



Networking

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COIMBRA, PORTUGAL **2006**

Tutorial Program, May/15

<i>May/15 – Morning</i>	<i>May/15 – Afternoon</i>
<p style="text-align: center;">Tutorial A <i>BGP – Interdomain Routing and Virtual Private Networks, by Olivier Bonaventure</i></p>	
<p style="text-align: center;">Tutorial B <i>IP-Oriented QoS in the Next Generation Networks: Application to Wireless Networks, by Pascal Lorenz</i></p>	<p style="text-align: center;">Tutorial D <i>Roadmap to Cross-Layer and Cross-System Optimization for B3G, by George Kormentzas and Charalabos Skianis</i></p>
<p style="text-align: center;">Tutorial C <i>Extensible IP Signaling: Architecture, Protocols and Practice, by Xiaoming Fu and Hannes Tschofenig</i></p>	<p style="text-align: center;">Tutorial E <i>Peer-to-Peer Networking, by Raouf Boutaba</i></p>
-	<p style="text-align: center;">Tutorial F <i>User directed and QoS driven routing: theoretical and experimental considerations, by Erol Gelenbe</i></p>

Tutorial A

BGP – Interdomain Routing and Virtual Private Networks

Olivier Bonaventure

May/15 (full-day)

Description:

Today's Internet is divided in about 20000 different domains interconnected in various ways. Two types of protocols are used to route IP packets across the global Internet. Inside a single domain, the intradomain routing protocol (RIP, OSPF, ISIS, ...) builds the routing tables inside the domain so that packets follow the shortest to reach their destination inside the domain. Between domains, the Border Gateway Protocol (BGP) is used to build the interdomain routing tables while taking into account the routing policy of each domain. Designed in the early 1990s, BGP has been improved several times. Introduced in 1995 to support CIDR prefixes, BGP-4, the current interdomain routing protocol, has also been significantly modified. Other improvements to BGP are currently being discussed within IETF in parallel with the finalization of a BGP-4 specification aligned with today's implementations. Besides its utilization in the global Internet, BGP is becoming more and more important for service providers due to its role in Virtual Private Network (VPN) services.

This one day tutorial is targeted at both researchers and network engineers having already a good knowledge of the IP protocol suite but who needs to better understand BGP-4. The course assumes a basic knowledge of IP and intradomain routing protocols, but no prior knowledge of BGP4.

BGP is the glue to allow packets to be forwarded through multiple Autonomous Systems (Ases) in the Internet. The growth of the Internet and of the VPN services is causing some problems to BGP and some researchers are considering the development of alternatives to BGP. However, to build those alternate protocols, a good understanding of the current usages of BGP is necessary.

Outline of the tutorial:

- Part 1: Organization of the global Internet. A quick overview of the meaning of AS, the roles of intradomain routing and interdomain routing and the interconnections between ASes.
- Part 2: BGP Basics. A step by step description of the BGP protocol starting from the basics. We try to explain both how the mechanisms behave and why they have been designed like this.
- Part 3: BGP in large networks. This part goes deeper in the BGP protocol and explains the role of iBGP, the need of route reflectors and confederations, BGP decision process.
- Part 4: BGP-based Virtual Private Networks. In this part, we explain the utilization of BGP to build BGP/MPLS VPNs. This usage of BGP is very important in ISP networks as large ISPs are now using VPNs as a basic mechanism to segment their network to support different types of services.
- Part 5: Research challenges. In this part, we survey the recent literature on BGP and discuss several of the challenges in interdomain routing such as scalability, fast convergence, traffic engineering and security.

Short Biography of the Presenter:

Olivier Bonaventure graduated from the University of Liège as engineer in computer science in 1992 and obtained a Ph.D. for his work on the performance of TCP over ATM networks. He worked during one year as a researcher at Alcatel in Antwerp. He was professor at the University of Namur, Belgium where he lead the networking research group composed of five researchers.

He received the Wernaers prize for his development of online networking courses and the Alcatel prize awarded by the Belgian National Fund for Scientific Research (FNRS) in 2001. He now leads the network research group at Université Catholique de Louvain (UCL), Belgium and is the leader of the TOTEM project that builds an open-source traffic engineering toolbox (<http://totem.info.ucl.ac.be>). He has published more than thirty papers, was granted four patents while working for industry. He is on the editorial board of IEEE Network Magazine, was guest editor of the special issue on interdomain routing and is on the editorial board of IEEE/ACM Transactions on Networking. His current research interest includes intra- and interdomain routing, traffic engineering, multicast and network security.

Recent papers and presentations may be found on: <http://www.info.ucl.ac.be/people/OBO>

Tutorial B

IP-Oriented QoS in the Next Generation Networks: Application to Wireless Networks

Pascal Lorenz

Morning of May/15 (half-day)

Description:

Emerging Internet Quality of Service (QoS) mechanisms are expected to enable wide spread use of real time services such as VoIP and videoconferencing. The "best effort" Internet delivery cannot be used for the new multimedia applications. New technologies and new standards are necessary to offer Quality of Service (QoS) for these multimedia applications. Therefore new communication architectures integrate mechanisms allowing guaranteed QoS services as well as high rate communications.

The service level agreement with a mobile Internet user is hard to satisfy, since there may not be enough resources available in some parts of the network the mobile user is moving into. The emerging Internet QoS architectures, differentiated services and integrated services, do not consider user mobility. QoS mechanisms enforce a differentiated sharing of bandwidth among services and users. Thus, there must be mechanisms available to identify traffic flows with different QoS parameters, and to make it possible to charge the users based on requested quality. The integration of fixed and mobile wireless access into IP networks presents a cost effective and efficient way to provide seamless end-to-end connectivity and ubiquitous access in a market where the demand for mobile Internet services has grown rapidly and predicted to generate billions of dollars in revenue.

This tutorial covers the issues of QoS provisioning in heterogeneous networks and Internet access over future wireless networks as well as ATM, MPLS, DiffServ, IntServ frameworks. It discusses the characteristics of the Internet, mobility and QoS provisioning in wireless and mobile IP networks. This tutorial also covers routing, security, baseline architecture of the inter-networking protocols and end to end traffic management issues.

Short Biography of the Presenter:

Pascal Lorenz (lorenz@ieee.org) received a PhD degree from the University of Nancy, France. Between 1990 and 1995 he was a research engineer at WorldFIP Europe and at Alcatel-Alsthom. He is a professor at the University of Haute-Alsace and responsible of the Network and Telecommunication Research Group. His research interests include QoS, wireless networks and high-speed networks. He was the Program and Organizing Chair of the IEEE ICATM'98, ICATM'99, ECUMN'00, ICN'01, ECUMN'02 and ICT'03, ICN'04, PWC'05 conferences and co-program chair of ICC'04. Since 2000, he is a Technical Editor of the IEEE Communications Magazine Editorial Board. He is the vice-chair of the IEEE ComSoc Communications Software Technical Committee and secretary of the IEEE ComSoc Communications Systems Integration and Modelling Technical Committee. He is senior member of the IEEE, member of many international program committees and he has served as a guest editor for a number of journals including Telecommunications Systems, IEEE Communications Magazine and LNCS. He has organized and chaired several technical sessions and gave tutorials at major international conferences. He is the author of 3 books and 160 international publications in journals and conferences.

Tutorial C

Extensible IP Signaling: Architecture, Protocols and Practice

Xiaoming Fu and Hannes Tschofenig

Morning of May/15 (half-day)

Description:

In the last few years, a number of applications have emerged that can benefit from network-layer signaling, i.e., the installation, maintenance and removal of control state in network elements. These applications include path-coupled and path-decoupled quality of service (QoS) management and resource allocation, as well as network diagnostics, NAT and firewall control. These applications call for an extensible and securable signaling protocol. This tutorial will elaborate the recent standardization efforts in the IETF for a new extensible IP signaling protocol suite developed by its Next Steps in Signaling (NSIS) working group. In particular, we present the architecture, protocol design and our development experiences of the NSIS protocol suite, and compare them with RSVP, the current Internet QoS signaling protocol.

Table of content:

- Motivation and tutorial overview
- A review of existing Internet signaling protocols
- NSIS: an extensible IP signaling architecture
- GIST: General Internet Signaling Transport protocol
- QoS signaling application protocol in NSIS
- NAT/firewall signaling application protocol in NSIS
- Security considerations in NSIS
- A comparison between NSIS and RSVP
- Implementation experiences and deployment perspectives
- Open issues and related work

Short Biography of the Presenters:

Xiaoming Fu received a Ph.D. degree in Computer Science from Tsinghua University, China, in 2000. He was research staff at Technical University Berlin before joining the University of Goettingen as an assistant professor in 2002. His research interests encompass network architectures, mobile networks, protocol design, validation, and performance evaluation. He is leading a research team comprising 1 postdoc, 7 Ph.D. candidates and several master students at Goettingen which is involved in several EU projects (including ENABLE, Daidalos II and VIDIOS) and other international and national research collaboration projects. He is a co-author of RFC 4094, more than 40 peer-reviewed papers and a book to be published by Jon Wiley & Sons Inc. He has served on the Technical Committees of IEEE ICDCS'06, GLOBECOM'06, ICC'06, AINA'04-'06, and the IEEE Computer Communications Workshop 2003, as well as session chair for IFIP Personal Wireless Conference 2005. He is an Expert of ETSI STFs for IPv6 Interoperability. He was a visiting scientist at the Computer Laboratory, University of Cambridge in September 2005.

Hannes Tschofenig received a Diploma degree in Computer Science from the University of Klagenfurt, Austria, in 2001. He joined Siemens Corporate Technology in the same year where he is currently a research scientist. His research focuses on security issues especially with mobile communications. He is active in IETF, e.g., the GEOPRIV, MOBIKE, PANA, EAP, TLS, RADEXT, AAA and MIP6 working groups. In addition, he serves as chair of the Emergency Context Resolution with Internet Technologies (ECRIT) working group and Secretary of the NSIS working group. He is a co-author of RFCs 3726, 4081, 4230 and 4279, a number of Internet drafts, and a forthcoming book. He has been a guest lecturer in several German universities, including University of Goettingen, Berufsakademie Stuttgart and Technical University Munich. He also participates in EU sponsored research projects, such as Ambient Networks and ENABLE.

Tutorial D

Roadmap to Cross-Layer and Cross-System Optimization for B3G

George Kormentzas and Charalabos Skianis

Afternoon of May/15 (half-day)

Description:

The beyond 3G vision constitutes in a diverse wireless networking world of “network-of-wireless-networks” accommodating a variety of radio technologies and mobile service requirements in a seamless manner. The achievement of this vision raises significant research challenges in view of system coexistence; system scale; network robustness requirements; and evaluation tools design and modeling. The key objectives of this tutorial are in part motivated by the importance of cross-layer interactions, in order to efficiently use the radio resource space in wireless networks, and in part by the vision of the integration of heterogeneous wireless technologies providing new wideband services running over flexible QoS-enabled IP based access and core networks. This tutorial brings into the foreground a broad range of research results on cross-system and cross-layer optimization algorithms taking into account issues related to usage behavior, mobility patterns, traffic profiling, QoS issues, security, network selection and relevant horizontal/vertical handovers. Specifically, the tutorial will firstly address the importance of cross-layer interactions, in order to efficiently use the radio resources in wireless networks. Afterwards, heterogeneous platform management algorithms will be presented and advanced resource management policies, including the potential for load balancing across different systems/networks, will be discussed. Subsequently, studies concerning both cross-layer and cross-system optimization in B3G environment will be presented. Finally, specific solutions/cases deployed in the context of various EU-funded projects will be analyzed in accordance with current efforts of various forums such as 3GPP, IEEE, IETF, ETSI and WWRF.

The potential audience can include researchers coming from both academia and industry, engineers, post-graduated students, IT managers and in general persons that would like to obtain a complete view on the cross-system/cross-layer optimisation issues for B3G networking environments. No special background knowledge is expected from the target audience.

Short Biography of the Presenters:

George Kormentzas is currently lecturer in the University of the Aegean, Department of Information and Communication Systems Engineering. He was born in Athens, Greece on 1973. He received the Diploma in Electrical and Computer Engineering and the Ph.D. in Computer Science both from the National Technical University of Athens (NTUA), Greece, in 1995 and 2000, respectively. From 2000 to 2002, he was a research associate with the Institute of Informatics & Telecommunications of the Greek National Centre for Scientific Research "Demokritos". His research interests are in the fields of traffic analysis, network control, resource management and quality of service in broadband heterogeneous wired/wireless networks. He has published extensively in the fields above, in international scientific journals, edited books and conference proceedings. He is a member of pronounced professional societies, an active reviewer and guest editor for several journals and conferences and EU-evaluator for Marie Curie Actions. George Kormentzas has participated in a number of national and international research projects, serving in some instances as the project's technical representative for University of Aegean and/or as WP leader and/or as the project's Technical Manager. Specifically, he acted as Guest Editor for Computer Communications journal (Elsevier Science) on 'Emerging Middleware for Next Generation Networks' (Special Issue to appear). Currently, he is chairing the 3rd International Workshop on Next Generation Networking Middleware (NGNM06) at the forthcoming Networking 2006. He also chaired NGNM04 and NGNM05 in the context of IFIP Networking 2004 and Networking 2005 respectively, and he was Technical Program co-chair of 5th International Network Conference (INC2005). Currently, he is Technical Manager of IST-2005-FP6 UNITE STREP project: "Virtual Distributed Testbed for Optimization and Coexistence of Heterogeneous Systems".

Dr. Charalabos Skianis is currently a Researcher with the Institute of Informatics and Telecommunications at the National Centre for Scientific Research 'Demokritos', in Greece and a visiting Lecturer in the Department of Information and Communication Systems at the University of the Aegean in Samos, Greece. He holds a PhD degree in Computer Science, University of Bradford, United Kingdom and a BSc in Physics, Department of Physics, University of Patras, Greece. He has been actively working on the area of computer and communication systems performance modeling and evaluation where he has introduced alternative methodologies for the approximate analysis of certain arbitrary queuing network models. He is also keen in traffic modeling and characterization, queuing

theory and traffic control of wired and wireless telecommunication systems. His current research activities take upon mobile and wireless networking, ubiquitous and pervasive computing and End-to-End Quality of Service provisioning in heterogeneous networks environment. His work is published in journals, conference proceedings and as book chapters and has also been presented in numerous conferences and workshops. He acts within Technical Program and Organizing Committees for numerous conferences and workshops and as a Guest Editor for scientific journals. He is at the editorial board of journals, a member of pronounced professional societies and an active reviewer for several scientific journals. He acted as Guest Editor for Computer Communications journal (Elsevier Science) on 'End-to-End QoS Provisioning Advances' (Special Issue to appear - articles in press). Currently, he is chairing the Symposium entitled 'World Class Solutions: Networking the Globe' at the forthcoming GLOBECOM 2006 and the workshop entitled 'IP over DVB networks' at the ICC 2006. He acted as member of the organizing committee for IFIP Networking 2004 and he chaired one of the workshops during IFIP Networking 2005 entitled 'World Class Events: Telecommunication Challenges'.

Tutorial E

Peer-to-Peer Networking

Raouf Boutaba

Afternoon of May/15 (half-day)

Description:

The past few years have witnessed the emergence of Peer-to-Peer (P2P) systems as a means to further facilitate the formation of communities of interest over the Internet in all areas of human life including technical/research, cultural, political, social, entertainment, etc. P2P technologies involve data storage, discovery and retrieval, overlay networks and application-level routing, security and reputation, measurements and management.

This tutorial will give an appreciation of the issues and state of the art in Peer-to-Peer Networking. It will introduce the underlying concepts, present existing architectures, highlight the design requirements, discuss the research issues, compare existing approaches, and illustrate the concepts through case studies. The ultimate objective is to provide the tutorial attendees with an in-depth understanding of the issues inherent to the design, deployment and operation of large-scale P2P systems.

Short Biography of the Presenter:

Dr. Raouf Boutaba is an Associate Professor in the School of Computer Science of the University of Waterloo. Before that he was with the Department of Electrical and Computer Engineering of the University of Toronto. Before joining academia, he founded and was the director of the telecommunications and distributed systems division of the Computer Science Research Institute of Montreal (CRIM).

Dr. Boutaba conducts research in the areas of network and distributed systems management and resource management in multimedia wired and wireless networks. He has published more than 200 papers in refereed journals and conference proceedings. He is the recipient of the Premier's Research Excellence Award, two NORTEL research excellence Award and several Best Paper awards. He is a fellow of the faculty of mathematics of the University of Waterloo and a distinguished lecturer of the IEEE Communications Society. Dr. Boutaba is the Chairman of the IFIP Working Group on Networks and Distributed Systems, the Chair of the IEEE Communications Society Technical Committee on Information Infrastructure and the IEEE Communications Society Technical Sub-Committee on Autonomic Communications, and the Director of the Related Societies Board of IEEE Communications Society. During the past years, Dr. Boutaba served as the Director of standards board of the IEEE Communications Society, the Vice Chair of IEEE Communications Society Technical Committee on Information Infrastructure, and a distinguished lecturer of the IEEE Computer Society. He is the founder and acting editor in Chief of the IEEE Transactions on Network and Service Management published online, on the advisory editorial board of the Journal of Network and Systems Management, on the editorial board of the KIKS/IEEE Journal of Communications and Networks, and the editorial board of the Journal of Computer Networks. He acted as the program chair for the IFIP Networking conference and the IEEE CCNC conference, and a general or program co-chair for the IEEE/IFIP NOMS, IFIP/IEEE MMNS, IEEE FIW, IEEE ACC and IEEE ICC symposia. Dr. Boutaba teaches computer networks and distributed systems and conducts research in the area of resource management in wired and wireless networks.

Tutorial F

User directed and QoS driven routing: theoretical and experimental considerations

Erol Gelenbe

Afternoon of May/15 (half-day)

Description:

One of the tendencies in network research is to consider opportunities to improve network performance and/or user perceived QoS through adaptability. Building adaptability in networks requires a choice of protocols, algorithms, and tools or methods both for system design and implementation. Furthermore, the need to deal with legacy aspects of networks requires that adaptability should preferably preserve compatible interfaces with the IP protocol.

Our tutorial will address all of these points in the framework of QoS driven routing where the users and routers share in the decision making process. We will describe a set of "provably sensible" algorithms based on route discovery that optimise QoS, and show how they translate into a network routing protocol. We will describe the protocol's implementation using neural networks and other techniques. We will report on both theoretical and experimental results on a test-bed that implements these techniques.

Short Biography of the Presenter:

Erol Gelenbe (PhD DSc) is Professor in Computer and Communication Networks at Imperial College where he holds the Dennis Gabor Chair. He is a Fellow of IEEE, ACM and IEE and a Member of Academia Europaea. One of the founders of the field of computer and network performance evaluation, his work over the last decade has included video compression, packet and ATM network QoS and admission control, product form queuing networks, and neural computation, for which he has been awarded three US patents and published articles in the IEEE J. on Selected Areas in Communications, IEEE Communications, Performance Evaluation, IEEE Trans. on Neural Networks, Proceedings of the IEEE and other journals. He has graduated over 50 PhDs and has been himself awarded honorary doctorates by the University of Rome Tor Vergata, Bogazici University in Istanbul, and the University of Liege (Belgium).