Middleware for Network Eccentric and Mobile Applications (MiNEMA)

Report from the MiNEMA Summer School
July 11 - 15 2005
Klagenfurt University, Austria

13th October 2005

Edited by Susana Guedes - MiNEMA Programme Coordinator

Sponsors ESF - European Science Foundation

1 Organizing committee

Steering Committee Chair Luís Rodrigues - University of Lisboa

General Chair Laszlo Böszörmenyi - Department for Information Technology, Klagenfurt University, Austria

Programme Chair Roy Friedman - Department of Computer Science, Technion, Israel Institute of Technology, Israel

Panel and Industry Chair Christian Bettstetter - DoCoMo Euro-Labs, Munich, Germany

2 Message from the MiNEMA Steering Committee chair

MiNEMA is an European Science Foundation (ESF) Scientific Programme aiming to bring together European groups from different communities working on middleware for mobile environment. The program intends to foster the definition and implementation of widely recognized middleware abstractions for new and emerging mobile applications.

The organization of a summer school addressing the topics covered by the MiNEMA programme has been, since the first day, one of the goals of the steering committee. It was felt that such school could be an invaluable help for young researchers and PhD students working in the field.

The MiNEMA steering committee is indebted to the General Chair, Laszlo *Boeszoermenyi* and to the the Programme Chair, Roy Friedman for organizing this school and making it a huge success, with an outstanding panel of speakers and such a large attendance.

3 Message from the General Chair

The MiNEMA SC meeting in December 2004 at Lancaster, GB charged me with the organization of the first MiNEMA Summer School. I accepted this with pleasure under the condition that Roy Friedman accepts to serve as a program chair - what he did indeed a few hours later. Later Christian Bettstetter joined the team by organizing an exciting industry panel. The very hard administrative work was led and to a great extent also accomplished by Martina Steinbacher with the support of several members of the Department of Information Technology (ITEC) of the Klagenfurt University. She designed also the excellent home page of the summer school, with intensive technical support by Andreas Grieser (See at: http://minema-itec.uni-klu.ac.at/).

Originally, we planned that the summer school would attract ca. 50 participants. At the end, thanks to the attractive program and the excellent speakers, we could be pleased to host 118 participants, among others many non-MiNEMA members. We had quite a few overseas speakers and visitors, e.g. two participants from Brazil.

Besides the scientific program, the social events were very successful as well. Participants had free entrance to the Lake Wörther beach the whole week. We enjoyed a nice reception at the Mayor of the City of Klagenfurt and a guided tour through the city. The summer school banquet took place at 'Minimundus', the mini-world, with more than 200 models of world famous buildings, such as the St. Stephan's Church in Vienna, the Eiffel Tower in Paris and the Sydney Opera. The visitors had also the opportunity to test the video guides, developed by the students of ITEC. As the questionnaires also show, the summer school was a great success and enjoyed a very good acceptance at the participants.

4 Message from the Program Chair

The MiNEMA summer school was held in Klagenfurt, Austria, during the week July 11-16. The school was attended by 118 registered participants, which included many graduate students and post-docs from all over Europe, as well as the speakers and a few senior researchers.

In forming the program, there was an attempt to balance between the aspiration to cover a broad range of topics with the desire to also go in-depth, in order to make the talks informative and interesting for the highly skilled audience. Time was also allocated for a few shorter presentations and a panel from industry, in order to complement the research oriented flavor of this event with a sanity check of what industry is doing and plans to do in these areas. The above were complemented with organized long coffee and lunch breaks as well as a reception and a couple of organized dinners, whose purpose was to give a chance for participants to meet each other, and in particular be able to discuss with the speakers and among themselves in an informal manner.

In accordance with the ESF standards of excellence, all speakers were among the world's top researchers in their respective domains. Specifically, the list of excellent speakers included Mads Haahr, Zygmunt Haas, Gordon Blair, Dave Johnson, Charles E. Perkins, Luis Rodrigues, Jean-Pierre Hubaux, Laszlo Boeszoermenyi, Roberto Baldoni, Kimmo Raatikainen, and myself. All of which responded eagerly to my invitation to give the talk and came from a far as the west coast of the USA specifically for this event, some of which changed the family vacation plans in order to participate, or left their pregnant wife at home for us, and I am truly thankful to all of them. Christian Bettstetter has also made a wonderful job of organizing the industrial session and panel, and of inviting the industry representatives Timo Kosch (BMW), Kirsten Matheus (CarMeq/VW), Hannes Hartenstein (U of Karlsruhe), Klaus-Dieter Kohrt (Siemens), Walter Liebhart (ILOGS), Mark Nielson (Microsoft).

I would like to thanks a few people that helped with advices along the way, including Laszlo Boeszoermenyi, Vinny Cahill, Rachid Guerraoui, Kimmo Raatikainen, Robbert van Renesse, and Luis Rodrigues. Finally, I would like to thank the local organizers from the University of Klagenfurt for the meticulous organization. In particular, I wish to thank our host Laszlo Boeszoermenyi as well Martina Steinbacher, who took care of the tiniest details in such a wonderful and pleasant way, which had a significant role in making this event so successful.

5 Panel of speakers

Roberto Baldoni

Roberto Baldoni is a Professor of Computer Science at the School of Engineering at the University of Rome "La Sapienza" where he founded and leads MIDLAB (a laboratory on middleware technologies). He has been visiting researcher at INRIA, Cornell University and EPFL. Roberto Baldoni serves regularly as PC member for the most prestigious International Conferences and Workshops in the context of distributed and mobile systems, middleware architectures and distributed object technology such as DISC, DSN, ICDCS, SRDS etc. In these fields he published more than 100 scientific papers in peer reviewed journals and conferences and has been the software architect of several innovative prototypes. He has been the recipient of grants form EU, the Italian National Research Council (CNR), the Italian Ministry of Research and Technology (MIUR), IBM, Finmeccanica and from the Italian Authority for Informatics in the Public Administration (AIPA). In the IST context, he regularly serves as expert for the EU and has been principal investigator of the following IST-EU projects: EU-PUBLI.COM, SEMANTIC-GOV, RESIST and MIDAS. He is finally leading a national research group for the specification of next generation e-government services on behalf of the Italian Government.

Gordon Blair

Gordon Blair graduated from Strathclyde University with a PhD in Computer Science in 1983. Since then, he has worked at Lancaster University and currently holds a chair in distributed systems at this institution. He is also an Adjunct Professor at Tromso University and a Visiting Researcher at the Simula Research Laboratory (both in Norway). He is Chair of the Steering Committee for the ACM/ IFIP/ Usenix Middleware conference and has been on the programme committes of many conferences in his field. He has published over 200 papers over a 20 year period. His current research interests include distributed systems architectures, reflective and adaptive middleware, middleware for embedded systems and autonomic computing.

Laszlo Böszörmenyi

Laszlo Böszörmenyi is full professor and the head of the Department of Information Technology (ITEC) at the University Klagenfurt, Austria. He is a member of ACM, IEEE and OCG, he is deputy head of the Austrian delegation at the Moving Picture Experts Group (MPEG, the ISO/IEC JTC1/SC29 WG11). He is member of the MiNEMA steering committee.

In his research, he is focusing currently on Adaptation in Distributed Multimedia Systems. He is leading a number of projects in this area, such as the QBIX (Adaptive, Quality-Based Intelligent Video Proxy used as a gateway and as a cache), the AMS (Adaptive Multimedia Server, based on a mobile agent based infrastructure) and the Calm-Video (Video applications with a large number of concurrent videos and video scenes in different quality) projects.

He is author of several books, he publishes regularly in refereed international journals and conference proceedings. He has been organizing several international conferences and workshops, such as the 6th Joint Modular Languages Conference (JMLC'03) August 25 - 27, 2003 in Klagenfurt/Austria, the 9th International Conference on Parallel and Distributed Computing (EuroPar'03) 26th - 29th August 2003 in Klagenfurt, Austria and the 61st ISO/IEC JTC 1/SC29/WG11 (MPEG) Meeting July 22 - 26, 2002 University Klagenfurt/Austria.

Roy Friedman

Roy Friedman's research interests include distributed systems and in particular group communication middleware in both static and mobile environments. He has published more than 70 technical papers on distributed systems, group communication, fault-tolerance, high availability, cluster computing, client/server middleware, and wireless mobile ad-hoc networks, and holds two patents. Roy Friedman regularly participates in program committees of the major scientific conferences in his domains, including serving as the vice chair of ICDCS 2006, heading the track on Middleware and Operating Systems. He has also managed several successful large research projects funded by both governmental bodies, such as the Israel Science Foundation, the Israeli Ministry of Science, and the EU FP5, as well as by industry, such as Intel, France Telecom R&D, IBM, and Compaq (now HP).

Roy Friedman obtained his B.Sc. and Ph.D. in Computer Science from the Technion in Haifa, Israel, in 1990 and 1994, respectively, where he is currently also a faculty member. In the past, Dr. Friedman worked an academic specialist at IRISA/INRIA (France) for one year and was a researcher at Cornell University for three years. He is also one of the two technical founders of PolyServe Inc.

Jean-Pierre Hubaux

Jean-Pierre Hubaux joined the faculty of EPFL in 1990; he was promoted to full professor in 1996. His research activity is focused on mobile networking and computing, with a special interest in wireless ad hoc and sensor networks.

He has been strongly involved in the definition and launching phases of a new National Competence Center in Research named 'Mobile Information and Communication Systems' (NCCR/MICS), since its genesis in 1999; this center is often nicknamed 'the Terminodes project'. In this framework, he has notably defined, in close collaboration with his students, novel schemes for the security and cooperation in fully self-organized mobile ad hoc networks; in particular, he has devised new techniques for key management, key establishment, and secure positioning in such networks. He has also made several contributions in the areas of power management in sensor networks and of group communication in ad hoc networks.

He is an Associate Editor of IEEE Transactions on Mobile Computing, Foundations and Trends in Networking, and the Journal on Ad Hoc Networks. He served as the general chair for the Third ACM Symposium on Mobile Ad Hoc Networking and Computing (MobiHoc 2002), held on the EPFL campus. He has been serving on the program committees of numerous conferences and workshops, including Infocom, Mobicom, Mobihoc, SenSys, WiSe, and VANET.

He has held visiting positions at the IBM T.J. Watson Research Center and at the University of California at Berkeley.

He was born in Belgium, but spent most of his childhood and youth in Northern Italy. After completing his studies in electrical engineering at Politecnico di Milano, he worked 10 years in France with Alcatel, where he was involved in R&D activities, primarily in the area of switching systems architecture and software.

Charles E. Perkins

Charles E. Perkins is a Nokia Fellow in the Network Technology Laboratory at Nokia Research Center, investigating mobile wireless networking and dynamic configuration protocols. He is serving as document editor for the mobile-IP working group of the Internet Engineering Task Force (IETF), and is author or co-author of standards-track documents in the mip4, mip6, manet, and seamoby (Seamless Mobility) working groups. He is an editor for several ACM and

IEEE journals for areas related to wireless networking. While at Nokia, he has continued strong involvment with reserach actitivies for ad hoc networking and scalability and performance issues related to Internet access for billions of portable wireless devices.

Charles has authored and edited books on Mobile IP and Ad Hoc Networking, and has published a number of papers and award winning articles in the areas of mobile networking, ad-hoc networking, route optimization for mobile networking, resource discovery, and automatic configuration for mobile computers. Charles was also one of the creators of MobiHoc, the premier conference series that has provided the forum for many of the most important publications in the field of ad hoc networking; he remains on the steering committee for that conference. He has served as general chair and Program Committee chair for MobiHoc, and is currently serving as general co-chair of MASS 2006. Charles has served on the Internet Architecture Board (IAB) of the IETF and on various committees for the National Research Council, as well as numerous technical assessment boards for Army Research Lab and the Swiss MICS program. He has also served as associate editor for Mobile Communications and Computing Review, the official publication of ACM SIGMOBILE, and has served on the editorial staff for IEEE Internet Computing magazine. See http://people.nokia.net/charliep for further details.

Before joining Nokia, Charles was a research staff member at IBM T.J. Watson Research center for 13 years. He was responsible for installing and maintaining the first Ethernet within the research center in the mid 80's, and subsequently for introducing Usenet newsgroups into IBM. Subsequently, he worked on various multiprocessor and wireless networking technologies, aimed at enabling successful use of IBM's initial wireless PC cards which were targeted for personal computers. As part of this effort, Charles led the development of Mobile IP within IBM, as well as the creation of DSDV and AODV which are well-known routing protocols for ad hoc networks.

Charles left IBM to join Sun Microsystems new 'Netcentricity' group, which (after several reorganizations) was responsible for introducing Mobile IP, Mobile IPv6, Service Discovery Protocol, and some initial concepts related to seamless handovers into Sun's networking groups.

Future projects include publication of a reactive routing protocol as Proposed Standard within the IETF, another book project, completion of several IETF protocol specifications related to Mobile IPv6, Mobile IPv4, and Fast Handovers for Mobile IP, as well as basic research into the fundamental concepts which characterize mobility, security, and the dynamic behavior of ad hoc networks.

Kimmo Raatikainen

Kimmo Raatikainen has M.Sc. (1983) and Ph.D. (1990) degrees in computer science (University of Helsinki). He was a system manager at the Finnish State Computer Centre, Division of University Support, 1981-1985. From 1986 he has been employed by the Helsinki University Computer Science Department as a research and teaching assistant, as Assistant, Associated and Full Professor (from 1998). He is the leader of Distributed Systems and Data Communications section at the department. From January 2000 Professor Raatikainen has been part-time Principal Scientist (and Research Fellow from April 2004) in Nokia Research Center and from January 2002 also part-time Principal Scientist (leading the Mobile Computing research area) in the Helsinki Institute for Information Technology (HIIT). From August 2004 he has been the head of Helsinki Graduate School in Computer Science and Engineering (HeCSE).

Professor Raatikainen has had a leading role in several European projects including DOLMEN (AC036), MONTAGE (AC325), PRIME (AC370), HPGIN (ESPRIT 29737), BRAIN (IST-1999-10050), CRUMPET (IST-1999-20147), MIND (IST-2000-28584). He has also led several national research projects (funded by the National Technology Agency of Finland (TEKES) and industry) on mobile computing, wireless communication, middleware for mobile computing

and on telecommunications software architectures. His current research interests include operating systems, Internet protocols and middleware for mobile distributed systems. He has over 100 scientific publications in these areas.

Luis Rodrigues

Luís Rodrigues graduated (1986), has a Master (1991) and a PhD (1996) in Electrotechnic and Computers Engineering, by the Instituto Superior Técnico de Lisboa (IST). From 1986 to 1996 he was a researcher at INESC and, since 1997, he is a (founding) member of the LASIGE laboratory at University of Lisbon where he leads the Distributed ALgorithms and Network Protocols (DIALNP) research group. He currently serves as directory of the Laboratory.

His current interests include fault-tolerant and real-time distributed systems, replicated data management, middleware and mobile computing. He participated in several national and international projects and has more than one hundred publications in these areas. He is co-author of a book on distributed systems.

He is the Steering Committee chair of the ESF research network 'MiNEMA: Middleware for Network Eccentric and Mobile Applications'. He served on the PC of many leading conferences such as DSN, ICDCS, Middleware, DISC, Percom, SRDS, among others. He serves as program co-chair for ICDCS 2006. He is a member of the Ordem dos Engenheiros, IEEE and ACM.

6 Program

Sunday, July 10, 2005

18:00 - 19:00 WELCOME RECEPTION / REGISTRATION

Monday, July 11, 2005

08:00 - 08:45 Registration
08:45 - 09:00 Welcome
09:00 - 10:30 Mads Haahr - Middleware for mobile Computing (I)
10:30 - 11:00 Coffee Break
11:00 - 12:30 Mads Haahr - Middleware for mobile Computing (II)
12:30 - 14:00 LUNCH
14:00 - 15:30 Zygmunt Haas - Mobility and its Effects on Network Performance (I)
15:30 - 16:00 Coffee Break
16:00 - 17:30 Zygmunt Haas - Mobility and its Effects on Network Performance (II)

Tuesday, July 12, 2005

09:00 - 10:30 Gordon Blair - Open Middleware Architecture and Adaptation (I)
10:30 - 11:00 Coffee Break
11:00 - 12:30 Gordon Blair - Open Middleware Architecture and Adaptation (II)
12:30 - 14:00 LUNCH
14:00 - 15:30 David B. Johnson - Introduction to Ad Hoc Network Routing (I)
15:30 - 16:00 Coffee Break
16:00 - 17:30 David B. Johnson - Introduction to Ad Hoc Network Routing (II)

Wednesday, July 13, 2005

09:00 - 10:30 Charles E. Perkins - Ad Hoc Networking in the IETF (I)
10:30 - 11:00 Coffee Break
11:00 - 12:30 Charles E. Perkins - Ad Hoc Networking in the IETF (II)
12:30 - 14:00 LUNCH
14:00 - 15:30 Luis Rodrigues - Gossiping in the mobile world (I)
15:30 - 16:00 Coffee Break
16:00 - 16:45 Luis Rodrigues - Gossiping in the mobile world (II)
17:00 - 18:30 PANEL: Ad hoc networking among vehicles for advanced telematics services

Thursday, July 14, 2005

09:00 - 10:30 Jean-Pierre Hubaux - Secure and Cooperative Wireless Networks (I)
10:30 - 11:00 Coffee Break
11:00 - 12:30 Jean-Pierre Hubaux - Secure and Cooperative Wireless Networks (II)
12:30 - 14:00 LUNCH

14:00 - 15:30 Laszlo Böszörmenyi - Multimedia Streaming in Heterogeneous Networks (I)

15:30 - 15:45 Coffee Break

15:45 - 16:30 Laszlo Böszörmenyi - Multimedia Streaming in Heterogeneous Networks (II)

16:30 - 16:45 Coffee Break

16:45 - 18:00 INDUSTRY SESSION (Chair: Roy Friedman)

18:30 - 19:30 SC MEETING - Room: E.2.42

20:00 Dinner SC Members

Friday, July 15, 2005

09:00 - 10:30 Roberto Baldoni - The Publish/Subscribe Communication Paradigm and its Application to Mobile Systems

10:30 - 11:00 Coffee Break

11:00 - 12:30 Kimmo Raatikainen - Recent Developments in Middleware Standardization for Mobile Computing

12:30 - 14:00 LUNCH

14:00 - 15:30 Roy Friedman - Group Communication for Mobile Environments (I)

15:30 - 16:00 Coffee Break

16:00 - 16:45 Roy Friedman - Group Communication for Mobile Environments (II)

7 Abstract of talks

The Publish/Subscribe Communication Paradigm and its Application to Mobile Systems

Roberto Baldoni
Universita di Roma 'La Sapienza', Italy

Abstract

Pub/subscribe communication is an appealing many-to-many abstraction to disseminate events in a distributed and mobile system.

Implementations of this abstraction have a main target: avoid the flooding of a network connecting publishers and subscribers while keeping very high the level of reliability of delivery of events to subscribers. The class studies the basic architectures of publis/subscribe communication systems.

These architectures will point out basic mechanisms that can be used to achieve that target. These mechanisms allow to classify different systems and prototypes according to the way they propagate and match events and subscriptions. The class then examines a few well-know pub/sub systems aiming to frame such a systems into previous classification. Finally the impact of mobility is analyzed in terms of instability of the underlying network, power consumption and reliablility of event delivery.

Open Middleware Architecture and Adaptation

Gordon Blair
Lancaster University, UK

Abstract

As a mobile devices moves it naturally encounters change in its environment, i.e. change in context (such as the device location), change in network conditions and change in available resources. Therefore, mobile middleware must be able to adapt its behaviour dynamically to continue to provide the best level of service to applications. In this chapter we focus on the use of reflection to build dynamic middleware. A series of case studies illustrate solutions that have successfully benefited from the reflective middleware approach.

Multimedia Streaming in Heterogeneous Networks

Laszlo Böszörmenyi
Klagenfurt University, Austria

Abstract

We discuss the inherent contradiction between the requirements of multimedia streaming and the actual capabilities of networks and operating systems. Actual resource management in networks and operating systems is optimized for the best-effort strategy; video streaming requires, however, quality-of-service aware strategies.

Group Communication for Mobile Environments

Roy Friedman
Technion, Israel

Abstract

Group communication middleware provide services that facilitate the development of distributed applications consisting of multiple participants that need to exchange information among themselves. In particular, group communication offer services such as consistent membership notification, automatic failure/recovery detection, reliable multicast, ordered delivery, flow control, etc. Group communication systems have been developed initially in the context of LAN oriented clustering. Indeed, group communication based clustering products play a central role in an increasing number of mission critical and business critical applications, including stock exchanges, air-traffic control, data centers of large retail chains, nuclear plant, energy companies, financial institutes, highly available Web server farms, as well as highly available and scalable clustered file systems.

As many abstractions, group communication brings with it a tradeoff between semantics and performance. In particular, when applying group communication to mobile computing environments, these tradeoffs become more acute, and often group communication middleware developed for wired LAN environment does not function well in a mobile setting.

At the same time, as been proven by projects performed by students in our lab, group communication middleware provide a very powerful programming paradigm for mobile applications as well. Examples for such applications include, e.g., ad-hoc auctioning systems, distributed interactive games, distributed collaborative tools, serverless video conferencing, collaborative caching, and automatic offloading of computation from weak devices to stronger ones. All these applications become simple to implement with an appropriate middleware!

In this talk I will give an overview of group communication, what they are, what they offer, what are these performance vs. semantics tradeoffs, and analyze what can and should be done in mobile systems. In particular, I will present the unique challenges of mobile environments and ways of addressing them. This will include, as time permits, both mobile ad-hoc networks and cellular networks.

Finally, I will present some open problems for the middleware research community.

Middleware for Mobile Computing

Mads Haahr
Trinity College, Ireland

Abstract

This talk will address the motivation for middleware support for mobile computing and the basic issues to be addressed by such middleware. It will consider possibilities for adapting traditional middleware paradigms for use in mobile settings versus the need for new middleware paradigms. It will examine techniques for adapting existing middleware architectures, especially those based on method invocation, for mobility and briefly consider other more asynchronous paradigms.

Mobility and its Effects on Network Performance

Zygmunt Haas
Cornell University, USA

Abstract

We usually think about mobility in wireless networks as an impairment; a penalty that the network provider and its users have to 'pay for' to support tether-less access. After all, mobility is responsible for fading of radio signal, which, in ad hoc networks, eventually leads to path breakage, and to the need to reroute a connection. In cellular networks, mobility requires call handover between base-stations and possibly between mobile switching centers. Mobility requires the system to re-authenticate a user and allows user to mount security attacks more easily.

But have you ever thought that mobility can actually have beneficial results on the operation and the performance of wireless networks. Could you imagine that mobility can actually increase the network capacity, improve the network reliability and its availability, and in some cases make the network actually more secure? Well, it can - sometimes.

In this presentation, I will attempt to expose both, the adverse and the favorable effects of mobility, and discuss ways to cope with the adverse and to exploit the favorable. In particular, I will discuss how mobility is modeled in the scientific literature and what the shortcomings of these models are, shortcomings that can transform results of studies into meaningless statements. I will discuss how replacing one mobility model by another can easily turn conclusions upside down. Finally, I will ponder on whether there is any hope that a realistic mobility model, one that is feasible to use with the current state-of-the-art simulation tools, will be available to researchers and network designers.

Secure and Cooperative Wireless Networks

Jean-Pierre Hubaux
EPFL Lausanne, Switzerland

Abstract

As wireless networks are becoming more and more pervasive, users will increasingly rely on them. At the same time, the devices are becoming more and more programmable, thereby paving the way to malicious and selfish behavior.

In the first part of this tutorial, we will review some basic techniques of security and cryptography; we will then show how they can be adapted to prevent malicious behavior in wireless networks. We will focus in particular on key establishment techniques, and consider the case of vehicular networks.

In the second part, we will briefly introduce game theory. We will then show how this formalism can be used to study selfish behavior in wireless networks. In particular, we will consider the problem of packet forwarding in self-organized multi-hop wireless networks.

Introduction to Ad Hoc Network Routing

David B. Johnson
Rice University, USA

Abstract

In an ad hoc network, mobile nodes such as notebook or handheld computers cooperate to forward packets for each other, without the aid of network infrastructure such as access points or base stations. To allow nodes not within direct wireless transmission range of each other to communicate, a route between them through one or more other nodes in the ad hoc network must be known. As nodes in the network move or as other factors such as node failures or wireless propagation changes occur, existing routes may break and new routes must be learned.

This presentation will provide an introduction to the problems and solutions in routing protocols for mobile ad hoc networks. For unicast packet routing, ad hoc network routing protocols are often classified as either proactive protocols–in which each node always attempts to maintain current routes to all possible destinations–and reactive protocols–in which a node dynamically attempts to discover a route to some node only when it has a packet to send to that destination. We will look at examples of both types of protocols, the tradeoffs between the two types, and ways in which they can be combined to form hybrid routing protocols. We will also look briefly at protocols for routing multicast packets in ad hoc networks.

Ad Hoc Networking in the IETF

Charles E. Perkins
Nokia Corporation, USA

Abstract

Within the IETF, the working group for Mobile Ad Hoc Networking [manet] has recently made new steps towards standardizing new routing protocols. In particular, there is now a document specifying a new protocol called DYMO (for Dynamic Mobile Networks).

I will discuss these recent steps forward, and to give concrete examples I will describe more specifically some recent improvements to 'Ad Hoc On-Demand Distance Vector' protocol (AODV) [RFC 3561]. Four protocols have been published as experimental specifications within the [manet] working group of the IETF. I will describe in brief certain aspects of these protocols, and then go into a more detailed description of DYMO. After describing these protocols, I will then give some opinions about how a convergence may be effected. Convergence between protocols does provide a significant force for acceptance, and so technology that finds commonality between otherwise divergent protocols is highly desirable. The good and recent news is that commonality has been identified, so that link-state and distance-vector protocols can be merged, as well as (possibly!) proactive and reactive protocols. Along the way, much has been learned about the basic nature of routing protocols, and yet much remains to be learned.

Recent Developments in Middleware Standardization for Mobile Computing

Kimmo Raatikainen
University of Helsinki, Finland

Abstract

To be posted

Gossiping in the mobile world

Luis Rodrigues
University of Lisbon, Portugal

Abstract

Gossip-based algorithms, also called "epidemic" or "probabilistic" broadcast algorithms, are protocols where nodes randomly contact other nodes to promote the fast dissemination of data. Gossip protocols are extremely resilient to failures of participants and to changes in the underlying network topology, which makes them quite appealing for highly dynamic settings such as mobile and ad hoc networks. Gossip-based algorithms have been applied to a variety of different uses, from monitoring, management, and data mining to the support of large number of participants in multi-user games.

This talk will introduce gossip-based algorithms and identify their strengths and weaknesses, namely when compared with flooding or tree-based approaches. Subsequently, the talk will concentrate on the use of gossip-based algorithms in mobile and ad hoc networks for different tasks, such as data dissemination and routing. The most significant approaches will be illustrated using concrete algorithms. We will conclude by pointing open issues and future research directions.

8 Panel

Panelists

- Hannes Hartenstein - University of Karlsruhe, Germany
- Jean-Pierre Hubaux - EPFL, Lausanne, Switzerland
- Timo Kosch - BMW Research, Munich, Germany
- Kirsten Matheus - CarMeq, Berlin, Germany
- Charles E. Perkins - Nokia Research, Mountain View, USA

Moderator

Christian Bettstetter - DoCoMo Euro-Labs, Munich, Germany

Abstract

Technologies for ad hoc networking will enable car companies to include new safety and communication features into their cars. For example, highly efficient accident warnings are possible: Cars involved in an accident can send warning messages back over a defined number of other vehicles, thus avoiding motorway pileups. We could also envision person-to-person applications using ad hoc communication between vehicles (e.g., simple text messaging, game communities, or even hop-by-hop telephony).

The goal of this panel is to discuss potential and feasible applications, technology and research challenges, visions, roadmaps, and risks of such scenarios. Each of the panelists will give a 5-10 minute statement, followed by a 20-minute discussion with questions from the audience.

9 List of participants

- Abdelhamid Bouchachia - Klagenfurt University
- Adnan Noor Mian - Università degli Studi di Roma 'La Sapienza'
- Adrian Holzer - University of Lausanne
- Armin Müller - Klagenfurt University
- Bart Elen - Katholieke Universiteit Leuven
- Benoit Garbinato - Université de Lausanne
- Bent Christensen - University of Aarhus
- Bernd Stroj - ILOGS
- Bert Lagaisse - Katholieke Universiteit Leuven
- Carole Mabrouk - ESF
- Charalambos D. Charalambous - University of Cyprus
- Charles E. Perkins - Nokia Corporation
- Christian Bettstetter - Senior Researcher DoCoMo Euro-Labs
- Christian Spielvogel - Klagenfurt University
- Costas Constantinou - University of Cyprus
- Daniela Gavidia - Vrije Universiteit Amsterdam
- Dario Bottazzi - Università degli Studi di Bologna
- David B. Johnson - Rice University
- Davide Astuti - University of Helsinki
- Davide Frey - Politecnico di Milano
- Duncan J. McCaffery - Lancaster University
- Eli Gjørven - Simula Research Laboratory
- Erik Kuiper - Linkoping University
- Eugene Burmakin - University of Helsinki
- Eugenio Magistretti - Università degli Studi di Bologna
- Frederic Aubert - University of Neuchâtel, Switzerland
- Gabriel Kliot - Technion - Israle Inst. Of Technology
- Gordon Blair - Lancaster University
- Günther Hölzl - HTL Mössingerstraße

- Hannes Hartenstein - Universität Karlsruhe (TH)
- Hermann Hellwagner - Klagenfurt University
- Hermann Jessner - HTL Mössingerstraße
- Hubert Piontek - University of Ulm
- Hugo Miranda - Universidade de Lisboa
- Ian Rickebusch - University of Lausanne
- Jaakko Kangasharju - University of Helsinki
- James Brown - Lancaster University
- Jean-Pierre Hubaux - EPFL (Swiss Federal Institute of Technology)
- Jesper Spring - Ecole Polytechnique Fédérale de Lausanne (EPFL)
- Jinshan Liu - INRIA
- João Barreto - Distributed Systems, Group (GSD), INESC ID, Portugal
- Joao Garcia - Technical University of Lisbon
- João Viegas - Universidade Nova de Lisboa - Faculdade de Ciências e Tecnologia
- Johann Klanschek - HTBL Mössingerstraße
- Johannes Schleicher - TU Wien
- Jörg Kaiser - Otto-von-Guericke-University of Magdeburg
- Jose Mocito - Universidade de Lisboa
- Josef Hammer - Klagenfurt University
- Jürgen Grossmann - Klagenfurt University
- Kari Rye Schougaard - University of Aarhus
- Karl-Heinz Eder - HTL Villach
- Katrine Skjelsvik - University of Oslo, Institute for Informatics
- Kimmo Raatikainen - University of Helsinki
- Kirsten Matheus - CarMeq, Berlin, Germany
- Klaus Kohrt - Siemens
- Klaus Schöffmann - Klagenfurt University
- Kulpreet Singh - Trinity College Dublin
- Laszlo Böszörmenyi - Klagenfurt University
- Leonardo Querzoni - Universitá di Roma

- Liliana Rosa - Universidade de Lisboa
- Luca Mottola - Politecnico di Milano
- Luís E. T. Rodrigues - University of Lisbon
- Mads Haahr - Trinity College
- Manuela Graf - Klagenfurt University
- Marc Nielson - Microsoft
- Marc Schiely - University of Neuchâtel, Switzerland
- Marek Lehmann - Klagenfurt University
- Margit Lang - Klagenfurt University
- Mario Döller - CenterPoint Connective Software Engineering GmbH
- Mark Gleeson - Trinity College Dublin
- Markus Fauster - Klagenfurt University
- Martin Brynskov - University of Aarhus
- Martin Santner - Klagenfurt University
- Martin Schaffer - Klagenfurt University
- Matija Puzar - University of Oslo, Institute for Informatics
- Matthew - Lancaster University
- Matthias Missoni - Klagenfurt University
- Maxime Monod - Ecole Polytechnique Fédérale de Lausanne (EPFL)
- Michael Kropfberger - Klagenfurt University
- Michael Przybilski - University of Helsinki
- Michael Schulze - University of Magdeburg
- Michael Zufferey - Klagenfurt University
- Natalija Vlajic - York University, Dept. of Computer Science and Engineering
- Norun Christine Sanderson - University of Oslo, Institute for Informatics
- Oriana Riva - University of Helsinki
- Ovidiu Valentin Drugan - DMMS, Department of Informatics, University of Oslo
- Panayiotis Panayiotou - University of Cyprus
- Paolo Costa - Politecnico di Milano
- Peter Leggio - HTBL Mössingerstraße

- Peter Rigole - Katholieke Universiteit Leuven
- Peter Schartner - Klagenfurt University
- Rainer Couto - Federal University of Minas Gerais, Brazil
- Ramya Thalainayar Balasubramanian - University of Helsinki
- Raphael Kummer - Université de Neuchâtel
- Riadh Kortebi - University of Pierre and Marie Curie, Paris
- Ricardo R. Oliveira - Federal University of Minas Gerais, Brazil
- Roberto Baldoni - University of Rome
- Roy Friedman - Technion - Israel Institute of Technology
- Sara Tucci Piergiovanni - Universitá di Roma
- Sasu Tarkoma - University of Helsinki
- Simone Leggio - University of Helsinki
- Sonia Ben Mokhtar - INRIA
- Susana Guedes - University of Lisbon
- Thirunavukkarasu Sivaharan - Lancaster University
- Thomas Frank - Klagenfurt University
- Timo Kosch - BMW München
- Tom Goovaerts - Katholieke Universiteit Leuven
- Vadim Drabkin - Israel Inst. Of Technology
- Vaide Zuikeviciute - Universita della Svizzera Italiana
- Vinny Reynolds - Trinity College Dublin
- Wouter Joosen - Katholieke Universiteit Leuven
- Zygmunt Haas - Cornell University

10 Event pictures

Klagenfurt University, Austria

The industry panel moderated by Christian Bettstetter

Wellcome dinner

11 Questionnaire

In order to receive a feedback about the overall outcom of the event, a feedback form was distributed between all the participants. The questionnaire made, the results obtained and the comments received are presented next. As we can see from the presented graphs, the results of the questionnaire are satisfatory and encouraging.

Summer School Questionnaire

MiNEMA Summer School / 11-15 July 2005 **Feedback Form**

Rate the items using the following scale:

1 = strongly disagree, 2 = disagree, 3 = agree, 4 = strongly agree

I. OUTCOME	Scale			
1. The Summer School broadened my understanding of concepts and principles.	1	2	3	4
2. The Summer School improved my ability to carry out original research.	1	2	3	4
3. The material presented in the Summer School was relevant to my research.	1	2	3	4
4. Overall, the Summer School met my expectations.	1	2	3	4

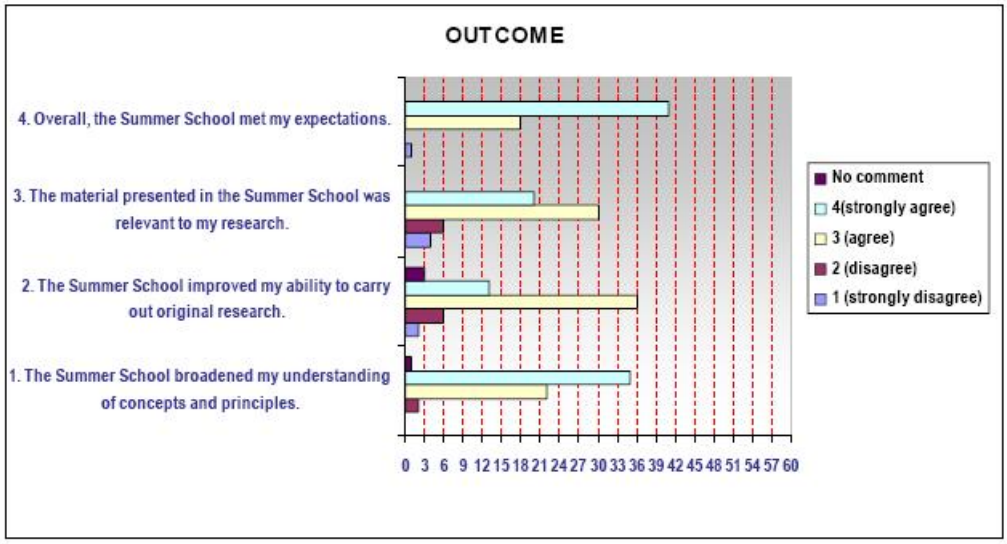
II. LECTURES	Scale			
1. The instructors' knowledge of the subjects was good.	1	2	3	4
2. The instructors explained the material well.	1	2	3	4
3. Lectures incorporated recent developments in the field.	1	2	3	4
4. The instructors stimulated my intellectual curiosity.	1	2	3	4

III. COMMUNICATION	Scale			
1. The Summer School web site was informative before the school started.	1	2	3	4
2. The course material was available online and well aligned with the talks.	1	2	3	4
3. Instructors were readily available for Q&A outside the lecture periods.	1	2	3	4
4. The range of lectures captured the overall essentials of the field.	1	2	3	4

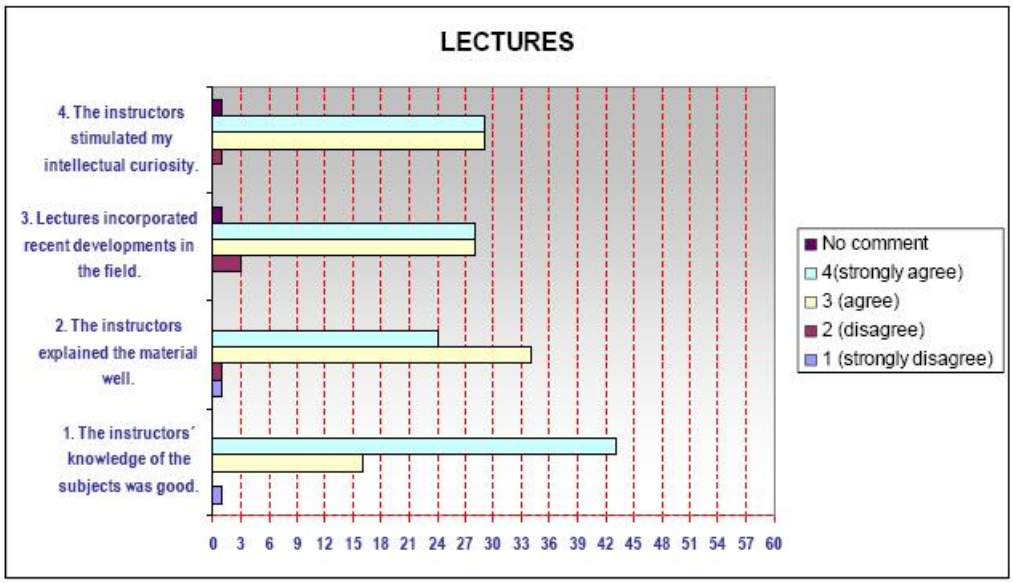
IV. ORGANIZATION	Scale			
1. The Summer School was well organized.	1	2	3	4
2. The lecture room (auditorium) was conducive to learning.	1	2	3	4
3. Access to the Internet was provided in a satisfactory manner.	1	2	3	4
4. The banquet enhanced the Summer School experience.	1	2	3	4

V. COMMENTS
1. What were the best things about the Summer School?
2. What could be improved for the next Summer School?

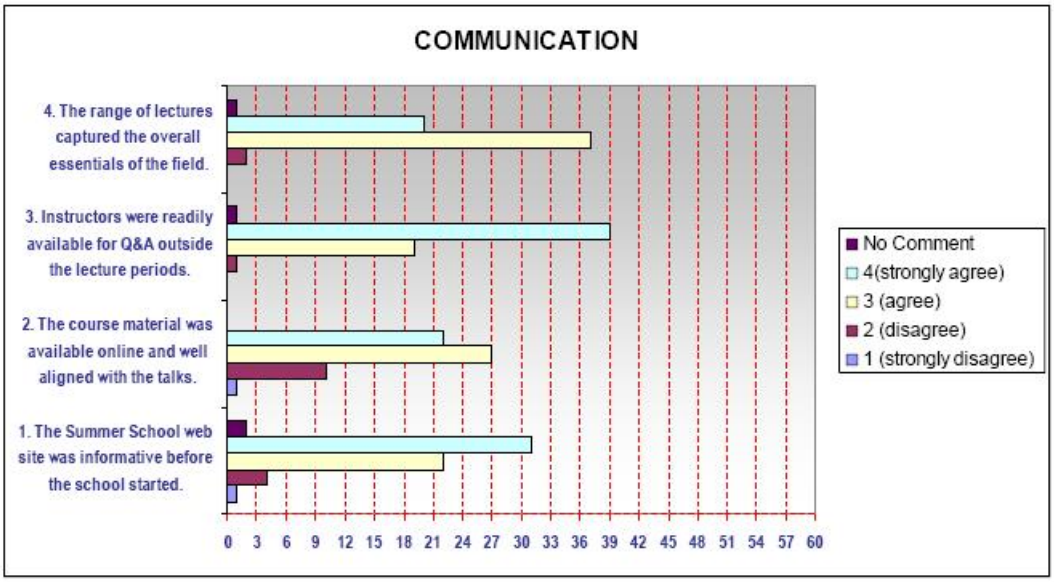
Summer School Questionnaire Results - Outcome



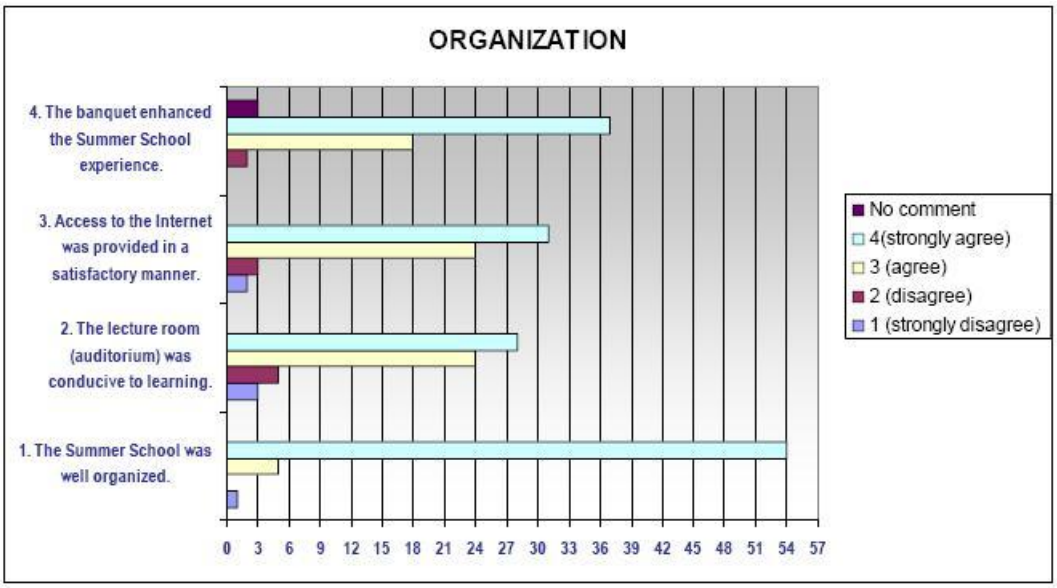
Summer School Questionnaire Results - Lectures



Summer School Questionnaire Results - Communication



Summer School Questionnaire Results - Organization



Summer School Questionnaire Results - The best things

Online access to slides
Very good speakers, knowledge in the field as well as good presentators
Organization and location, Good subjects
Bringing in the leading figures in the field including america colleagues
The high quality of the discussions and material presented
A great event for young researchers, well done Minema!
Interesting subjects. Organization
Plenty of opportunities on interact and socialize, very nice location, material was available in advance (very nice!)
The ability to listen to talks given by top researchers
People, Klagenfurt, Social events, some excellent material
Lecturers were available for discussions
The place, choice of lectures, choice of topics and great organization!
Meeting interesting people, getting new impulses, learning new areas of communication
The quality of the speakers and talks. Very good school!
Social/professional aspects, meeting other young researchers in related fields
The talks by David B. Johnson, Charles E. Perkins and Luis Rodrigues. Good size, diversity
The quality of the instructors was very good and helped me understand many things and motivate my interest in the investigation of the new problems.
The speakers are high-level researchers in their field; many lessons and the panels; well organized
Saved me of reading all the papers on a subject; gave me a good insight to many subjects.
Events, organization, comfort
The panel of instructors was really good and some of the instructors really motivated the audience. Nice and efficient organization. Great location.
Invited speakers were very prepared on their topics. The university structures were very good!
The very good atmosphere, the interesting topics, surroundings!
The range of speakers, well organized, middleware talks, especially Gordon Blair
Quality of speakers, large number of students
Provided an excellent opportunity to interact with the fellow researchers and outstanding personalities in the mobile middleware field.
Session on routing protocols for ad hoc networks
The possibility to meet reserachers working in my research field who have influenced my work and to exchange opinion and experience was great!
Overall the presentations were very well done, Also, the logistics and events were very well done, Thanks for such a hard work at organizing this!
I was very positively impressed of the quality of organization and the speakers great ability to explain the presented material. It was great to be able to ask and discuss with the speakers offline.
The speakers had a broad knowledge and experience in their fields. They are significant people in those areas and it was a unique opportunity to see them in 'real life', to talk to them after the sessions. Also it was great that the talks were mostly overviews of different areas and gave an insight info what´s curently going on in those areas. I also appreciate that most of talks presented current research challenges for the area, which is especially important for PHD Students. Generelly, it was for me a great opportunity to get a lot of info about whole area of mobile and ad-hoc networks, that will be very helpful in my future research.
Interact with the leading people in the field of middleware for mobile computing, came to know some latest ideas in the field; Klagenfurt is a beautiful city. It has a lot of natural beauty and history, I really enjoyed my stay here.
Hearing about the research from the people in this field.
Community creation! Exchange of ideas, very condensed information, good coverage of topics!

Summer School Questionnaire Results - Future improvements

I really think this summer school was excellent!
More insight on frameworks abd similarities with p2p
More emphasis to active research, less to introduction.
Stay and be the same
Hotels closer to University
A half day to take advantage of the city, shops, beach etc
More time at panel discussion
More discussion on recent developments on the field, road map and more industry presence and panels
Real together at the evening in the way of more discussions
More variety of topics, some shorter and more specific talks, maybe a showcase/demonstration of systems that have been implemented
To go deep on more subjects that were addressed there
Wireless access, special software, some material was disappointing
There was not enough time for discussions between lectures
The timing was often too tight
The food provided for lunches should have been better, I would be happy to attend next year some talk related to the sensor network field
Food at lunch, make material available earlier and organize student forums/panels to increase interaction
Given that there were two areas: middleware and networking, the program could have been more balanced and could have a bit mor presentations on middleware.
Attendees should all be placed in the same hotel. This would allow offline talks and the establishment of cooperation relationships.
Please provide better information on the website on how the university can be reached from the suggested hotels. The internet access is plagued by the nonstandard encription system. Your instructors dont even mention how to connect with a Macintosh computer.
Different lecture room! Badges that are more convenient to wear. More, but shorter breaks. Distribute people in fewer hotels.
Concentrate more on MANETS, try to avoid overlapping talks (e.g. epidemic routing), theme was no talk on service discovery and location based services
Thank you, you were great!
Just a minor comment regarding the seats of the auditorium. These seats are surely not comfortable, especially if one has to sit for a long time, the back becomes very uncomfortable.
A interactive workshop could be interesting.
Short talks, but more diversity and more topics