

Research Report 2000

Research Group "Computer Networks and Distributed Systems"

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Student Researchers

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Research Projects

Charging and Accounting Technologies for the Internet (CATI)

The main goal of the CATI project has been the design, evaluation and implementation of charging and accounting mechanisms for value-added Internet services such as Integrated Services, Differentiated Services and Virtual Private Networks (VPNs). CATI was a CNEC (Competence Network Electronic Commerce) project within the Swiss Priority Program for Information and Communications Structures (SPP ICS) of the Swiss National Science Foundation (SNF) running from July 1998 to March 2000. The

RVS group developed a flexible VPN service system including Quality-of-Service (QoS) support. The user can set up, modify and tear down VPN connections on-line and choose from IP Security features for the VPN service as well as QoS features similar to the IETFs Differentiated Services. The developed system supports both Cisco and Linux routers and handles accounting of VPN connections considering bandwidth, duration of the reservation, time of day, security parameters etc. To support Integrated Services applications, a gateway has been implemented on Linux for mapping Integrated Services to Differentiated Services reservations. Automatic set up and management of VPNs between the universities of Genève and Bern as well as the Integrated / Differentiated Services gateway using an RSVP capable video application have been demonstrated successfully during the final SNF CNEC workshop in March 2000 at Bern. In addition, bandwidth broker protocols have been developed and implemented in order to support multi-provider VPN services.

Research Staff

Manuel Günter, Ibrahim Khalil, Linqing Liu, Roland Balmer, and Emmanuel Granges

Financial Support

Swiss National Science Foundation Projects No. 5003-054559/1 and 5003-054560/1

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

ANAIsoft is a project in the framework of the 2nd phase of the SNF CNEC programme. Academic project partners are the Universities of Zürich and Genève, EPF Lausanne, and ETH Zürich. In addition, several non-academic partners collaborate within the project: Etat de Vaud, SER Systeme A.G., Swisscom, Swissmetro, TheNet - Internet Services AG. The RVS group continues the CATI work into two directions: First, an architecture to enhance the VPN services for mobile users has been designed and will be implemented. Mobile IP VPN services enable Mobile IP users that are roaming in the Internet to access the VPN of their organization. Second, monitoring functions are required to make sure that the service contracts established between customers and ISPs for a VPN service, are really met. This includes both security functions and Quality-of-Service (QoS). These monitoring functions have been implemented on the basis of mobile agent technology. Mobile Java agents can be executed in measurement environments located at the ISPs premises. The environments offer a secured interface for direct and generic IP network measurements to customers, peer providers or the ISPs own network management crew.

Research Staff

Manuel Günter, Ibrahim Khalil, and Marc Danzeisen

Financial Support

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

Commercialization of Streamed Information (StreamCom)

StreamCom is another 2nd phase SNF CNEC project. Its main goal is to study various problems and issues related to the commercialization of streamed information. Project partners are EPF Lausanne, and the Universities of Genève, St. Gallen, and Zürich. The RVS group focuses on the development of Quality-of-Service (QoS) support for streamed information such as video streams. The provider of the StreamCom service can set up and tear down the QoS support for the data streams by delivering the corresponding parameters to a bandwidth broker of the ISP. The bandwidth broker receives and processes these requests and configures the ISPs routers appropriately. The data streams 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 CATI which allows the StreamCom service provider to negotiate the desired service with the ISPs bandwidth broker. This protocol is being implemented in Java.

Research Staff

Roland Balmer

Financial Support

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

Mobile IP Telephony (MIPTel) and Mobile IP Quality-of-Service (MobiQoS)

The Mobile IP Telephony project funded by SNF aims to develop an architecture supporting IP telephony applications over DiffServ IP networks. The project is directly linked with the Mobile IP Quality-of-Service (MobiQoS) research activity performed in collaboration with INRIA Rhône Alpes and ENST (Ecole National Supérieure de Telecommunication) Bretagne. The first goal of MIPTel is to develop adaptive audio applications that can make use of Differentiated Services provided in home / foreign networks with wireless access. The basic framework of the Differentiated Services Internet Telephone (dsphone) has been implemented and is running on Linux end systems. The implementation includes a graphical user interface to configure the system, and start / stop connections. It also displays the current network transmission status. A simplified version of RTP/RTCP, which omits certain functionalities only used in applications with more than two participants, has been developed. An audio application can select the DiffServ Codepoint of an outgoing packet dynamically. Two audio encoding schemes with different sampling rates are currently being supported (PCM and mLaw). The second issue investigated in MIPTel is the determination of the desired service level of a mobile user visiting a foreign network provider. A comprehensive architecture has been developed to support authentication, service level detection, service provisioning as well as charging and accounting. The architecture is based on AAA servers (AAA: Authentication, Authorization, and Accounting) and a protocol running between AAA servers located in home and foreign networks. Mobile nodes make use of the IETFs Service Location Protocol (SLP) for the discovery of network services such as Differentiated Services. The architecture enables a mobile user to use the same service levels in a foreign network as used to in the home network.

Research Staff

Li Ru, Günther Stattenberger, and Matthias Scheidegger

Financial Support

Swiss National Science Foundation Project No. 2100-057077.99/1, Institut National de Recherche en Informatique et en Automatique (INRIA)

QoS Support for the Internet based on Intelligent Network Elements

Active Networking (AN) is a promising technology for flexible and powerful service provisioning in future telecommunications and computer networks. The project includes a collaboration with a research group at Purdue University that already gained experience with this rather new AN technology. AN shall be 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), signaling, QoS routing and the development of appropriate multimedia applications, capable to exploit the AN benefits. A prototypical AN system and a special hybrid network simulator have been designed and implemented, allowing to emulate larger Active Networks and to study their behaviour using real applications simultaneously. This environment is being used to evaluate different AN based methods of resource reservation mapping (Integrated to Differentiated Services) and network management.

Research Staff

Florian Baumgartner

Financial Support

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

Virtual Telecommunications Laboratory Switzerland

This project is one of a first series of Virtual Campus Switzerland (VCS) projects. The goal is to develop a course that provides practical exercises in the area of telecommunications / computer networks to the students. The course language is English. The exercises shall be performed by students remotely. Students do not need to be present in particular laboratory rooms. In addition, supplementary tutorial material and theoretical on-line exercises are under development. In total, seven modules and the authentication/authorization infrastructure will be developed and maintained by the different involved institutes (Universities of Bern, Fribourg, Genève, Neuchâtel and Engineering School Fribourg) and integrated into a common web environment. Two of these modules are developed at Bern: IP Network Simulation Configuration and Management of Virtual Private Networks. Several design activities addressing the accessibility and restorability of the laboratory equipment have been started in 2000. Valuable experiences have already been gained during the development of traditional network laboratory course.

Research Staff

Marc-Alain Steinemann

Financial Support

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

Differentiated Services over ATM

The Differentiated Services implementation on a Linux-based router has been extensively tested and detailed performance measurements have been performed. Both, Expedited and Assured Forwarding implementations have proven their ability to protect traffic against aggressive flows and congestion. The implementation has also been extended to support IPv6 traffic. Those extensions have been tested and initial results are similar as for IPv4. The second part of the project focuses on the development of a platform independent Quality of Service (QoS) management API, that enables an application programmer to develop QoS management software to be used in heterogeneous network environments. An interface for addressing the Linux DiffServ router by calling the API functions has been implemented. The main goal of this part of the project is the design of a generic bandwidth broker architecture that can be used on Linux router test beds.

Research Staff

Günther Stattenberger, Matthias Scheidegger, and Arik Dasen

Financial Support

Computer & Communication Research Laboratories, Heidelberg, Germany

Virtual Private Network Management

TBD Networks provides a management application for of all types of VPNs (site-to-site, remote access and extranet) throughout the entire VPN life cycle. It enables an enterprise's security policy information, created during the design phase, to feed a fully automated provisioning, where device configurations are interpreted directly from the security policy and are automatically deployed to the VPN devices in the network. An intelligent device driver for VPN device provisioning has been developed by University of Bern. The device driver includes audit capabilities and is intended for Nortel routers. It automatically verifies the appropriate network configuration at any given time and raises the necessary alarms when a security break has been identified.

Research Staff

Ibrahim Khalil

Financial Support

TBD Networks Inc., Fremont, California, USA

ISDN/MBone-Gateway

The ISDN/MBone-Gateway is a solution to enable ISDN/PSTN users to join IP multicast (MBone) sessions using (mobile) ISDN/PSTN telephones. Gateway control mechanisms allowing users to select and join those conferences easily have been developed. With the comprehensive gateway control implementation on a Linux platform integrated with available public domain software components such as for audio forwarding, a mobile user with a WAP capable mobile phone or with a regular web browser can select current available multicast sessions and conferences, create new conferences, register to the gateway and then dial up to the gateway for joining the sessions. All of the session information and gateway contact information can be distributed using several communication channels such as HTML / WML pages or SMS / email.

Research Staff

Linqing Liu

Financial Support

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

Testbed for Mobile and Internet Communications

An experimental test network serves for the implementations performed within the various research projects mentioned above. The network consists of UNIX servers, Linux and commercial routers, ATM switches, LAN switches as well as a variety of multimedia end systems. Two experimental subnetworks, one for Mobile IP implementation tests and one for DiffServ / IPv6 experiments have been established additionally. The two networks include Linux routers and hosts based on publicly available Mobile IP and IPv6 implementations. In addition, several traffic generators for DiffServ and IPv6 tests have been developed.

Research Staff

Roland Balmer, Florian Baumgartner, Ibrahim Khalil, Günther Stattenberger, Thomas Bodenmann, and Attila Weyland

Financial Support

Stiftung zur Förderung der wissenschaftlichen Forschung an der Universität Bern.

Diploma Theses

- Emmanuel A. Granges: Bandwidth Broker für Differentiated Services, March 2000

Student Projects

- Arik Dasen: Implementation of Differentiated Services over ATM, January 2000
- Marc Brogle: Active Networking mit ANTS, May 2000
- Attila Weyland: Evaluation of Mobile IP Implementations under Linux, December 2000

Activities

Conference Program Committee Memberships

- IEEE Conference on High Performance Switching and Routing (HPSR), Heidelberg, Germany, June 26 - 29, 2000 (Torsten Braun)
- 1st IEEE European Conference on Universal Multiservice Networks, ECUMN'2000, Colmar, France, October 2-4, 2000 (Torsten Braun)
- 6th IFIP Conference on Intelligence in Networks (SmartNet 2000), Vienna, Austria, September 18 - 22, 2000 (Torsten Braun)
- 25th IEEE Annual Conference on Local Computer Networks (LCN), Tampa, Florida, USA, November 8-10, 2000 (Torsten Braun)
- GI/ITG-Fachtagung Kommunikation in Verteilten Systemen, Hamburg, Germany, February 20-23, 2001 (Torsten Braun)
- 11th IEEE Workshop on Local and Metropolitan Area Networks, Boulder, Colorado, USA, March 18-21 2001 (Torsten Braun)

Technical Committees

- SWITCH Stiftungsrat (Torsten Braun)
- SWITCH Stiftungsratsausschuss (Torsten Braun)
- SPEEDUP Society Committee (Torsten Braun)

Reviewing Activities

- Journal on Integrated Computer-Aided Engineering, IOS Press
- Computer Networks Journal, Elsevier
- International Conference on Communications (ICC), Helsinki, Finland, June 11-15, 2001
- IEEE Infocom, Anchorage, Alaska, USA, April 22-26, 2001

Invited Talks

- Torsten Braun: Service Broker für globale Internet-Dienste, Informatikkolloquium, University of Karlsruhe, Germany, January 7, 2000
- Torsten Braun: Service Broker for Global Internet Services, Cisco, San Jose, California, USA, February 16, 2000
- Ibrahim Khalil: Implementation of a Service Broker for Management of QoS Enabled VPNs, VPNcon, San Jose, California, March 2, 2000
- Torsten Braun: A Broker-Architecture for Value-Added Internet Services, Dagstuhl Seminar Quality-of-Service, Dagstuhl, Germany, May 10, 2000
- Torsten Braun: Virtual Telecommunications Laboratory Switzerland, Dagstuhl Seminar Multimedia for Multimedia, Dagstuhl, Germany, June 12, 2000
- Torsten Braun: MPLS and Computer Networking Research at University of Berne, TBD Networks, Fremont, California, USA, November 7, 2000

Tutorials

- Torsten Braun: Quality-of-Service and Traffic Engineering in IP Networks, IEEE Workshop on IP-oriented Operations & Management (IPOM), Cracow, Poland, September 4-6, 2000
- Torsten Braun: Next Generation Internet Protocols for Optical Network Environments, SPIE Photonics East, Boston, Massachusetts, USA, November 6, 2000
- Florian Baumgartner, Torsten Braun, Manuel Günter: Sicherheit im Internet, Sicher2000, Bern, November 16-19, 2000.

Organized Events

- Swiss National Science Foundation symposium on Research Results of the Competence Network for Applied Research in Electronic Commerce (CNEC), Bern, February 22, 2000
- Séminaire de Printemps du 3ème Cycle Romand d'Informatique on Agent Technology, Lenk im Simmental, March 6-10, 2000

Publications

Journal and Conference Papers

- Burkhard Stiller, Torsten Braun, Bernhard Plattner, Roland Balmer, Florian Baumgartner, David Billard, Gabriel Dermler, George Fankhauser, Noria Foukia, Manuel Günter, Ibrahim Khalil, Helmut Kneer, Simon Leinen, Christian Matt, Peter Reichl, David Schweikert, Nathalie Weiler, and UrsZurfluh: Charging and Accounting Technology for the Internet, in: Schweizerischer Verband der Informatikorganisationen SVI/FSI (ed.): INFORMATIK/INFORMATIQUE 1/2000, pp. 66-68, ISSN 1420-6579
- Manuel Günter: Virtuelle Private Netze für das Internet, Bulletin des Schweizerischen Elektrotechnischen Vereins, 7/2000, pp. 23-27, ISSN 1420-7028
- Gabriel Dermler, Manuel Günter, Torsten Braun, and Burkhard Stiller: Towards a Scalable System for Per-Flow Charging in the Internet, Applied Telecommunication Symposium, in B. Bodnar, A.

Sharon (eds.): Simulation Series, Vol. 32, No. 4, The Society for Computer Simulation International, ISBN:1-56555-196-6

- Torsten Braun, Arik Dasen, Matthias Scheidegger, Karl Jonas, and Heinrich Stüttgen: Implementation of Differentiated Services over ATM, Proceedings of the IEEE Conference on High Performance Switching & Routing, June 26-29, 2000, Heidelberg, Germany, pp. 317-322, ISBN 1098-7789
- Ibrahim Khalil, Manuel Günter, and Torsten Braun: Implementation of a Service Broker for Management of QoS Enabled VPNs, IEEE Workshop on IP-oriented Operations & Management (IPOM 2000), September 4-6, 2000, Cracow, Poland, pp. 13-23, ISBN 83-88309-00-5
- Manuel Günter and Torsten Braun: Service Delivery Control with Mobile Code, in H. van As (ed.): Telecommunication Network Intelligence, 6th International IFIP Conference on Intelligence in Networks (SmartNet 2000), September 18-22, 2000, Vienna, Austria., pp. 3-19, ISBN 0-7923-7932-2
- Florian Baumgartner and Torsten Braun: Virtual Routers: A Novel Approach for QoS Performance Evaluation, in: J. Crowcroft, J. Roberts, M. Smirnov (eds.): Quality of Future Internet Services, First COST 263 International Workshop, QofIS'2000, September 25-26, 2000, Berlin, Germany, Lecture Notes in Computer Science 1922, Springer, pp. 336-347, ISBN 3-540-41076-7
- Torsten Braun, Matthias Scheidegger, Hans Joachim Einsiedler, Günther Stattenberger, Karl Jonas, and Heinrich J. Stüttgen: A Linux Implementation of a Differentiated Services Router, in S. Rao, K. I. Sletta (eds.): Next Generation Networks (Networks and Services for the Information Society), INTERWORKING' 2000, October 3-6, 2000, Bergen, Norway, Lecture Notes in Computer Science 1938, pp. 302-315, ISBN: 3-540-41140-2
- Roland Balmer Florian Baumgartner, Torsten Braun, and Manuel Günter: A Concept for RSVP over DiffServ, in T. Engbersen, E. Park: Proceedings of the 9th International Conference on Computer Communication and Network (ICCCN 2000), October 16-18, 2000, Las Vegas, USA, pp. 412-417, ISBN 0-7803-6494-5
- Ibrahim Khalil and Torsten Braun: Edge Provisioning and Fairness in VPN-Diffserv Networks, in T. Engbersen, E. Park: Proceedings of the 9th International Conference on Computer Communication and Network (ICCCN 2000), October 16-18, 2000, Las Vegas, USA, pp. 424-431, ISBN 0-7803-6494-5
- Florian Baumgartner and Torsten Braun: Quality of Service and Active Networking on Virtual Router Topologies, in H. Yasuda (ed.): 2nd International Working Conference on Active Networks, IWAN 2000, October 16-18, 2000, Tokyo, Japan, Lecture Notes in Computer Science 1942, pp. 211-224, ISBN 3-540-41179-8
- Ibrahim Khalil and Torsten Braun: Implementation of a Bandwidth Broker for Dynamic End-to-End Resource Reservation in Outsourced Virtual Private Networks, 25th IEEE Conference on Local Computer Networks (LCN 2000), November 9-10, 2000, Tampa, Florida, pp. 511-519, ISBN 0-7695-0912-6
- Torsten Braun: Multicast-Kommunikation im Internet, in: Elektrotechnik und Informationstechnik (e&i), Zeitschrift des Österreichischen Verbandes für Elektrotechnik, Heft 6 / 2000, pp. 389-398, ISBN 0932-383X

Posters and Workshop Abstracts

- Manuel Günter and Torsten Braun: Extended Abstract: Internet Service Delivery Control with Mobile Agents, 2nd International Symposium on Agent Systems and Applications / Mobile Agents (ASA/MA 2000), September 13-15, 2000, Zürich, Switzerland
- Florian Baumgartner and Torsten Braun: Active Networking, QoS and Virtual Routers, Extended

Abstract for the ASA/MA 2000, September 13-15, 2000, Zürich.

- Florian Baumgartner and Torsten Braun: Virtual Routers Supporting Active Networking, Extended Abstract, Stockholm Active Networks Day (SANday), August 28, 2000, Stockholm, workshop organized by Uppsala University, Sweden, held in conjunction with ACM SIGCOMM 2000

Technical Reports

- Manuel Günter, Marc Brogle, and Torsten Braun: Secure Communication: a New Application for Active Networks, Technical Report, IAM-00-007, July 2000
- Torsten Braun: Multicast for Small Conferences, Technical Report, IAM-00-008, July 2000.
- Li Ru, Torsten Braun, and Günther Stattenberger: An AAA based Architecture for Providing Differentiated Services to Mobile IP Users, Technical Report, IAM-00-009, November 2000.
- Günther Stattenberger and Torsten Braun: Implementation and Configuration of a Linux Differentiated Services Router, Technical Report, IAM-00-010, November 2000.