

1 Research Group on Computer Networks and Distributed Systems

1.1 Personnel

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* with financial support from a third party

1.2 Overview

The research group for Computer Networks and Distributed Systems (Rechnernetze und Verteilte Systeme, RVS) is active in several areas of computer communications and distributed systems.

Multimedia Communications The Internet is increasingly being used for multimedia data transfer (audio, video, data). We are studying how such services with high demands on the quality and reliability of communication systems and networks can be supported. In the past, we developed scalable simulation tools to support planning and operation of global IP networks. Nowadays, overlay networks and peer-to-peer systems are becoming more important for new Internet services, in particular to support communication within user groups. We are focusing on the design, development, and evaluation of methods to construct such overlay networks supporting the quality-of-service requirements of distributed applications and using network resources efficiently.

Wireless and Mobile Communication Decentralized system architectures and self-organization are fundamental concepts of future wireless and mobile communication systems. These concepts are particularly important in application scenarios such as sensor networks, mobile ad hoc networks (e.g. for direct communication between vehicles) and so-called mesh networks, which form low cost alternatives for the network access by end users. There is an urgent need for research on routing and transport protocols as well as on security and management mechanisms. In sensor networks, limited energy, computing and memory resources as well as limited reliability require special forms of distributed data processing and management.

Security in Distributed Systems The Internet simplifies access to distributed resources and services such as web services, e-learning contents, computer grids or sensor nodes. Traditional techniques for authentication and authorization are not very user-friendly and barely scalable. We investigate, design, implement, and evaluate novel schemes for efficient and secure authentication and authorization.

Distance Learning In all our lectures, we are using distance learning elements that are based on standard components but also on developments resulted from recent research projects. We are developing new methods and tools to support learners and teachers in e-learning environments. In particular, we aim to support practical experiments, mobile learning, and support for groups of learners.

1.3 Research Projects

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

The NCCR-MICS (<http://www.mics.ch>) project was launched in 2001. Its goal is to study fundamental and applied research questions raised by new generation mobile communication and information services, based on self-organization. Such systems have become very topical with the advent of mobile ad-hoc, peer-to-peer, and sensor networks. NCCR-MICS is composed of more than twenty research projects distributed over four clusters. The research project of the RVS group on “Distributed event detection and localization architecture for wireless sensor networks” (IP4) aims at designing and implementing a distributed event detection, event localization, and data aggregation framework. It includes efficient and reliable signaling protocols as well as mechanisms to dynamically reprogram sensor network applications.

Based on previous work, the distributed event detection and localization architecture (DELTA) has been developed. The current DELTA implementation provides algorithms to efficiently detect environmental events and build dynamic tracking groups to observe them. Each tracking group is led by a designated node (leader), which is responsible for the group organization, to gather and process event relevant data, and to initialize the leadership handover in case the event moves out of its area. The gathered data contains the locations of the group members observing the events and their sensor readings. Based on this information the group leader performs nonlinear function optimization, i.e., a simplex downhill function optimization, to estimate position and amplitude of the event. This information can then be used to classify the event and is reported to the base station. We are planning to use fuzzy logic concepts for classification and outlier detection. We are currently investigating the applicability of a fuzzy c-means clustering algorithm to identify different event classes. This information will then be used to build a fuzzy inference system, which will be implemented on the sensor nodes to classify events and filter outliers.

To support the DELTA framework with a routing topology on the one hand and to provide a energy saving mechanism on the other, a virtual backbone has been developed and implemented. The virtual backbone is able to temporally disconnect redundant nodes. Furthermore, it is periodically (re)established to distribute the backbone load and provides link repair mechanisms.

Another work was the implementation and evaluation of two MAC proto-

cols, namely LMAC and TEEM, on Embedded Sensor Boards (ESBs). We got a number of insights concerning the implementation of a theoretical concept on real sensor hardware with all its limitations. Improvements of SYNC-based MAC protocols have been achieved. The SYNC messages are used to setup a backbone structure enabling the temporal disconnection of redundant nodes on the MAC layer without any additional traffic.

Research staff: Markus Wälchli, Reto Zurbuchen, Michael Meer, Markus Anwander, Samuel Bissig, Piotr Skoczylas, Torsten Braun

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

Mobile IP Telephony (MIPTel)

Wireless mesh networks (WMN) are evolving to an important access technology for wireless broadband services. They provide a cost efficient way to interconnect isolated networks as well as to enhance the network coverage. WMNs usually consist of static mesh routers and mobile or static mesh clients. Both support multi-hop communication and may act as routers. The mesh nodes might support multiple heterogeneous radio interfaces. WMNs offer a more robust and redundant communication infrastructure than many wireless networks deployed today. They provide communication facilities even in special situations where certain systems such as GSM are overloaded.

Our project aims at exploiting wireless mesh networks as an infrastructure for Mobile IP telephony. IP telephony requires short delays and moderate packet loss. In WMNs the quality of the routes may vary unpredictably because of the unreliable and erroneous wireless medium. Routes may break, if the network topology changes due to node or link failures. Links and nodes may become congested, which leads to larger delays or packet loss. This makes the deployment of a real time application such as IP telephony a challenging task.

We see two important approaches to improve the speech quality and to reduce outages in a Mobile IP telephony application in WMNs: path diversity and multi-stream coding. The characteristics of multiple paths are usually uncorrelated, i.e. the delay, jitter, and loss rate of the paths differ a lot from each other. Therefore, the transmission over multiple paths can be used to compensate for the dynamic and unpredictable nature of WMNs. In order to exploit this path diversity for improving the quality of the

audio transmission, a robust multi-path routing protocol and a mechanism for selecting appropriate coding and path allocation for the given network conditions are needed. Our work focuses on developing these protocols and allocation schemes. We currently evaluate different multi-path routing protocols and routing metrics using network simulators and a real world test bed. In order to manage our testbed consisting of 17 low priced embedded x86 based systems, we have developed a secure remote management and software distribution architecture for WMNs. The individual nodes have to be easily managed by a central unit. This includes possibilities of rapidly changing the system software, routing protocols and radio parameters. Further, configuration and system software errors have to be corrected without physical access to the nodes. During the project an embedded Linux distribution is being developed including a management solution with different fallback behaviors in case of errors. Our WMN test bed is now ready for testing protocols. In order to make experiments with larger topologies we have carried on our evaluation on virtualization of a wireless mesh network. We have defined an architecture for integrating real and virtual mesh nodes using a virtual wireless interface driver.

Research staff: Thomas Staub, Alican Gecyasar, Stefan Ott, Michael Lustenberger, Daniel Balsiger

Financial support: Swiss National Foundation Project No. 200020-113677/1

Efficient and Robust Overlay Networks (ERON)

The ERON projects aims at developing an efficient and robust overlay network. An overlay network is a virtual communication network built on top of an existing communication network such as the Internet. Overlay networks are used for different tasks such as routing of multicast messages. Since the full-mesh overlay network, in which every pair of participants is communicating directly with each other, is not scalable, overlay networks usually have other structures. One of the most important criteria for deciding, which overlay network participants get “connected” is the communication delay, since it is the limiting factor on the maximum effective bandwidth for the TCP connections. Similar to a full-mesh overlay networks, measuring the communication delay between all overlay participants does not scale. To still be able to exploit the communication delay information, numerous communication delay

prediction systems such as IDMaps, GNP, ICS, Vivaldi, S-Vivaldi etc. were developed. Most promising communication delay prediction systems are coordinates-based. In coordinates-based systems, communication partners are represented as points in an n -dimensional Euclidean space such that the distance function in that space predicts the communication delay.

In the second phase of the ERON project we focus on improving embedding hosts into the virtual space. We have identified that the objective function, which is minimized to obtain a host position, can have more than one local minimum. The consequence of the existence of multiple local minima is that the numerical function minimization method used by GNP (Downhill Simplex) may converge towards a local minimum that may not be the global one. If such embedding is used for RTT prediction, the results would not be optimal. To solve this problem, we have developed an algorithm to find all local minima of the objective function and thus its global minimum. Currently, we are evaluating the statistical properties of RTT measurements (regarding the mean and variance) for embedding hosts in coordinates-based systems.

As a part of this project we are developing an application level multicast (ALM) routing protocol, which exploits the information about the host positions. The development of the ALM system has two tasks: 1. Developing a general peer-to-peer multicast routing protocol similar to PIM-DM but adapted to conditions of peer-to-peer networks. 2. Developing a system for choosing neighbors based on a fisheye view of the network. Those two tasks combined should result in an ALM, which takes the underlay structure into account to efficiently build multicast trees.

Research staff: Dragan Milic, Roger Strähl

Financial support: Swiss National Foundation Project No. 200021-109270/1

End-to-end Quality of service support over heterogeneous networks (EuQoS)

The *EuQoS* project (<http://www.euqos.eu>) aims to resolve outstanding design issues presently associated with the delivery of end to end Quality of Service across heterogeneous networks. With the help of EuQoS these issues should be solved and the infrastructures should be upgraded so

that new applications can be supported by the Internet and new service packages can be offered by operators, ISPs and other service providers. Our research group is involved in the work packages WP1, WP3, WP5 and WP6.

WP1 (Business Model and System Design) aims to define an architecture for different aspects of the EuQoS system. Support for QoS in IP multicast is difficult to achieve due to the lack of wide deployment of IP multicast in the Internet and it seems that this will probably not change in the near future, even with the adoption of IPv6. Our research focuses on providing transparent support for application level multicast on end systems. This enables multicast communication across the Internet using only unicast communication offering QoS support. The distribution of multicast data is handled by an Application Layer Multicast (ALM) facility called Scribe, which runs on top of the Peer-to-Peer (P2P) routing substrate called Pastry. Mechanisms for setting up a QoS-aware P2P overlay network have been investigated and resulted in an architectural adaptation of Scribe / Pastry. The the ID assignment method of Pastry, which arranges the peers in the overlay has been enhanced and made QoS requirements aware, in order to enforce Scribe to build QoS supporting multicast distribution trees in terms of bandwidth requirements.

WP3 (Implementation of the EuQoS System) delivers the proposed applications and services according to the architectures defined in WP1. We developed a transparent multicast facility known as "Multicast Middleware," which is based on a virtual network interface (TAP) and has been implemented mostly using Java (version 5.0) to support different operating systems (Win32, Linux and Mac OS X). The Multicast Middleware aims to be independent from the underlying QoS mechanisms. It will either use the EuQoS QoS signaling (introduced by the EuQoS project) or the measurement-based multicast to bridge gaps where no QoS is offered by the underlying network. The overlay network is constructed using a Scribe/Pastry implementation called Freepastry. This implementation has been extended to support QoS-aware construction of multicast trees by Scribe through modifying the basic node distribution mechanisms of Pastry. Another focus has been the performance. Therefore, the Multicast Middleware has been optimized to support high bandwidth data dissemination with 100 Mbps and more on end-systems with recent hardware.

WP5 (EuQoS Pan European trials) builds a testbed environment in which the developed prototypes and applications can be tested and evaluated. Different heterogeneous networks (WLAN, UMTS, LAN, xDSL, etc.) are interconnected in a full mesh among the partners. Our testbed represents a high speed gigabit-LAN-based network, which is interconnected by GRE

tunnels to twelve other testbeds belonging to other EuQoS consortium partners involved in WP5. It is directly connected to the university's border router through a 1 Gbit/s network link. Different prototypes of the EuQoS system and some of its applications have been successfully tested in this environment. The testbed located in Bern is also used for evaluating and testing the Multicast Middleware developed in WP3.

WP6 (Dissemination, Standards and Training) focuses on delivering the project results to the public. This shall be achieved by four activities, namely development of training material, delivery of training, standardization contributions, as well as dissemination by demonstrations and publications. In addition to leading and managing the whole work package, our main contributions address the training activities. Within this context, a course focusing on QoS related topics is being developed for students and industrial learners. The goal of the course is also to raise the familiarity with QoS technologies for next generation networks and applications. The course is based on distance learning technologies and consists of seven QoS related modules. We have developed the didactical concept of the e-learning course and are coordinating its implementation. In particular, we have developed the course modules "Applications' QoS demands", "Implementing protocols on network simulators." including a tool for the visualization and animation of simulator trace files (VAT4Net), "Multicast in EuQoS system.", and an overview animation for the "EuQoS overview" module. Some of these course modules have been used for the lecture called "Multimediakommunikation" held during the summer semester 2007. We are further developing and providing the course management system and the authentication & authorization framework required for the various module exercises. The EuQoS e-learning has been recently migrated to the new e-learning platform WebCT Vista.

Starting from the e-learning course the book project "End-to-End Quality of Service over Heterogeneous Networks" has evolved. Besides the coordination of the book project, we are contributing to several chapters and subchapters.

Research staff: Thomas Bernoulli, Marc Brogle, Dragan Milic, Matthias Scheidegger, Thomas Staub, Patrick Lauer, Gerald Wagenknecht, Markus Wulff, Jana Krähenbühl, Daniel Frey, Milan Nikolic, Luca Bettosini, Sonia Schär, Torsten Braun

Financial support: EU project IST-2003-004503

Virtual Internet and Telecommunications Laboratory of Switzerland (VITELS)

VITELS, a first series Swiss Virtual Campus (SVC) project has been funded within the SVC consolidation program. The VITELS goal has been to develop an e-learning course in English language that provides theory and practical hands-on exercises in the area of telecommunications and computer networks with real network hardware for computer science students. Currently, VITELS consists of eight modules, six designed and maintained by University of Bern, one by University of Neuchâtel, and one by University of Fribourg. The course is fully operational and has been productively used in different regular courses on the Bachelor level at the Universities of Bern (in the "Computer Networks" lecture), Fribourg, and Neuchâtel.

In the reporting period several VITELS related activities have been performed. The VITELS course has been migrated to WebCT Vista as the new e-learning platform supported by SWITCH. The course and its hands-on exercises have been maintained. Upgrades to new versions of the Shibboleth based authentication and authorization infrastructure have been performed. The graphical illustration of the VITELS course has been reviewed and possible enhancements have been identified. In the reporting period we have also continued the development of an improved course management system with student profiles and a much more flexible hands-on session resource reservation system. Further, the portal software for the hands-on session has been adapted for the new course management. A first version of the new course management system has been productively used during the summer semester 2007. The gained experiences influence the current development. An enhanced version of the course management system is planned to be deployed in 2007. Additional equipment resources for the "IP Security Module" module have been deployed.

Research staff: Thomas Staub, Markus Anwander, Patrick Lauer, Thomas Bernoulli, Daniel Frey, Reto Gantenbein, Torsten Braun

Financial support: Staatssekretariat für Bildung und Forschung (SBF), Virtual Campus Switzerland Project No. 991043

Operating Systems Laboratory (OSLab)

The Operating System Laboratory, OSLab, is an online course that will teach students about the principles of computer operating systems using a progressive approach and problem-oriented learning. OSLab focuses on the hands-on training experience of the students and will complement existing lectures. The course is modularly structured, each module covers a topic and is self-contained. A teacher can select modules according to his needs and easily add new modules to the course.

During the reporting period four modules have been created together with the project partners at Fribourg and Neuchâtel. The file systems, security, process scheduling as well as the device drivers and input/output modules are finished. This includes a theory section as well as hands-on exercises. In the hands-on part the students have to solve programming and/or configuration tasks in order to deepen the knowledge they gathered by working through the theory chapter. The remaining three modules are currently under development.

In addition to the learning modules we developed a Java applet in order to present a common user interface for the hands-on exercises. The applet can be adapted to the special needs of the respective exercise. The learner sends the solution for the given task to the server and gets a "pass code" and possible log/error messages in return. The pass code contains the user ID, the source code submitted by the user, the test input/output, and the results from the automatic evaluation. It can optionally be encrypted and will be delivered to the tutor of the course for evaluation. Therefore, the tutor uses a complementary tool to decode the pass code and review the solution. Although this infrastructure is already functioning, it is still actively developed to include necessary features and improve stability.

Research staff: Torsten Braun, Gerald Wagenknecht, Markus Wulff

Financial support: Staatssekretariat für Bildung und Forschung (SBF), Programm Virtueller Campus Schweiz, Project No. P-4-019, and University of Bern

Energy-efficient Management of Heterogeneous Wireless Sensor Networks

This project focuses on the investigation of efficient and reliable communication mechanisms that are required for the efficient operation of a wireless sensor network (WSN) management framework. An appropriate WSN management architecture needs to be identified and implemented. The main scientific contributions will be in the design and evaluation of reliable unicast, multicast, and broadcast protocol mechanisms that are essential for the efficient maintenance of WSNs to support individual node management but also for application and operating system code updates / installations in the whole WSN or in parts of it. Reliable and robust transport protocols are needed to distribute operating system / application level code and node parameters efficiently as well as to solicit specific node information.

A WSN consists of a huge number of nodes, often randomly distributed in a large area. Currently, available sensor nodes are mainly prototypes for research purposes. The RVS group owns about 30 Embedded Sensor Board (ESB) nodes. An additional number of sensor nodes have been evaluated, from which three more types of sensor nodes have been chosen to build a heterogeneous sensor network. Beside the available ESB nodes, tmote SKY, BTnodes and micaZ have been chosen. They are widely used in the research community, are well documented and have the adequate properties (memory, energy-efficiency, etc.). For the management backbone a Wireless Router Application Platform Board (WRAP) has been selected.

As operating system we have chosen Contiki (from SICS), which is a dynamic operating system with special focus on portability. It is written in C and supports over 14 platforms and 5 CPUs. A small TCP/IP stack (μ IP) is available. Protothreads, a novel thread-like construct on top of the event-driven kernel, reduces the complexity of event-driven programs by removing state machines. Contiki supports preemptive multi-threading, inter-process communication and dynamic run-time linking of standard Executable Linkable Format (ELF) files. Program modules can be updated and loaded at run-time. Contiki and the network simulator COOJA for Contiki are open source projects and run under BSD license.

A heterogeneous wireless sensor network consists of different types of sensor nodes, which might measure different data and perform different tasks. To operate such a (sub)network the following devices are required: a management station, several mesh nodes, sensor node gate-

ways plugged into a mesh node and a comparatively high number of heterogeneous sensor nodes. To realize the communication between the sensor (sub)networks we use wireless mesh nodes as gateways. From the management point of view there are several tasks required to manage a WSN and its sensor nodes: monitoring the network and the sensor nodes, (re)configuring the nodes and as a special configuration task updating the nodes.

Based on these tasks we defined a management architecture, which affects all components of the WSN. The management station is running on a laptop or remote workstation with a web browser as user interface and the management system for Wireless Mesh Networks (WMN). The mesh nodes contains the main functionality of the management architecture. The WSN manager consists of three databases and three program modules. The databases are: the program version database, the WSN information database, and the sensor value database. The modules consist of the WSN monitor module, the WSN configurator module, and the code update manager module. A sensor node manager running on the sensor nodes performs the managing tasks. The management architecture on the management station (user interface), the mesh nodes (WSN manager) and the code updating functionality are currently being implemented. The latter includes further the evaluation of different code update mechanisms as, e.g., differential patches.

Research staff: Markus Anwander, Gerald Wagenknecht, James Matheka, Simon Morgenthaler

Financial support: Hasler Foundation under grant number ManCom 2060

Power Saving in Wireless Ad Hoc Networks

Power saving mechanisms in wireless multi-hop networks mainly switch off the transmission and reception hardware for a maximum amount of time and turn it on again periodically for a given interval. Many approaches aim to synchronize the state changes of the nodes in the network through distributed beacon generation and introduce mechanisms, where nodes synchronously wake up at designated points of time to exchange announcements about pending traffic. However, synchronization is difficult to achieve, in particular in wireless ad hoc networks. We developed, evaluated, and improved a power saving approach based on asynchronous

wake-up patterns and wake-up announcements integrated with Ad-hoc On-demand Distance Vector (AODV) protocol. This algorithm has been further improved by moving wake periods and integrated into a wireless sensor network scenario. In particular, the broadcast mechanism of the WiseMAC protocol, a medium access control protocol for wireless sensor networks, has been significantly improved in terms of energy efficiency by applying the improved asynchronous wake-up pattern scheme. The evaluation results obtained by simulation will be the basis for an implementation of the scheme on real sensor hardware.

Research staff: Philipp Hurni, Torsten Braun

E-learning module “Sensor Networks”

With the e-learning module “Sensor Networks” some key characteristics of wireless sensor networks will be presented and developed in detail. With this module students have an additional medium to learn key problems of wireless sensor networks in a guided, self-explaining and closed form.

The course essentially consists of a theoretical part introducing the course subject in detail, and of a practical part, in which the learned theoretical concepts are applied. The theoretical part is enhanced with interactive animations and self-tests. In the final, practical hands-on sessions some of the acquired concepts are demonstrated, deepening the understanding and showing some additional properties. Moreover, challenges of real implementations of theoretical concepts can be addressed. The practical exercises start with the implementation of the investigated concepts in a simulator/emulator. The resulting code, also executable on real hardware, then might be downloaded to the sensor nodes in a real testbed allowing the investigation of effects and behaviour in realistic environments.

The scientific focus of the course is on medium access and localization in wireless sensor networks. Both are basic challenges of wireless sensor networks research and development. The e-learning course provides a medium to address these two aspects in more detail than it was possible in the masters course.

Research staff: Markus Wälchli, Torsten Braun

Financial support: University of Bern, VC-Kleinprojekt

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. The ERON project for example uses the available CPU power to compute embeddings of network distances into Euclidean space. Furthermore, a significant part of EuQoS project's testbed is located within the RVS testbed. It is a Gigabit LAN environment of 10 machines for pan-european trials, and it is connected via IP tunnels to 11 partners' sites. The available CPU power is used by three network traffic measuring points. An educational laboratory network for students' training is also connected and being extended by the OSLab project. The RVS group also takes part in PlanetLab (<http://planet-lab.org>), an open platform for developing, deploying, and accessing planetary-scale services. For this purpose we are hosting two PlanetLab nodes in our testbed network. The RVS group owns a number of sensor nodes, about 30 Embedded Sensor Board (ESB) nodes, 10 tmote SKY nodes, 5 BTnodes and 5 micaZ nodes. They are widely used in the research community, are well documented and have adequate properties (memory, energy-efciency, etc.). A testbed consisting of multiple MESH nodes has been deployed throughout the building and work environment of the RVS group. In this testbed reliable. secure communication and software distribution/updates are being performed and evaluated.

Research staff: All members of the RVS research group

1.4 Ph.D. Theses

- Matthias Scheidegger: Prediction of Internet Characteristics for Distributed Applications, February 2, 2007

1.5 Diploma Theses

- Benjamin Zahler: An Experience Based Prediction Service for Internet Distance Estimation, May, 2007

- Michael Meer: The DELTA Object Tracking and Localization Algorithm for Sensor Networks, November, 2006
- Markus Anwander: Comparison of TDMA and contention based MAC protocols on embedded sensor boards, September, 2006

1.6 Bachelor Theses and Computer Science Projects

- Dave Wick: Delay Tolerant Networks in a Nutshell, August, 2007
- Reto Gantenbein: The Implementation of the Vitels IP Security Distance Learning Module, April, 2007
- Alican Gecyasar: Ad-Hoc Multipath Routing Protokolle, November, 2006

1.7 Further Activities

Memberships

- Chair of ERCIM working group on eMobility (Torsten Braun)
- Secretary General of ERCIM working group on eMobility (Markus Wulff)
- Erweitertes Leitungsgremium Fachgruppe "Kommunikation und Verteilte Systeme", Gesellschaft für Informatik (Torsten Braun)
- Management Board of EU IST project EuQoS (Torsten Braun)
- Swiss Representative, Management Committee Member, and Working Group Chair of COST 290 Action "Traffic and QoS Management in Wireless Multimedia Networks" (Torsten Braun)
- SWITCH Stiftungsrat (Torsten Braun)
- SWITCH Stiftungsratsausschuss (Torsten Braun)
- Kuratorium Fritz-Kutter-Fonds (Torsten Braun)
- Expert for Diploma Exams at Fachhochschule Bern (Torsten Braun)

Editorial Boards

- Editorial Board of Elsevier's Computer Communications Journal (Torsten Braun)
- Editorial Board of Elsevier's Computer Networks Journal (Torsten Braun)
- Editorial Board of Informatik Spektrum / Springer-Verlag (Torsten Braun)
- Editorial Board of Journal of Internet Engineering (Editor in Chief, Torsten Braun)

Conference Chairs

- Co-chair of 15. ITG/GI Fachtagung Kommunikation in Verteilten Systemen (KiVS), Bern, February 26-March 2, 2007 (Torsten Braun)
- General Chair of 1st ERCIM Workshop on eMobility, May 21, 2007, Coimbra, Portugal (Torsten Braun)
- TPC Co-Chair of 1st ERCIM Workshop on eMobility, May 21, 2007, Coimbra, Portugal (Markus Wulff)
- Co-Chair of the Fourth ACM SIGACT-SIGOPS International Workshop on Foundations of Mobile Computing (DIAL M-POMC 2007), August 16, 2007, Portland, Oregon, USA (Torsten Braun)

Conference Program Committees

- International Conference on Digital Telecommunications, ICDT 2006, August 29–31, 2006, Cap Esterel, Côte d'Azur, France (Torsten Braun)
- 31st Annual IEEE Conference on Local Computer Networks (LCN 2006), Tampa, Florida, November 14–16, 2006 (Torsten Braun)
- 49th Annual IEEE Global Communications Conference (IEEE GLOBECOM 2006), November 27–December 1, 2006, San Francisco, California, USA (Torsten Braun)

- 2nd International Conference on Wireless Communication and Sensor Networks (WCSN-2006), December 17–19, 2006, India (Torsten Braun)
- 4th Annual IEEE Consumer Communications and Networking Conference, Las Vegas, January 11–13, 2007 (Torsten Braun)
- 4th International Conference on Wireless On-demand Network Systems and Services, WONS 2007, January 24–26, 2007, Obergurgl, Austria (Torsten Braun)
- 4th European Conference on Wireless Sensor Networks (EWSN 2007), Delft, The Netherlands, January 29–31, 2007 (Torsten Braun)
- 4th Workshop on Mobile Ad-Hoc Networks (WMAN 2007), Bern, March 1, 2007 (Torsten Braun)
- IEEE Wireless Communications and Networking Conference 2007 (WCNC), March 11–15, Hongkong (Torsten Braun)
- 6th IFIP Networking 2007, May 14–18, 2007, Atlanta, Georgia, USA (Torsten Braun)
- 5th International Conferences on Wireless/Wired Internet Communications, WWIC 2007, May 23–25, Coimbra, Portugal (Torsten Braun)
- 7th International Workshop on Applications and Services in Wireless Networks (ASWN 2007), Santander, Spain, May 24–26, 2007 (Torsten Braun)
- 15th IEEE LAN/MAN Workshop, June 10–13, 2007, Princeton, New Jersey, US (Torsten Braun)
- 2nd Conference on Security in Network Architectures and Information Systems Annecy, France, June 12–15, 2007 (Torsten Braun)
- 2nd IEEE Workshop on advanced Experimental Activities on Wireless Networks & Systems, EXPONWIRELESS, June 18, 2007, Helsinki, Finland (Torsten Braun)
- IEEE International Conference on Communications 2007 (ICC 2007), June 24–28, 2007, Glasgow, UK (Torsten Braun)
- 1st International Workshop on Specialized Ad Hoc Networks and Systems (SAHNS 2007), June 29, 2007, Toronto, Canada (Torsten Braun)

- 33rd Euromicro Conference on Software Engineering and Advanced Applications (SEAA), Track on Multimedia and Telecommunications (MMTC), August 28-31, 2007, Lübeck, Germany (Torsten Braun)

Reviewing Activities

- Institute for the Promotion of Innovation by Science and Technology in Flanders (IWT) (Torsten Braun)
- Swiss National Science Foundation (SNF) (Torsten Braun)
- RMIT University, Melbourne, Australia (Torsten Braun)
- Ph.D. Jury, Université de Nice, France (Torsten Braun)
- Ph.D. Jury, Institut National des Télécommunications, Evry, France (Torsten Braun)
- IEEE Communications Magazine (Torsten Braun)
- IEEE Network Magazine (Torsten Braun)
- IEEE Transactions on Mobile Computing (Torsten Braun)
- IEEE Transactions on Parallel and Distributed System (Torsten Braun)
- IEEE/ACM Transactions on Networking (Torsten Braun)
- ACM Transactions on Multimedia Computing (Torsten Braun)
- ACM/Kluwer Wireless Networks Journal (Torsten Braun)
- Journal of Network and Systems management (Torsten Braun)
- Wiley (Torsten Braun)

Invited Talks and Tutorials

- Torsten Braun: Networking issues in wireless sensor networks, Tutorial at International Symposium on Wireless Communication System, September 5, 2006, Valencia, Spain
- Torsten Braun: TCP Support in Sensor Networks, Séminaire Réseaux, INRIA Sophia-Antipolis, September 21, 2006

- Thomas Staub: Multipath Routing in Wireless Mesh Networks, 7th COST 290 Meeting, September 29, 2006, Split, Croatia
- Torsten Braun: Energy-efficient communication protocols for wireless sensor networks, Informatikkolloquium, Universität Zürich, November 9, 2007
- Torsten Braun: System Issues in Wireless Sensor Networks, Tutorial at 2nd International Conference on Wireless Communication and Sensor Networks (WCSN2006), December 17, 2006, India
- Torsten Braun: Energy-Efficient Communication Protocols for Wireless Sensor Networks, Keynote at 2nd International Conference on Wireless Communication and Sensor Networks (WCSN 2006), December 17, 2006, India
- Torsten Braun: Secure Remote Management and Software Distribution for Wireless Mesh Networks, 8th COST 290 Meeting, February 16, 2006, Malaga, Spain
- Torsten Braun: Energie sparende Kommunikationsprotokolle für Mobile Ad-Hoc und Sensornetze, Informatikkolloquium, TU München, February 23, 2007
- Torsten Braun: Energy-efficient protocols for wireless sensor networks, Keynote at Euro American Conference on Telematics and Information Systems (EATIS 2007), May 17, 2007, Faro, Portugal
- Torsten Braun: Programmability Models for Sensor Networks, Autonomous Infrastructure, Management and Security (AIMS 2007), International conference in cooperation with the ACM, June 21, 2007, Oslo, Norway
- Torsten Braun: Communication Protocols in Wireless Sensor Networks, Tutorial at IEEE Symposium on Computers and Communications (ISCC'07), July 1, Aveiro, Portugal
- Torsten Braun: Federation of Experimental Networks for Teaching and Research, 2nd Opennet Workshop, July 4, 2007, Sophia-Antipolis
- Torsten Braun: Reliability Support in Multicast Overlay Networks, Dagstuhl-Seminar 07301 Resilient and Survivable Networks, Infrastructure and Services, July 23, 2007

- Torsten Braun: Telematiknetze, Kaderkurs Telematik, Bundesamt für Bevölkerungsschutz, November 28, 2006, April 17, 2007, June 5, 2007, Schwarzenburg, Switzerland
- Thomas Staub: Réseaux de communications, cours de cadres pour chefs de la télématique, Office fédéral de la protection de la population, November 28, 2006, April 17, 2007, June 5, 2007, Schwarzenburg, Switzerland

Organized Events

The RVS group organized the following events:

- Organizing a seminar on “Dependable Systems” together with TNS group of University Fribourg, Quarten, Switzerland, July 2–4, 2007
- Hosting and organizing the conference “Kommunikation in Verteilten Systemen” (KiVS), Bern, February 26–March 2, 2007
- Hosting and organizing the “EuQoS Plenary Meeting”, Bern, January 17–19, 2007

Awards

Markus Wälchli, Piotr Skoczylas, Michael Meer and Torsten Braun received the “WWIC 2007 Best Paper Award” for his paper on “Distributed event localization and tracking with wireless sensors” during the 5th International Conference on Wired/Wireless Internet Communications held from May 23–25, 2007, at the University of Coimbra / Portugal.

1.8 Publications

Publications submitted in the academic year 2006/2007 and appearing in 2007/2008 or later are not listed.

Books and Book Chapters

- Arunabha (Arun) Sen, Torsten Braun: Dial-M-POMC 2007, The Fourth ACM SIGACT-SIGOPS International Workshop on Foundations of Mobile Computing, Portland, Oregon, USA, August 16, 2007, ACM, ISBN 978-1-59593-874-9 CD-ROM

- Torsten Braun, Dimitri Konstantas, Saverio Mascolo, Markus Wulff: First ERCIM Workshop on eMobility, May, 2007, ISBN 978-972-95988-9-0
- Torsten Braun, Georg Carle, Burkhard Stiller: KiVS 2007 Kommunikation in Verteilten Systemen, Industriebeiträge, Kurzbeiträge und Workshops, February, 2007, VDE Verlag, ISBN 978-3-8007-2980-7
- Torsten Braun, Georg Carle, Burkhard Stiller: Kommunikation in Verteilten Systemen (KiVS), 15. Fachtagung Kommunikation in Verteilten Systemen (KiVS 2007), February, 2007, Springer Verlag, ISBN 978-3-540-69961-3

Reviewed Journal and Conference Papers

- Marc Brogle, Dragan Milic, Torsten Braun: Supporting IP Multicast Streaming Using Overlay Networks, QShine: International Conference on Heterogeneous Networking for Quality, Reliability, Security and Robustness, Vancouver, British Columbia, Canada, August 14 - 17, 2007, ICST, ISBN 978-1-59593-756-8 CD-ROM
- Markus Anwander, Gerald Wagenknecht, Thomas Staub, Torsten Braun: Management of Heterogenous Wireless Sensor Networks, 6. Fachgespräch, Aachen, Germany, July 16 - 17, 2007, pp. 63-66, Distributed Systems Group, RWTH Aachen University, ISSN 0935-3232
- Marc Heissenbüttel, Torsten Braun, Markus Wälchli, Thomas Bernoulli: Evaluating the limitations of and alternatives in beaconing, Ad Hoc Networks, Vol. 5, Nr. 5, July, 2007, pp. 558-578, Elsevier, ISSN 1570-8705
- Torsten Braun: Programmability Models for Sensor Networks, First International Conference on Autonomous Infrastructure, Management and Security, AIMS 2007, Oslo, Norway, June 21 - 22, 2007, pp. 233, Springer Verlag, ISBN 978-3-540-72985-3
- Thomas Staub, Daniel Balsiger, Michael Lustenberger, Torsten Braun: Secure Remote Management and Software Distribution for Wireless Mesh Networks, 7th International Workshop on Applications and Services in Wireless Networks (ASWN 2007), Santander, Spain, May 24 - 26, 2007, pp. 47-54, ISBN 978-84-690-5727-8

- Markus Wälchli, Piotr Skoczylas, Michael Meer, Torsten Braun: Distributed event localization and tracking with wireless sensors, 5th International Conference on Wired/Wireless Internet Communications (WWIC '07), Coimbra, Portugal, May 23 - 26, 2007, pp. 247-258, Springer Verlag, ISBN 978-3-540-72694-4 Best Paper Award
- Philipp Hurni, Torsten Braun: Improving Unsynchronized MAC Mechanisms in Wireless Sensor Networks, 1st ERCIM Workshop on eMobility, Coimbra, Portugal, May 21, 2007, pp. 71-82, ISBN 978-972-95988-9-0
- Markus Wälchli, Thomas Bernoulli, Torsten Braun: Receiver-based Backbone Construction and Maintenance for Wireless Sensor or Multi-Hop Networks, Workshop on Mobile Ad-Hoc Networks (WMAN 2007) at KiVS 2007, Bern, Switzerland, March 1 - 2, 2007, pp. 409-420, VDE Verlag, ISBN 978-3-8007-2980-7
- Torsten Braun, Burkhard Stiller: Netzwerkforschung im Schweizer Hochschulumfeld, Praxis der Informationsverarbeitung und Kommunikation, Vol. 07, Nr. 1, March, 2007, pp. 2-3, K.G. Saur Verlag, ISSN 0930-5157
- Marc Heissenbüttel: Routing and Broadcasting in Ad-Hoc Networks, Kommunikation in Verteilten Systemen (KiVS 2007), Bern, Switzerland, February 26 - March 2, 2007, pp. 259-266, Springer Verlag, ISBN 978-3-540-69961-3
- Matthias Scheidegger, Torsten Braun: Improved Locality-Aware Grouping in Overlay Networks, Kommunikation in Verteilten Systemen (KiVS 2007), Bern, Switzerland, February 26 - March 2, 2007, pp. 27-38, Springer Verlag, ISBN 978-3-540-69961-3
- Ruy de Oliveira, Torsten Braun: A Smart TCP Acknowledgment Approach for Multihop Wireless Networks, Transactions on Mobile Computing, Vol. 6, Nr. 2, February, 2007, pp. 192-205, IEEE, ISSN 1536-1233
- Torsten Braun, Thiemo Voigt, Adam Dunkels: TCP Support for Sensor Networks, IEEE/IFIP WONS 2007, Obergurgl, Austria, January 24 - 26, 2007, pp. 162-169, IEEE, ISBN 1-4244-0860-1
- Torsten Braun, Georg Carle, Sonia Fahmy, Yevgeni Koucheryavy: Editorial - Wired/Wireless Internet Communications, Computer Com-

munications, Vol. 30, January 20, 2007, pp. 1441-1442, Elsevier, ISSN 0140-3664

- Marc Brogle, Dragan Milic, Torsten Braun: QoS Enabled Multicast for Structured P2P Networks, P2PM Workshop at the 4th IEEE Consumer Communications and Networking Conference, Las Vegas, NV, USA, January 11 - 13, 2007, pp. 991-995, IEEE, ISBN 1-4244-0667-6
- Attila Weyland, Carolin Latze, Torsten Braun, Thomas Staub: Linux Implementation and Evaluation of a Cooperation Mechanism for Hybrid Wireless Networks, Sixth International Workshop on Wireless Local Networks (WLN), Tampa, FL, USA, November 14, 2006, pp. 939-946, IEEE, ISBN 1-4244-0419-3

Magazine Papers

- Torsten Braun: First ERCIM Workshop on eMobility, Ercim News, Nr. 70, July, 2007, pp. 6-7, ERCIM EEIG, ISSN 0926-4981

Technical Reports

- Markus Anwander, Gerald Wagenknecht, Torsten Braun: Energy-efficient Management of Heterogeneous Wireless Sensor Networks, April 30, 2007, Technical Report IAM-07-002
- Pascal Le Guern, Olivier Dugeon, Marc Brogle, Dragan Milic, et al.: Trial report release 2, EuQoS Deliverable D5.1.5, CEC Deliverable Number 004503/FTRD/DS/D5.1.5/A1, February 15, 2007
- Donal Morris, Thomas Staub, Marc Brogle, et al.: Second summary of standardization documents, EuQoS Deliverable D6.2.2, CEC Deliverable Number 004503/REDZINC/DS/D6.2.2/A1, January 31, 2007
- José Enríquez, María Ángeles Callejo, Marc Brogle, Dragan Milic, et al.: EuQoS Architecture update for Phase 2, EuQoS Deliverable D1.2.2, CEC Deliverable Number 004503/TID/DS/D1.2.2/A1, January 31, 2007
- José Enríquez, María Ángeles Callejo, Marc Brogle, Dragan Milic, et al.: Annex to D1.2.2: EuQoS Architecture update for

Phase 2, EuQoS Deliverable D1.2.2, CEC Deliverable Number 004503/TID/DS/D1.2.2/A1 - ANNEX, January 31, 2007

- Thomas Staub, Marc Brogle, et al.: Report on teaching experiences of the e-learning course, the improvements to be done and the improvements achieved as well as the newly produced e-learning modules, EuQoS Deliverable D6.2.1, CEC Deliverable Number 004503/UoB/DS/D6.2.1/A1, December 26, 2006
- Martin Potts, Thomas Staub, et al.: Second report on using and disseminating knowledge, including description of dissemination activities (e.g. demonstrations, publications), EuQoS Deliverable D6.2.3, CEC Deliverable Number 004503/Martel/DS/6.2.3/A1, December 26, 2006
- Pascal Le Guern, Olivier Dugeon, Marc Brogle, Dragan Milic, et al.: Testbed integration test plan Release 2, EuQoS Deliverable D5.1.4, CEC Deliverable Number 004503/FTRD/DS/D5.1.4/A2, December 4, 2006
- Piotr Skoczylas, Markus Wälchli, Torsten Braun: Implementation of the DELTA object tracking algorithm on the ESB sensor nodes, November, 2006, Technical Report IAM-06-008