd</sup> Workshop on Applications and Services in Wireless Networks (ASWN 2003), Bern, Switzerland, July 2-4, 2003 (Ruy de Oliveira)
- Local Arrangements Committee Members of the 3<sup>rd</sup> Workshop on Applications and Services in Wireless Networks (ASWN 2003), Bern, Switzerland, July 2-4, 2003 (Ruth Bestgen, Attila Weyland)
- Chair of the Swiss IPv6 Task Force's Application Working Group (Florian Baumgartner)
- 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

- 13<sup>th</sup> IFIP/IEEE International Workshop Distributed Systems: Operations & Management (DSOM), Montreal, Canada, October 21-23, 2003 (Torsten Braun)
- 3<sup>rd</sup> Workshop on Applications and Services in Wireless Networks (ASWN 2003), Bern, Switzerland, July 2-4, 2003 (Torsten Braun)
- IEEE Workshop on High Performance Switching and Routing (HPSR 2003), Torino, Italy, June 24-27, 2003 (Torsten Braun)
- 4<sup>th</sup> International Conference on Internet Computing (IC 2003) 2003, Las Vegas, Nevada, USA, June 23-26, 2003 (Torsten Braun)
- 5<sup>th</sup> International Conference on New Educational Environments, Lucerne Switzerland, May 26-28 (Torsten Braun)
- IEEE 2003 International Conference on Communications, May 11-15, 2003, Anchorage, Alaska, USA (Torsten Braun)

- Workshop on End-to-End Service Differentiation (EESD), in conjunction with the IEEE International Performance Computing and Communications Conference (IPCCC), Phoenix, Arizona, USA, April 9-11, 2003 (Florian Baumgartner & Torsten Braun)
- High Speed Networking Workshop (HSN 2003), March 30, 2003, San Francisco, California, USA, in conjunction with INFOCOM 2003 (Torsten Braun)
- Kommunikation in Verteilten Systemen (KiVS), February 24-28, 2003, Leipzig, Germany (Torsten Braun)
- 4<sup>th</sup> International IFIP TC6 Working Conference on Active Networks (IWAN2002), Zürich, Switzerland, December 4-6, 2002 (Torsten Braun)
- 27<sup>th</sup> Annual IEEE Conference on Local Computer Networks (LCN 2002), November 6-8, 2002, Tampa, Florida, USA (Torsten Braun)
- 2<sup>nd</sup> International Workshop on Internet Charging and QoS Technology (ICQT'02), Zürich, Switzerland, October 16-18, 2002 (Torsten Braun)

## Reviewing Activities

- IEEE Communication Letters (Torsten Braun)
- IEEE Communications Magazine (Torsten Braun)
- IEEE Internet Computing (Torsten Braun)
- IEEE Transactions on Multimedia (Torsten Braun)
- IEEE Transactions on Systems, Man and Cybernetics (Torsten Braun)
- IEEE/ACM Transactions on Networking (Torsten Braun)
- Computer Networks Journal, Elsevier (Torsten Braun)
- Computer Communications Journal, Elsevier (Torsten Braun)
- Journal of Systems and Software, Elsevier (Torsten Braun)
- Simulation Modelling Practice and Theory, Elsevier (Torsten Braun)
- Annales des Télécommunications, Hermes Science (Torsten Braun)
- Addison-Wesley (Torsten Braun)
- Kluwer Academic Publications (Torsten Braun)
- OR Spektrum, Springer-Verlag (Torsten Braun)
- International Conference on Mobile Systems, Applications, and Services (MobiSys), May 5-8, 2003, San Francisco, California, USA (Torsten Braun)
- 6<sup>th</sup> EU Framework Programme for Research and Technological Development (Torsten Braun)
- Schweizerischer Nationalfonds (Torsten Braun)

## Invited Talks and Tutorials

- Torsten Braun, Marc Danzeisen, Beat Perny: Innovative Dienste für die mobile Kommunikation & Forschungskooperation zwischen der Universität Bern und der Swisscom, Telematik-Cluster Bern: Know-how Transfer in der Telematik, June 24, 2003, Bern
- Marc-Alain Steinemann: Technical Workshop, Presentation of AAI-Portal, SVC Days, May 26-28, 2003, Luzern, Switzerland
- Torsten Braun: A Novel Protocol Architecture for Scalable and Energy-Saving Routing in Mobile Ad-Hoc Networks, Advanced Communications and Networking Colloquium, May 23, 2003, Sabanci University, Istanbul



- Torsten Braun: Routing and Transport Protocol Issues in Large Scale Terminode Networks, MICS Annual Workshop 2003, Zürich, February 13, 2003
- Torsten Braun: Ein Labor für virtuelle und entfernte Experimente im Bereich Computernetze, Kolloquium "Informatik und Computational Sciences," University of Basel, December 11, 2002
- Torsten Braun: Studienplan in Informatik der Universität Bern, SARIT: Nationales Treffen für Bachelor und Master der Informations- und Kommunikationstechnologien, University of Applied Sciences Fribourg, November 28, 2002
- Marc-Alain Steinemann: VITELS - Internet-based Computer Networks Laboratory, 2<sup>nd</sup> Workshop on Web Enabling Technologies for Scientists, Abdus Salam International Centre for Theoretical Physics, Trieste, Italy, UNESCO, November 19, 2002
- Marc-Alain Steinemann: Technical and Didactical Aspects of an Open Course Architecture for eLearning, 2<sup>nd</sup> Workshop on Web Enabling Technologies for Scientists, Abdus Salam International Centre for Theoretical Physics, Trieste, Italy, UNESCO, November 19, 2002
- Torsten Braun: IP Telephony over Differentiated Services, Dagstuhl Seminar 02441: Quality of Service in Networks and Distributed Systems, Dagstuhl, Germany, October 30, 2002
- Torsten Braun: Next Generation Internet Protocols for Optical Networks, Tutorial at National Fiber Optic Engineers Conference, Dallas, Texas, USA, September 15, 2002
- Torsten Braun: Mobile Information and Communication Systems - A Swiss National Center of Competence in Research, Computer Science Colloquium, September 11, 2002, Purdue University, USA

## Organized Events

### Know-How Transfer in der Telematik

The Telematik Cluster Bern (TCBE) organized an event to show the success of several collaborations between research institutes and industrial partners. The RVS group presented the successful collaboration between the University of Bern and Swisscom Innovations (R&D department of Swisscom). At the event, the complete Mobile Virtual Private Network solution was demonstrated as a result from the collaboration between the RVS and Swisscom.

### 3<sup>rd</sup> Workshop on Applications and Services in Wireless Networks (ASWN 2003)

The University of Bern hosted the third international Workshop on Applications and Services in Wireless Networks ([http://www.iam.unibe.ch/~rvs/events/ASWN\\_2003](http://www.iam.unibe.ch/~rvs/events/ASWN_2003)) which took place in Bern on July 2-4, 2003. ASWN 2003 provided a high level forum for discussions on recent and new developments in the area of applications and services over wireless networks. The event comprised three days of presentations of invited and regular papers from manufacturers, academia, and services providers. Most of the papers came from Europe but there were also papers from the Americas and Asia. In total there were 61 papers submitted from which 31 were accepted after a systematic review process with at least three reviewers per paper. In addition to the accepted papers the workshop also included a tutorial on mobile ad hoc networking, a keynote talk on software challenges and solutions in ad hoc networks, a panel session about seamless integration of heterogeneous wireless network technologies and services, as well as an invited talk about the rollout of Swisscom's nationwide Public Wireless LAN Service.

# Publications

## Books and Book Chapters

- Torsten Braun, Nada Golmie and Jochen Schiller: Proceedings of the 3<sup>rd</sup> Workshop on Applications and Services in Wireless Networks, July 2003, ISBN 3-9522719-0-X
- Marc-Alain Steinemann, Torsten Braun, Marc Danzeisen and Manuel Günter: Wiley Encyclopedia of Telecommunications, Chapter "Virtual Private Networks," 2002, ISBN 0-471-36972-1

## Journal and Conference Papers

- Roland Balmer and Torsten Braun: Zugangskontrolle für einen Videoverteildienst mit Multicast, 17. DFN-Arbeitstagung über Kommunikationsnetze, Düsseldorf, Germany, June 2003, ISBN 3-88579-373-3, pp. 427-443.
- Torsten Braun and Marc-Alain Steinemann: The Virtual Internet and Telecommunications Laboratory of Switzerland, Whitepaper, in Proceedings of the SIGCOMM 2003 Workshop on Networking Education: How to Educate the Educators? (NetEd), Karlsruhe, August 25 2003, pp. 2-3
- Marc Heissenbüttel and Torsten Braun: A Novel Position-based and Beacon-less Routing Algorithm for Mobile Ad-Hoc Networks, in Proceedings of the 3<sup>rd</sup> IEEE Workshop on Applications and Services in Wireless Networks (ASWN03), Bern, Switzerland, July 2003, ISBN 3-9522719-0-X, pp. 197-209
- Ruy de Oliveira, Torsten Braun and Marc Heissenbüttel: An Edge-Based Approach for Improving TCP in Wireless Mobile Ad hoc Networks, in Peter G. Kropf (ed.): Design, Analysis, and Simulation on Distributed Systems (DASD 2003), part of ASTC 2003, Orlando, FL, USA, March 30 - April 03, 2003, ISBN 1-56555-266-0, pp. 172-177
- Florian Baumgartner, Torsten Braun, Evelin Kurt, Marc-Alain Steinemann and Attila Weyland: Implementation of a Distance Learning Module Based on Emulated Routers, in Proceedings of the 13. ITG/GI-Fachtagung Kommunikation in verteilten Systemen (KiVS 2003), Leipzig, Germany, March 25-28, 2003, ISBN 3-8007-2753-6, pp. 71-80
- Marc Heissenbüttel and Torsten Braun: Ants-Based Routing in Large Scale Mobile Ad-Hoc Networks, in Proceedings of the 13. ITG/GI-Fachtagung Kommunikation in verteilten Systemen (KiVS 2003), Leipzig, Germany, February 25-28, 2003, ISBN 3-8007-2753-6, pp. 91-99
- Günther Stattenberger and Torsten Braun: Performance of a Bandwidth Broker for DiffServ Networks. in Proceedings of the 13. ITG/GI-Fachtagung Kommunikation in verteilten Systemen (KiVS 2003), Leipzig, Germany, March 25-28, 2003, ISBN 3-540-00365-7, pp. 93-104
- Florian Baumgartner, Matthias Scheidegger, Torsten Braun: Enhancing Discrete Event Network Simulators with Analytical Network Cloud Models, in Proceedings of the International Workshop on Inter-domain Performance and Simulation (IPS), Salzburg, Austria, February 20-21 2003, pp. 21-30
- Florian Baumgartner, Torsten Braun and Bharat Bhargava: Design and Implementation of a Python-Based Active Network Platform for Network Management and Control, IFIP-TC6 4<sup>th</sup> International Working Conference (IWAN2002), Zürich, December 2002, ISBN: 3-540-00223-5, pp. 171-190 .
- Florian Baumgartner, Torsten Braun and Bharat Bhargava: Virtual Routers: A Tool for Emulating IP Routers, The 27<sup>th</sup> Annual IEEE Conference on Local Computer Networks (LCN2002), Tampa, November 2002, ISBN: 0-7695-1591-6, pp. 363-371.

- Marc-Alain Steinemann and Torsten Braun: Remote versus Traditional Learning in a Computer Networks Laboratory, in Proceedings of Communications and Computer Networks (CCN 2002), Cambridge, USA, November 4-6 2002, ISBN 0-88986-329-6, pp. 503-507

## **Patents**

- Marc Danzeisen, Jan Linder, Torsten Braun: Verfahren und Vorrichtung zum Aufbauen eines virtuellen privaten Kommunikationsnetzes zwischen Kommunikationsendgeräten, patent application, November 26, 2002

## **Technical Reports**

- Matthias Scheidegger, Florian Baumgartner et al.: Integration of the Inter-Domain Modelling and Simulation Toolkit, InterMON Deliverable 11, June 2003
- Marc-Alain Steinemann, Attila Weyland, Jacques Viens, Torsten Braun: VITELS, Didactics and Design Guide Version 1, Technical Report, IAM-03-002, April 2003
- Marc Heissenbüttel and Torsten Braun: BLR: A Beacon-Less Routing Algorithm for Mobile Ad-Hoc Networks, Technical Report IAM-03-001, University of Bern, March 2003
- David Jud: Drei Module für Angewandtes Lernen von Computernetzwerken, Computer Science Project, March 2003
- Mauro Gargiulo, Matthias Scheidegger et al.: Architecture Components and Interactions, InterMON Deliverable 4, March 2003
- Matthias Scheidegger, Florian Baumgartner et al.: Specification of the Modelling and Simulation Toolkit, InterMON Deliverable 6, December 2002
- Summer School of RVS group, Technical Report, IAM-02-004, November 2002