

Research Report 2002

Research Group "Computer Networks and Distributed Systems"

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Research Projects

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

NCCR-MICS (www.mics.ch) represents a Swiss-wide effort launched in 2001 to promote long-term research projects on mobile communications based on self-organizing paradigms. These paradigms have been receiving increasing interest with the advent of ad-hoc networks and peer-to-peer services on the Internet. NCCR-MICS is funded by the Swiss government, the participating institutions and third parties. It involves a broad group of researchers, from universities and renowned research institutions in Switzerland. NCCR-MICS is composed of eleven research projects, and the RVS group of the University of Berne is taking part in the individual project Self-Organizing Networking Mechanisms (IP4). This project aims at investigating in a broad sense the main networking issues in ad-hoc networks. Specifically, the RVS research group is doing research on two topics: bio-inspired routing and TCP in mobile ad-hoc networks. In the area of bio-inspired routing the RVS group is focusing on the network layers and is investigating novel routing mechanisms for such mobile ad-hoc networks inspired by the behavior of social insects like ants and the way they forage and explore their neighborhood. A protocol architecture has been developed introducing three novel algorithms in order to be able to deal with the dynamics and complexity of such networks. A first version of these protocols is being implemented to determine the performance of this approach. Another topic has been investigating the main problems faced by TCP in highly dynamic and unpredictable mobile ad-hoc environments. The work concentrated on evaluating the existing proposed approaches and also on defining our own contributions toward effective enhancements in such a scenario. As a result, related work has been studied in detail and some initial original ideas have been outlined. The performance of TCP over several mobile ad-hoc routing protocols such as AODV, DSDV, DSR and TORA has been evaluated using the network simulator ns. Based on these results, we have started to work on simulation models for the evaluation of our novel conceptual ideas.

Research Staff

Marc Heissenbüttel, Ruy de Oliveira, Eveline Kurt

Financial Support

Swiss National Science Foundation Project no. 5005-067322 and University of Bern

Mobile IP Telephony (MIPTel)

The MIPTel project aims to develop and support mobile telephony applications over Differentiated Services (DiffServ) IP networks. Bandwidth brokers are components responsible for managing nodes within a DiffServ domain in order to provide the Quality-of-Service (QoS) requested by the users. Within the project a signaling protocol has been designed and implemented that allows mobile IP 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 can also be used for context transfer as well as for negotiating flow aggregations between bandwidth brokers of different domains. This signaling protocol is a main part of a proposed extension to the Authorization, Authentication and

Accounting (AAA) architecture. The extension allows mobile users to reserve bandwidth for some flows. Any reservation must be negotiated with a bandwidth broker that performs the necessary network reconfigurations. Depending on the Mobile IP routing method different reconfigurations have to be performed when the mobile node roams from one access network to another. Additional effort has been made to minimize hand-over delay and QoS degradation. The knowledge of when a hand-over will happen is provided by a signal monitoring program. This information is used to pre-negotiate QoS specifications with the bandwidth broker responsible for the new access network.

Research Staff

Günther Stattenberger

Financial Support

Swiss National Science 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 service 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. Moreover, 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 distributed emulation does not limit the power of the virtual router approach. Another set of experiments 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. Finally, a new active networking system based on the Python language has been implemented. This 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 Foundation Project No. 2100-57789.98/2 and 2000-066624.01/1

Virtual Internet and Telecommunications Laboratory of Switzerland (VITELS)

VITELS (www.vitels.ch) belongs to the 1st series of the Swiss Virtual Campus (SVC) projects started in the year 2000. The goal of the project is to develop a course in English language that provides theory and practical hands-on exercises in the area of telecommunications / computer networks. The developed experiments are based on simulation or real network hardware and are intended 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 allowing several institutes to provide content for course modules. The course architecture includes authentication, authorization, and scheduling functions and allows that the exercises can be accessed by many students located anywhere in the Internet. The web-learning platform WebCT leads the students through the modules and offers a broad spectrum of collaboration and exercise tools with integrated assessment functions. First prototypes of the IP Security exercise module and the supporting course architecture have been demonstrated and tested in a regular course during summer semester 2002. During these tests we could already gain valuable experiences and adapt the IP Security module. In this module, students have to configure real IP routers and establish IP Security tunnels. The second module developed at University of Bern called IP Simulation includes exercises based on Java applets and router emulations. Students have to experiment with network interface and routing table configurations.

Research Staff

Marc-Alain Steinemann, Attila Weyland, Thomas Jampen, Eveline Kurt, Christine Rosenberger, Thomas Spreng, Stefan Zimmerli

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) are systems that simplify the mobility of network services users. SWITCH started to establish an AAI for Swiss universities and related organizations. Student data and the authentication process remain at the respective university (home organization). Resource providers (typically universities and related organizations) that connect to the AAI provide the resources to authenticated users. A disadvantage of an AAI is that resources must be adapted to it, but in many cases this is not possible, for example when the resource code is not based on open software. In other cases it is too costly to adapt a single resource to the AAI significantly. The AAI portal that is under

development is located between the core AAI and the resource provider and simplifies the process of connecting non-AAI-enabled resources to the AAI. The design of the AAI portal has almost been finished and the implementation of a first prototype has already started.

Research Staff

Marc-Alain Steinemann, Thomas Spreng

Financial Support

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

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

InterMON (www.ist-intermon.org) is an EU-IST project with 12 participants from several European countries and is part of the 5th 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. The deliverable entitled "Specification of the Modeling and Simulation Toolkit" has been compiled, edited and delivered to the EU successfully. The developed concept achieves scalability by combining analytical models for network domain clouds and inter-domain links with classical packet-based simulation techniques. Several ways for integrating these analytical models into the widely used packet-based simulator ns-2 have been investigated.

Research Staff

Florian Baumgartner, Matthias Scheidegger

Financial Support

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

Service Quality across Independently Managed Networks (SEQUIN)

SEQUIN (www.dante.net/sequin/) was an EU-IST project involving eight partners (mainly national research network providers) in seven European countries and running from November 2000 to April 2002. The main goal of this project has been to define and implement an end-to-end QoS approach to operate across multiple management domains combining distinct network technologies. In this way, SEQUIN would ensure that researchers across Europe had access to network facilities that could be tailored to the requirements of individual groups. As an overall view, the project has been successful in defining an achievable QoS model by taking into account the user requirements and the capabilities of emerging technologies. Additionally, such a definition has been evaluated in a pilot environment involving purely experimental networks as well as production networks. During the whole project, University of Bern has supported SWITCH in two aspects mainly: test-bed set-up / measurements and tool development / configuration for QoS monitoring. In particular, QoS measurements have been performed over

international test-beds. The goal of has been to determine the real capacity of the networks in place. Another task was the investigation of effective QoS monitoring tools to be used by SEQUIN. The main outcome was the demand for very specific QoS monitoring tools. This can be met by developing tailored tools or upgrading the existing ones toward the needs of this project.

Research Staff

Ruy de Oliveira

Financial Support

SWITCH / EU project IST-1999-20841

Next Generation Networks Initiative (NGNi)

The European Next Generation Networks Initiative (www.ngni.org) analyzed standards as well as identified technology, market trends and forecasts in the area of network technology for next-generation wired and wireless networks. The Quality-of-Service subgroup consisting of partners from BITS Pilani (India), University of Haute-Alsace (France), UPM Madrid, Versaware (Spain), and University of Bern investigated QoS technologies that are currently being used and tested in Internet networks and that might be useful for next generation networks. The project also developed a roadmap for emerging QoS technologies in next generation networks. Based on that a vision has been defined about the most likely future technical scenarios with respect to QoS in next generation networks

Research Staff

Torsten Braun, Linqing Liu

Financial Support

EU project IST-2000-26418

Cellular Assisted Ad-Hoc / Peer-to-Peer Networking

Most of the problems that are faced in ad-hoc networking research are based on the limited global information about the entire network topology that is available at a mobile node. To find the best route without knowing the location of the correspondent node is a hard problem. Security issues are also getting much more critical without a centralized infrastructure that is able to act as an authentication, authorization, and accounting platform. The reuse of existing cellular infrastructure does make much sense to overcome the shortcomings of pure ad-hoc systems. The main advantage of such a cellular management plane is the availability of global information about the identity and even the location of each member. This approach avoids many problems that rise up in pure and decentralized ad-hoc networks. One of the main problems in the domain of ad-hoc and peer-to-peer communication including data transactions is authentication of mobile nodes. Without centralized authentication services like certificate authorities or home location registers it seems to be very hard to authenticate a peer device or a user who is not registered or does not have a common shared secret. Moreover, paid services will never be available without authentication. In the elaborated concept that reuses cellular networks as management layer for

ad-hoc and peer-to-peer networks, other radio technologies than cellular networks should be used to enable broadband data channels between the participating nodes. The first designed concepts for authenticated message exchange even allow service detection without the need of user intervention. This behavior of environment exploration can have significant impact on the market of location based services like information distribution by sightseeing, timetable broadcasting at train stations, but also newspaper download at kiosks. Ad-hoc services like these will occur wherever electronic information has to be transferred to a mobile device like a personal digital assistant. Within this research work basic concepts have been elaborated (patent pending). General use-cases for "Cellular Assisted Ad-hoc / Peer-to-Peer Networking" have been defined and will be implemented in prototypes to allow future usability and performance tests.

Research Staff

Marc Danzeisen, Simi Winiker

Financial Support

Swisscom AG

PhD Theses

- § Florian Baumgartner: Quality of Service Support by Active Networks, February 2002
- § Günther Stattenberger: Scalable Quality of Service Support for Mobile Users, December 2002

Diploma Theses

- § Stefan Egger: Performance Simulation of Multicast for Small Conferences, November 2002
- § Marco Studer: Ein Simulations-Framework für Endpoint Admission Control, November 2002
- § Thomas Jampen: Authentication, Authorization and Resource Reservation for Distributed Laboratories, June 2002
- § Eveline Kurt: Implementation of a Web-Based Interface for Virtual Router Configuration, June 2002

Activities

Events

- RVS Summer School, Summer School 2002, Vira-Gambarogno, August 26-30, 2002 (supported by Burgergemeinde Bern)

Memberships

- § SWITCH Stiftungsrat (Torsten Braun)
- § SWITCH Stiftungsratsausschuss (Torsten Braun)
- § SWITCH Projektausschuss e-Academia / Authentifizierungs- und Autorisierungs-Infrastruktur (AAI): Pilot-Phase (Marc-Alain Steinemann)
- § SWITCH AAI Task Forces Attributes and Policy (Marc-Alain Steinemann)
- § 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 committees at University of Zürich, ETH Zürich and University of Fribourg (Torsten Braun)
- § Ph.D. Jury of Imad Aad (University of Grenoble) (Torsten Braun)
- § Expert for Diploma Exams at FH Bern (Torsten Braun)

Conference Program Committees

- § 1st Workshop on End-to-End Service Differentiation (EESD), held in conjunction with the IEEE International Performance Computing and Communications Conference (IPCCC), Phoenix, Arizona, USA, April 3-5, 2002 (Torsten Braun)
- § 7th IFIP/IEEE International Workshop on Protocols For High-Speed Networks (PfHSN 2002), April 22 - 24, 2002, Berlin, Germany (Torsten Braun)
- § 4th International Conference on New Educational Environments, Lugano, Switzerland, May 8-11 (Torsten Braun)
- § 2002 IEEE Workshop on High Performance Switching and Routing (HPSR 2002), Kobe, Japan, May 26-29, 2002 (Torsten Braun)
- § 3rd International Conference on Internet Computing (IC 2002), Las Vegas, Nevada, USA, June 24 - 27, 2002 (Torsten Braun)
- § 1st International Workshop on Wired / Wireless Internet Communications (WWIC 2002), Las Vegas, Nevada, USA, June 24 - 27, 2002 (Torsten Braun)
- § 2nd IEEE Workshop on Applications and Services in Wireless Networks (ASWN 2002), Paris, France, July 3-5, 2002 (Torsten Braun)

§ 12th IEEE Workshop on Local and Metropolitan Area Networks, August 11-14, 2002, Stockholm, Sweden (Torsten Braun)

§ 2nd International Workshop on Internet Charging and QoS Technology (ICQT02), Zürich, Switzerland, October 16-18, 2002 (Torsten Braun)

§ 13th IFIP/IEEE International Workshop Distributed Systems: Operations & Management (DSOM), Montreal, Canada, October 21-23 (Torsten Braun)

§ 27th Annual IEEE Conference on Local Computer Networks (LCN 2001), November 6-8, 2001, Tampa, Florida, USA (Torsten Braun)

§ 4th International IFIP TC6 Working Conference on Active Networks (IWAN2002), Zürich, Switzerland, December 4-6, 2002 (Torsten Braun)

Reviewing Activities

§ IEEE Communication Letters (Torsten Braun)

§ IEEE Communications Magazine (Torsten Braun)

§ IEEE Internet Computing (Torsten Braun)

§ IEEE International Conference on Communications, New York, April 28 May 2, 2002 (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)

§ Annales des Télécommunications, Hermes Science (Torsten Braun)

§ Addison-Wesley (Torsten Braun)

Invited Talks and Tutorials

§ Torsten Braun: QoS Monitoring and Configuration with Active Networks, Dagstuhl Seminar 02071: Concepts and Applications of Programmable and Active Networking Technologies, Dagstuhl, Germany, February 14, 2002

§ Torsten Braun and Marc Steinemann: Virtuelles Internet und Telekommunikations-Labor, Fachschaftstag Informatik, Department of Teachers Training, University of Bern, May 13, 2002

- § Torsten Braun: Aktive Netze, Informatikseminar Zürcher Hochschule Winterthur, June 18, 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
- § Torsten Braun: Next Generation Internet Protocols for Optical Networks, Tutorial at National Fiber Optic Engineers Conference, Dallas, Texas, USA, September 15, 2002
- § Torsten Braun: IP Telephony over Differentiated Services, Dagstuhl Seminar 02441: Quality of Service in Networks and Distributed Systems, Dagstuhl, Germany, October 30, 2002
- § Marc-Alain Steinemann: Technical and Didactical Aspects of an Open Course Architecture for eLearning, 2nd Workshop on Web Enabling Technologies for Scientists, Abdus Salam International Centre for Theoretical Physics, Trieste, Italy, UNESCO, November 19, 2002
- § Marc-Alain Steinemann: VITELS - Internet-based Computer Networks Laboratory, 2nd Workshop on Web Enabling Technologies for Scientists, Abdus Salam International Centre for Theoretical Physics, Trieste, Italy, UNESCO, November 19, 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
- § Torsten Braun: Ein Labor für virtuelle und entfernte Experimente im Bereich Computernetze, Kolloquium "Informatik und Computational Sciences", University of Basel, December 11, 2002

Publications

Books and Book Chapters

- § Manuel Günter: Customer-Based IP Service Monitoring with Mobile Software Agents, Birkhäuser Verlag, 2002, ISBN 3-7643-6917-5
- § Marc-Alain Steinemann, Torsten Braun, Marc Danzeisen, Manuel Günter: Virtual Private Networks, in John G. Proakis (editor): Wiley Encyclopedia of Telecommunications, December 2002, ISBN 0-471-36972-1, pp.2807-2815

Journal Papers

- § Ibrahim Khalil and Torsten Braun: Edge Provisioning and Fairness in VPN-DiffServ Networks, Journal of Network and System Management, Kluwer Academics / Plenum Press, Vol. 10, No. 1, March 2002, ISSN 1064-7570, pp. 11-37
- § Manuel Günter and Torsten Braun: Internet Service Monitoring with Mobile Agents, IEEE Network Magazine, May / June 2002, Vol. 16, No. 3, ISSN 0890-8044, pp. 22-29

§ Günther Stattenberger, Torsten Braun, Marcus Brunner and Heinrich Stüttgen: Performance Evaluation of a Linux DiffServ Implementation, *Computer Communications Journal*, Elsevier, Vol. 25, Issue 13, August 2002, ISSN 0140-3664, August 2002, pp. 1195 - 1213

Conference Papers

§ Matthias Scheidegger and Torsten Braun: An Adaptive IP Telephony Application over Differentiated Services, in: *Proceedings of 21st IEEE International Performance, Computing, and Communications Conference, 1st Workshop on End-to-End Service Differentiation (EESD2002)*, Phoenix, USA, April 3-5, 2002, ISBN: 07803-7371-5, pp. 361-368

§ Ibrahim Khalil and Torsten Braun: Automated Service Provisioning in Heterogeneous Large-Scale Environment, in: Rolf Stadler, Mehmet Ulema (editors): *8th IEEE/IFIP Network Operations and Management Symposium (NOMS 2002)*, Firenze, Italia, April 15-19, 2002, ISBN 0-7803-7382-0, pp. 575-588

§ Marc-Alain Steinemann, Thomas Jampen, Stefan Zimmerli, and Torsten Braun: Architectural Issues of a Remote Network Laboratory, *Networked Learning 2002 (NL 2002)*, Berlin, May 1-4, 2002, ISBN 3-906454-31-2, pp. 133

§ Silvia Bechter, Torsten Braun, and Günther Stattenberger: Development of a Virtual Computer Architecture Course, *4th International Conference on New Educational Environments (ICNEE 02)*, Lugano, May 8-11, 2002, ISBN 3-0345-0031-9, pp. 1.1/3-6

§ Marc-Alain Steinemann, Thomas Jampen, Stefan Zimmerli, Torsten Braun: Didactical Issues of a Remote Network Laboratory, *4th International Conference on New Educational Environments (ICNEE 02)*, Lugano, May 8-11, 2002, ISBN 3-0345-0031-9, pp. 1.2/39-41

§ Marc Steinemann, Stefan Zimmerli, Thomas Jampen, and Torsten Braun: Global Architecture and Partial Prototype Implementation for Enhanced Remote Courses, *Computers and Advanced Technology in Education (CATE 2002)*, Cancun, Mexico, May 20-22, 2002, ISBN 0-88986-332-6, pp. 441-446

§ Attila Weyland, Günther Stattenberger, and Torsten Braun: User-Controlled Handover in Wireless LANs, *2nd IEEE Workshop on Applications and Services in Wireless Networks 2002 (ASWN 2002)*, Paris, France, July 3-5, 2002, pp. 45-49

§ Thomas Jampen, Manuel Günter, and Torsten Braun: A Java API for Using a Native PGP Implementation, in : N. Mastorakis, V. Mladenov (editors): *Recent Advances in Computers, Computing and Communications*, WSEAS Press, *6th WSEAS CSCC Multiconference*, Rethymnon, Crete, Greece, July 7-14, 2002, ISBN 960-8052-62-9, pp. 27-30

§ Attila Weyland, Günther Stattenberger, and Torsten Braun: Mobile-Controlled Handover in Wireless LANs, *12th IEEE Workshop on Local and Metropolitan Area Networks 2002 (LANMAN 2002)*, Stockholm, Sweden, August 11-14, 2002, pp. 119-120

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

§ Florian Baumgartner, Torsten Braun, and Bharat Bhargava: Virtual Routers: A Tool for Emulating IP Routers, 27th Annual IEEE Conference on Local Computer Networks (LCN 2002), Tampa, USA, November 6-8, 2002, ISBN 0-7695-1591-6, pp. 363-371

§ Florian Baumgartner, Torsten Braun, and Bharat Bhargava: Design and Implementation of a Python-Based Active Network Platform for Network Management and Control, 4th International IFIP TC6 Working Conference on Active Networks (IWAN2002), Zürich, Switzerland, December 4-6, 2002, ISBN 3-540-00223-5, pp. 177-190

Patents

§ Marc Danzeisen, Jan Linder: Method and System for Mobile IP Nodes in Heterogeneous Networks, International publication number: WO 02/103978 A2, Publication date: 27.12.2002

Technical Reports

§ Ruy de Oliveira and Torsten Braun: TCP in Wireless Mobile Ad Hoc Networks, Technical Report, IAM-02-003, July 2002

§ Ruy de Oliveira (ed.): Computer Networks and Distributed Systems, Technical Report, IAM-02-004, November 2002

§ Serge Droz, Marc-Alain Steinemann et al.: Authentication and Authorization Infrastructure (AAI) - Authorization Attribute Specification, December 2002, http://www.switch.ch/aai/docs/AAI_Attr_Specs.pdf

§ Nicole Beranek Zanon, Marc-Alain Steinemann et al.: Authentication and Authorization Infrastructure (AAI) - Preparatory Study, July 2002, http://www.switch.ch/aai/AAI_Study_v10a.pdf

§ Florian Baumgartner, Timea Dreiling, Gianluca Foddìs, Pedro A. Aranda Gutiérrez, Tamas Mahr, Ilka Miloucheva, Maurizio Molina, Fausto Saluta, Matthias Scheidegger, Carsten Scholl, Joern Seger, Cristina Soto, Attila Vidacs: Modelling and Simulation Specification, InterMON Deliverable 6, December 23, 2002, http://www.ist-intermon.org/download/Deliverable_6.pdf

§ Marc Danzeisen: MANET in the World of Telecom Operators, Project Deliverable, August 19, 2002

§ Marc Danzeisen, Jan Linder, and Torsten Braun: Cellular Assisted Adhoc/P2P Networking, Patent Application, September 11, 2002

§ Rahul Banerjee, Juan Quemeda, Pascal Lorenz, Torsten Braun, and Bernardo Martinez: Mechanisms for Attaining QoS in IPv6-based Multimedia Internetworks, NGNi project deliverable D2, February 2002, <http://www.ngni.org/projects/NGNI-QoS-D2-v1-3-secure.pdf>

§ Torsten Braun, Linqing Liu, F. J. Gonzalez Castano, Rahul Banerjee, Juan Quemeda, Pascal Lorenz, and Bernardo Martinez: Benchmark of Next Generation Network Quality of Service Technologies, NGNi project deliverable D3, March 2002, <http://www.ngni.org/projects/NGNI-MMI-QoS-Deliverable-D3-v1.3.pdf>

§ Rahul Banerjee, Juan Quemeda, Pascal Lorenz, Bernardo Martinez, Torsten Braun, Linqing Liu, and F. J. Gonzalez Castano: Roadmapping and Standardization of Next Generation Network Quality-of-Service Technologies, NGNi project deliverable D4, April 2002, <http://www.ngni.org/projects/NGNI-MMI-QoS-Deliverable-D4-v1.pdf>

§ Simi Winiker: Horizontal Heterogeneity through SecMIP Controlled Infrastructure, Computer Science Project, June 2002

§ Christine Rosenberger: IP Routing Tutor, Computer Science Project, June 2002

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