# Research Report 2001

# Research Group "Computer Networks and Distributed Systems"

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## Research Projects

### Advanced Network and Agent Infrastructure for the Support of Federations of Workflow Trading Systems (ANAISOFT)

ANAISOFT was a project in the 2nd phase of the SNF CNEC (Competence Network Electronic Commerce) programme. Academic project partners have been the Universities of Zürich and Genève, EPF Lausanne, and ETH Zürich. In addition, several non-academic partners collaborated within the project: Etat de Vaud, SER Systeme A.G., Swisscom, Swissmetro, TheNet - Internet Services AG. The RVS group provided several mechanisms to set up and monitor mobile virtual private networks. In particular, scalable

resource provisioning mechanisms for DiffServ VPNs have been designed and evaluated. Monitoring mechanisms based on Java agent technology have been developed and implemented. The monitoring mechanisms are able to monitor whether the parameters negotiated in a service level agreement (SLA) such as delay, bandwidth, and security features such as strong encryption and authentication can really be provided by the Internet Service Provider (ISP) to the customer. The SLA monitoring environment offers a secured interface for direct and generic IP network measurements to customers, peer providers or the ISPs own network management staff. Moreover, a concept called SecMIP (Secure Mobile IP) for providing VPN services to mobile users has been developed by integrating Mobile IP and IP Security protocols. In collaboration with Swisscom Corporate Technology (CT) a Linux prototype has been implemented to demonstrate the feasibility of SecMIP concept. SecMIP allows to keep an active IP communication even if the mobile nodes IP address is changing. For both the SLA monitoring work and the Mobile VPN demonstrators have been developed and successfully been presented at the final project site visit.

### Research Staff

Manuel Günter, Ibrahim Khalil, and Marc Danzeisen

### Financial Support

Swiss National Science Foundation Project No. 5003-057753/1

## Commercialisation of Streamed Information (StreamCom)

StreamCom was another 2nd phase SNF CNEC project. Its main goal was to investigate various problems and issues related to the commercialisation of streamed information. Academic project partners have been EPF Lausanne, as well as the Universities of Geneva, St. Gallen, and Zürich. The RVS group focused on the development of Quality-of-Service (QoS) support for the streamed information such as video streams. The provider of the StreamCom service can establish, modify, and terminate QoS support for unicast or multicast data streams by delivering the corresponding SLA parameters to a bandwidth broker at the adjacent ISP. The bandwidth broker receives and processes these requests and configures the ISP's routers appropriately. StreamCom data are distributed using multicast and, therefore, the Differentiated Services based QoS support must be able to support IP multicast streams. A protocol has been designed on the basis of the bandwidth broker protocol developed in a previous project (CATI) which allows the StreamCom service provider to negotiate the desired service with the ISP's bandwidth brokers. This protocol has been implemented in Java on a content server responsible for video stream transmission and in C++ on the bandwidth broker. A demonstration scenario has been built in the RVS laboratory and successfully been demonstrated at the final project site visit. Two concepts for network usage optimisation in the case of providing QoS to multicast streams have been designed. First, a client authentication mechanism has been introduced, in order to be able to reduce the amount of reservations at runtime to an adequate minimum. Second, a form of measurement based admission control adapted to multicast enables clients to join and leave a running session.

### Research Staff

Roland Balmer, Matthias Scheidegger

### Financial Support

Swiss National Science Foundation Project No. 5003-057755/1.

## Mobile IP Telephony (MIPTel)

The MIPTel project aims to develop and support telephony applications over Differentiated Services (DiffServ) IP networks. Bandwidth Brokers (BBs) are components responsible for managing nodes within a DiffServ domain in order to provide the requested Quality-of-Service (QoS) requested by the users. Within the project a signaling protocol has been designed and implemented that allows mobile IP systems such as mobile nodes or home agents to specify the QoS demands of mobile users. Additional functionality is needed in the bandwidth broker to handle the case of a mobile user that moves from one access network to another but wants to keep its Quality of Service in the new access network. The protocol itself builds on remote procedure calls (RPC) and can also be used for context transfer between BBs of different domains as well as for negotiating flow aggregations. This signaling protocol is a main part of an proposed extension to the AAA architecture of the IETF. The extension allows mobile users to reserve bandwidth for some flows. This reservation must be negotiated with a bandwidth broker that performs the necessary network reconfigurations. Depending on the routing method the Mobile IP implementation uses different reconfigurations that have to be performed when the mobile host roams from one access network to another. Moreover, the project has investigated the issue of mapping audio data to DiffServ. An audio application has been designed and implemented that can automatically and quickly select the cheapest DiffServ class that is able to provide the desired QoS. This has been achieved by using RTP-based (Real-Time Transport Protocol) QoS monitoring mechanisms.

### Research Staff

Günther Stattenberger, Matthias Scheidegger

### Financial Support

Swiss National Science Foundation Project No. 2100-057077.99/1

## QoS Support for the Internet based on Intelligent Network Elements

The project on QoS support in the Internet based on Active Networks includes a collaboration with a research group at Purdue University that already gained experience with Active Networking (AN). AN technology has been applied for management related tasks, i.e. so-called AN capsules (packets carrying programs that can be executed in network nodes such as IP routers) are used to reconfigure routers in order to provide QoS for specific flows in the Internet. This includes topics like traffic conditioning components (especially for Differentiated Services), QoS signalling and routing and the development of appropriate multimedia applications, capable to exploit the AN technology benefits. A network emulation tool has been designed and implemented, allowing to combine real network devices like Linux routers with emulated networks. Based on this environment a toolkit for Active Networks emulation has been

implemented. Several concepts using AN technology for the support of Quality of Service have been developed and evaluated. Especially the power of AN capsules to configure network devices along a specific path has been investigated. The developed mechanisms support resource reservation for specific flows as well as the establishment of QoS tunnels. The ability of Active Networks to add new services to a network was another focus of this project. A special AN based traffic conditioning mechanism supporting video applications has been developed, implemented and evaluated. Besides the creation of new services AN technology supports the integration of different concepts to provide Quality of Service. An architecture for Integrated to Differentiated Services mapping has been developed by combining the use of Active Networks for the installation of new functionalities as well as for signalling purposes. Another promising AN application area is the realization of scalable / explicit multicast services for which prototype capsules have been implemented.

### Research Staff

Florian Baumgartner

### Financial Support

Swiss National Science Foundation Project No. 2100-055789.98/1

## Virtual Internet and Telecommunications Laboratory Switzerland

VITELS is part of the 1st series of the Swiss Virtual Campus (SVC) projects. The goal is to develop a remote 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 seven modules designed and maintained by five institutes (Universities of Bern, Fribourg, Genève, Neuchâtel and 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. First prototypes of the IP Security exercise module and the supporting course architecture have been demonstrated. The web-learning platform WebCT leads students through the modules offering a broad spectrum of collaboration and exercise tools with integrated assessment functions. 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 in summer semester 2001. In addition to the development of the IP Security module, the development of the module Simulation of IP Network Configuration is going on.

### Research Staff

Marc-Alain Steinemann, Thomas Jampen, Stefan Zimmerli, Eveline Kurt

### Financial Support

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

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

The MICS project will focus usually dispersed efforts towards a single and common goal, namely the creation of an entirely new paradigm for communication and information services, based on the idea of a decentralized, self-organizing network based on (mobile) terminals that could simultaneously work as terminals for users, as well as network nodes connecting inter-user traffic. These multi-purpose terminals are called terminodes (terminal + node). The RVS group especially takes part in the Individual Project 4 (IP4) about self organizing network layers and investigate novel routing mechanisms for such terminode networks inspired by the behaviour of social insects like ants and the way they forage and explore their neighbourhood. First steps have been made toward the design of such a new routing protocol (key features have been defined), and different simulation tools are under evaluation to find an appropriate environment to test these new protocols. Another activity is related to the problem of combining TCP into such a mobile ad-hoc environment. Related approaches to adapt TCP for mobile ad-hoc networks are being analysed.

### Research Staff

Marc Heissenbüttel, Ruy de Oliveira

### Financial Support

Swiss National Science Foundation and University of Bern

## Service Quality across Independently Managed Networks (SEQUIN)

SEQUIN is a project that involves eight partners (mainly national research network providers) in seven European countries and is co-funded by the European Commission under the Information Society Technologies (IST) Programme. RVS is participating in the project as subcontractor of SWITCH. The project objective is to define and implement an end-to-end QoS approach that will operate across multiple management domains combining distinct network technologies. In this way, SEQUIN will ensure that researchers across Europe have access to network facilities that can be tailored to the requirements of individual groups, thereby offering predictable and stable quality across multiple underlying management domains and networking technologies. The project also intends to address the migration of existing ATM-based QoS (like the TEN-155 Managed Bandwidth Service) to hybrid environments (like IP over ATM) as well as to pure IP environments (like the existing pan-European research infrastructure called GÉANT). So far the project has established a definition for QoS tailored to its goals and test-beds have been set up as well, so that the proposed definitions can be evaluated in a pragmatic approach. RVS has been supporting SWITCH focusing on mainly two aspects: test-bed set-up / measurements and tool development / configuration for QoS monitoring. Specifically, a test-bed connecting the RVS laboratory at Berne to the Poznan laboratory at Poland via the ATM-based TEN-155 has been established and

measurements of QoS parameters were performed in order to evaluate the actual capacity of the networks involved. Currently, RVS is investigating potential QoS monitoring tools (SNMP protocol based) to be used by SEQUIN. It includes not only configuration but also adjustments (by new PERL modules inclusion) of existing tools towards SEQUIN requirements.

### Research Staff

Ruy de Oliveira

### Financial Support

SWITCH / EU project IST-1999-20841

## Differentiated Services over ATM

This project was a collaboration with NEC Europe Ltd over three years. In its first part the project focused on the implementation of Differentiated Services for Linux Routers in both, Ethernet and ATM networks. The implementation has been tested by various other external organizations, among them a few European telecommunication service providers. The second part of the project during focused on the development of a management software for networks providing QoS for (mobile) users. We have designed and implemented a QoS management API that enables an application programmer to develop QoS management software for heterogeneous networks and various topologies. A generic implementation of this API provides a framework that can support heterogeneous router hardware. As a first application an interface for addressing the Linux router previously developed in this project has been implemented. A generic bandwidth broker to assist a network administrator or a user in configuring a large network to provide QoS for specific flows has been designed and implemented using the API and the Linux DiffServ Router implementation. This broker has successfully been tested in the experimental RVS experimentation network and in the research lab of NEC in Heidelberg, Germany. A mobile client software has been implemented that allows a user to register one or several flows at the bandwidth broker which in turn performs the necessary reservations at the routers. After the mobile client roams to a new access network the previous reservations can be changed to support the traffic from the new location. Those changes can be automatically performed by the bandwidth broker after the new location has been notified.

### Research Staff

Günther Stattenberger

### Financial Support

Computer & Communication Research Laboratories, Heidelberg, Germany

## Next Generation Networks Initiative (NGNi)

The NGN initiative is an open European initiative investigating analysing standards, identifying technology and market trends and forecasts in the area of network technology for next-generation wired and wireless networks. The QoS group within the umbrella project NGNi identifies and investigates solutions for providing QoS in IPv6-based next generation networks. It also identifies, studies, analyses,

and compares various potential QoS technologies for the future Internet and develops roadmaps for the future introduction of QoS technologies. A first deliverable document on Quality of Service Directions, Benchmarking and Roadmaps for IPv6-oriented NGN Multimedia Internetworks has been produced together with project partners from BITS Pilani (India), University of Haute-Alsace (France), UPM Madrid and Versaware (Spain).

### Research Staff

Torsten Braun

### Financial Support

EU project IST-2000-26418

## Mobile Wireless Office

This project was established based on the Mobile VPN developments performed within the Anaisoft project. The resulting concept called Secure Mobile IP (SecMIP) has been implemented on Linux and installed at a laboratory and demonstration environment at Swisscom. This prototype implementation demonstrates the feasibility of the SecMIP (or "Mobile Office") concept. The longer-term vision of the resulting Mobile Office project is on secure roaming between different access network technologies. In an example scenario, a business traveller is connected to the Intranet while his train arrives in the airport. In this hot spot area of the airport there is a powerful wireless infrastructure deployed such as GPRS or IEEE Wireless LAN (WLAN). The traveller gets connectivity to this broadband infrastructure without being forced to reconnect on the new network and loosing his Intranet session. The SecMIP concept has been extended to fit the needs in heterogeneous networks. Support of GPRS, WLAN and Ethernet has been designed and implemented. In addition, an interface was implemented to make an automated decision, which access technology should be used by the software. In collaboration with an external software company Swisscom has transferred the SecMIP concept to Windows platforms. A prototype version of the SecMIP client software was demonstrated. Future activities focus on the evaluation and integration of other access technologies. Considering the growing research activities in ad-hoc networking, technologies such as Bluetooth and security issues in mobile ad-hoc networks will be of special interest.

### Research Staff

Marc Danzeisen, Simi Winiker

### Financial Support

Swisscom AG

## Easy Accessible Voice Gateway between Mbone and ISDN/PSTN Networks

This project was aiming for an easy access solution for ISDN/PSTN users to join IP multicast (MBone) sessions. An easy accessible voice gateway between MBone and ISDN/PSTN networks has been implemented on Linux. The gateways functionality contains gateway control and administration

mechanisms. It utilizes some available public domain software to achieve necessary functionalities. With this solution, users can easily set up voice conferences with mobile WAP phones or web browsers, and join in multicast sessions using (mobile) telephones. Another possible application area is the retrieval of Internet audio streaming data via any telephone end system.

### Financial Support

Bundesamt für Berufsbildung und Technologie (BBT) / Kommission für Technologie und Innovation (KTI) Project No. 4486.1 KTS and Telscom AG, Bern

### Research Staff

Linqing Liu

## Management of QoS-VPNs on Linux Routers

The combination of VPNs and DiffServ based QoS appeared to be a promising approach for corporation communication infrastructure. However, the management of QoS enabled VPN could be time consuming and error-prone. This project aimed to present a framework for the web-based management approach regarding the related problems, specifically with the combination of FreeS/WAN IPSec and DiffServ on Linux routers. Various related issues have been discussed and analysed. The DiffServ package in Linux platform has been upgraded to kernel version of 2.2.19 and configuration scripts have been implemented in order to establish QoS-VPN in provider environments.

### Financial Support

Bundesamt für Berufsbildung und Technologie (BBT) / Kommission für Technologie und Innovation (KTI), project no. 5157.1 and TheNet Internet Services AG.

### Research Staff

Linqing Liu

## Test-bed for Mobile and Internet Communications

An experimental test network serves for the implementations performed within the various research projects mentioned above. The network consists Linux Routers and an Ethernet Switch, that allows the simple configuration of various network topologies. The Linux Routers support the IPv4 and IPv6 protocols as well as Differentiated Services, IPSec encryption, Mobile IP and IP Multicast, all based on open source implementations. Several experiments for service provisioning and video streaming in multicast networks have been performed. Two multi-processor computers are being used for network emulation and the evaluation of active networking implementations. Several measurements were performed for QoS evaluation in the TEN-155 network between the Berne and Poznan in Poland. Those experiments used several of the available commercial routers and switches.

### Research Staff

Roland Balmer, Florian Baumgartner, Günther Stattenberger, Ruy de Oliveira

### Financial Support

Stiftung zur Förderung der wissenschaftlichen Forschung an der Universität Bern.

# PhD Theses

§ Manuel Günter: Management of Multi-Provider Internet Services with Software Agents, June 2001

# Diploma Theses

§ Marc Danzeisen: Secure Mobile IP Communication, May 2001

§ Matthias Scheidegger: IP-Telefonie über Differentiated Services, June 2001

§ Attila Weyland: Mobile-Controlled Handover in Wireless LANs, December 2001

# Activities

## Awards

§ Best Paper Award for the Paper A Range-Based SLA and Edge Driven Virtual Core Provisioning in DiffServ-VPNs presented at the 26th Annual IEEE Conference on Local Computer Networks (Ibrahim Khalil and Torsten Braun)

## Memberships

§ SWITCH Stiftungsrat (Torsten Braun)

§ SWITCH Stiftungsratsausschuss (Torsten Braun)

§ SPEEDUP Society Committee (Torsten Braun)

§ Swiss Representative of COST 263 Action Quality of future Internet Services (Torsten Braun)

§ Professor election committees at University of Zürich and ETH Zürich (Torsten Braun)

§ Ph.D. Jury of Alex Villazon (University of Geneva) (Torsten Braun)

§ Expert for Diploma Exams at FH Bern (Torsten Braun)

## Conference Program Committees

§ 10th IEEE International Conference on Computer Communications and Networks (ICCCN 2001), October 15-17, Scottsdale AZ, USA (Manuel Günter)

§ 29th SPEEDUP Workshop on Distributed Computing and High-Speed Networks University of Bern, Switzerland, March 22 - 23, 2001 (Torsten Braun, Chair)

§ Applications & Services in Wireless Networks (ASW2001), Evry (Paris), France, July 25-27, 2001 (Torsten Braun)

§ 2001 IEEE Workshop on High Performance Switching and Routing (HPSR 2001), Dallas, Texas, USA, May 29-31, 2001 (Torsten Braun)

§ 26th IEEE Annual Conference on Local Computer Networks (LCN 2001), November 14-16, 2001, Tampa FL, USA (Torsten Braun)

§ GI/ITG-Fachtagung Kommunikation in Verteilten Systemen (KiVS2001), February 20-23, 2001, Hamburg, Germany (Torsten Braun)

§ 11th IEEE Workshop on Local and Metropolitan Area Networks (LANMAN2001), March 18-21 2001, Boulder CO, USA (Torsten Braun)

§ Advanced Internet Charging and QoS Technology (ICQT'01) Workshop of "Informatik 2001", Part of the GI and OCG General Annual Meeting, Vienna, Austria, September 26-28, 2001 (Torsten Braun)

## Reviewing and Editor Activities

§ Editor of Electronic Notes in Future Generation Computer Systems, Elsevier (Torsten Braun)

§ Computer Networks Journal, Elsevier (Torsten Braun)

§ Computer Communications Journal, Elsevier (Torsten Braun)

§ International Conference on Communications (ICC), Helsinki, Finland, June 11-15, 2001 (Torsten Braun)

§ IEEE Infocom, Anchorage, Alaska, USA, April 22-26, 2001 (Torsten Braun)

§ Journal of Parallel and Distributed Computing (JPDC), Special Issue: "Mobile and Wireless Ad Hoc Networking and Computing", Academic Press

§ International Conference on Networking (ICN'01), Colmar, France, July 9-13 (Torsten Braun)

§ First IFIP Conference on E-Commerce, E-Business, E-Government 2001, Zürich, October 3-5, 2001 (Torsten Braun)

## Tutorials

§ Torsten Braun: IP Next Generation, Tutorial, GI/ITG-Fachtagung Kommunikation in Verteilten Systemen (KiVS2001), February 20, 2001, Hamburg, Germany

## Organized Events

§ 29th SPEEDUP Workshop on Distributed Computing and High-Speed Networks University of Bern, Switzerland, March 22 - 23, 2001

# Publications

## Journal and Conference Papers

§ Torsten Braun: Distributed Computing and High-Speed Networks, Electronic Notes in Future Generation Computer Systems, Volume 1, Elsevier, http://www.elsevier.nl/locate/enfgcs

§ Florian Baumgartner and Torsten Braun: Distributed Emulation of IP Networks, 29th Speedup Workshop, Berne 2001, Electronic Notes in Future Generation Computer Systems, Volume 1, Elsevier, http://www.elsevier.nl/locate/enfgcs

§ Manuel Günter and Torsten Braun: A Fast and Trend-Sensitive Function for the Estimation of Near-Future Data Network Traffic Characteristics, in B. Bodnar (ed.): Applied Telecommunication Symposium (ATS01), Seattle, USA, 22-26 April, 2001, SCS Simulation Series, Vol. 33, No. 3, ISBN 1-56555-235-0, pp.141-146

§ Linqing Liu and Torsten Braun: Easy Accessible Voice Gateway between Mbone and ISDN/PSTN Networks, 2nd IP-Telephony Workshop, Columbia University, New York, April 2-3, 2001, pp. 149-158, http://www.fokus.gmd.de/events/iptel2001/pg/final_program/25.pdf

§ Torsten Braun, Manuel Günter, and Ibrahim Khalil: Management of Quality of Service Enabled VPNs, IEEE Communications Magazine, Vol. 39, No. 5, May 2001, ISSN 0163-6804, pp. 90-98

§ Günther Stattenberger, Torsten Braun, and Marcus Brunner: A Platform-Independent API for Quality of Service Management, IEEE Workshop on High Performance Switching and Routing (HPSR2001), Dallas, Texas, USA, May 29-31, 2001, ISBN 0-7803-6711-1, pp. 255 - 259

§ Torsten Braun, Li Ru, and Günther Stattenberger: An AAA Architecture Extension for Providing Differentiated Services to Mobile IP Users, Proceedings of the 6th IEEE Symposium on Computers and Communications (ISCC 2001), Hammamet, Tunesia, July 3-5, 2001, ISBN 0-7695-1177-5, pp. 472-478

§ Torsten Braun and Linqing Liu: Multicast for Small Conferences, Proceedings of the 6th IEEE Symposium on Computers and Communications (ISCC 2001), Hammamet, Tunesia, July 3-5, 2001, ISBN 0-7695-1177-5, pp. 145-550

§ Manuel Günter, Marc Brogle, and Torsten Braun: Secure Communication: A new Application for Active Networks, in P. Lorenz (ed.): Networking - ICN 2001, Part II, International Conference on Networking (ICN'01), Colmar, France, July 9-13, 2001, Springer LNCS 2094, ISBN 3-540-42303-6, pp. 206-216

§ Günther Stattenberger and Torsten Braun: QoS Provisioning for Mobile IP Users, in H. Afifi, D. Zeghlache (eds.): Applications & Services in Wireless Networks, Evry (Paris), France, July 25-27, 2001, Hermes Science, ISBN 2-7462-0305-7, pp. 41-50

§ Linqing Liu and Torsten Braun: Easy Accessible Voice Gateway for Between Mbone and ISDN/PSTN Networks, in O. Johnson, K. Waefler, G. Zeibekakis (eds.): 7th International Netties Conference / 3rd International Conference on New Learning Technologies, University of Applied Sciences of Western Switzerland, Fribourg, Switzerland, September 13-15, 2001. ISBN 2-940156-21-2, pp. 6.4.1

§ Roland Balmer, Manuel Günter, and Torsten Braun: Video Streaming in a DiffServ/IP Multicast Network, Workshop Advanced Internet Charging and QoS Technologies (ICQT), in: K. Bauknecht, W. Brauer, Th. Mück (eds.): Informatik 2001 Wirtschaft und Wissenschaft in der Network Economy Visionen und Wirklickeit, Tagungsband der GI/OCG-Jahrestagung, Band I, September 25-28, 2001, Vienna, ISBN 3-85403-157-2, pp. 159-165

§ Marc Danzeisen and Torsten Braun: Secure Mobile IP Communication: Workshop Mobile Communication over Wireless LAN: Research and Applications, in: K. Bauknecht, W. Brauer, Th. Mück (eds.): Informatik 2001 Wirtschaft und Wissenschaft in der Network Economy Visionen und Wirklickeit, Tagungsband der GI/OCG-Jahrestagung, Band I, September 25-28, 2001, Vienna, ISBN 3-85403-157-2, pp. 562-567

§ Ibrahim Khalil and Torsten Braun: Implementation of a Bandwidth Broker for Dynamic End-to-End Capacity Reservation over Multiple Diffserv Domains, 4th IFIP/IEEE International Conference on Management of Multimedia Networks and Services (MMNS), Chicago, USA, Oct 29 - Nov 1, 2001

§ Günther Stattenberger and Torsten Braun: Providing Differentiated Services to Mobile IP Users, Proceedings 26th Annual IEEE Conference on Local Computer Networks (LCN'2001), Tampa, USA, Nov 15-16, 2001, ISBN 0-7695-1321-2, pp. 89-90

§ Ibrahim Khalil and Torsten Braun: A Range-Based SLA and Edge Driven Virtual Core Provisioning in DiffServ-VPNs, Proceedings 26th Annual IEEE Conference on Local Computer Networks (LCN'2001), Tampa, USA, Nov 15-16, 2001, ISBN 0-7695-1321-2, pp. 12-21

§ Torsten Braun and Marc Danzeisen: Secure Mobile IP Communication: Workshop on Wireless Local Networks, Proceedings 26th Annual IEEE Conference on Local Computer Networks (LCN'2001), Tampa, USA, Nov 15-16, 2001, ISBN 0-7695-1321-2, pp. 586-593

§ Torsten Braun and Marc Danzeisen: Mobile Virtuelle Private Netze, SWITCHjournal 2/2001, November 2001, pp. 28-30

## Technical Reports

§ Florian Baumgartner: Virtual Router User Manual and API Description, Technical Report IAM-01-001, University of Berne, December 2001

§ R. Banerjee, J. Quemeda, P. Lorenz, T. Braun, B. Martinez: Quality of Service Directions, Benchmarking and Roadmaps for IPv6-oriented NGN Multimedia Internetworks, NGNi Deliverable, November 2001, http://ipv6.bits-pilani.ac.in/ngni/NGNI-QoS-D1-v1-2-Secure.pdf

§ Matthias Scheidegger: StreamCom QoS Reservation Architecture: Design of Network Elements, StreamCom Project Deliverable, November 2001, http://www.iam.unibe.ch/~rvs/publications/scom-design-ne.pdf

§ Thomas Bodenmann: Aufbau eines IPv4/IPv6-Experimentiernetzes, Informatikprojekt, March 2001

§ Thomas Jampen: Java API for PGP, Informatikprojekt, April 2001

§ Marco Studer: Drei Module für das Praktikum Computernetzwerke, Informatikprojekt, July 2001

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