Guest Editorial
Special issue on "Cross-Layer Design for QoS Support in Wireless and Hybrid Networks"

Multimedia services provision is an important pre-requisite for today's telecommunication networks and a great achievement of the Information Era. Significant developments have recently involved wired and wireless networks. In this regard, wireless systems represent a very challenging scenario for the fruition of services due to the dynamically-varying conditions of the physical medium. Nevertheless, Quality of Service (QoS) levels should not be affected by the used access technology. Different wireless networks are now available that allow an IP-based broadband connectivity for the users while on the move. Among others, we can refer here to 3G packet-switched data, WiFi (and its recent evolution for QoS support, IEEE 802.11e), WiMAX, etc. An interesting sector, requiring original approaches, is also represented by hybrid networks that combine different wireless segments in the network for a better coverage and service provision.

System efficiency is an important requirement for wireless system operators to provide services at competitive costs. Whereas, QoS support is a pre-requisite for end-users who do not care about resource utilization and adopted Internet access technology, but expect a good service level. System optimization and QoS support are typically conflicting needs that are exacerbated in the wireless context due to the error-prone nature of the wireless medium. In addition to this, highly-varying traffic, energy consumption and user mobility create problems that must be addressed before broadband wireless Internet services can be widely and successfully deployed.

A strict modularity and protocol layer independence may lead to non-optimal performance in IP-based wireless communication systems. The interest of this special issue is in protocol architectures modifying the reference layered architecture, for example, by allowing direct communication between protocols at non-adjacent layers or sharing state variables between layers. This is *cross-layer design* that permits to exploit interactions between protocols that otherwise are operated independently, according to the classical layer separation approach of the protocol stack. Different cross-layer interactions can be envisaged in the wireless scenario (PHY with MAC, PHY with transport layer, application with transport and network layers, etc.). These interactions allow improving performance and the capability to adapt to system dynamics.

This special issue of the Journal of Communications Software and Systems, brings together: a) one best paper of the *14th International Conference on Software, Telecommunications and Computer Networks* (SoftCOM 2006), Split-Dubrovnik, Croatia, September 29 – October 1, 2006 and b) submitted papers from the journal open call. All these papers were reviewed by experts in the appropriate areas.

The first paper by *D. Moltchanov* is entitled "Cross-layer Performance Control of Wireless Channels Using Active Local Profiles". It proposes the optimization of applications running over state-of-the-art wireless access technologies by means of a number of channel adaptation mechanisms. A new cross-layer performance optimization system is envisaged for the exchange of control information between different layers. This paper proposes the design of a cross-layer performance control system for wireless access technologies with dynamic adaptation of protocol parameters at different layers of the protocol stack. Controllable parameters include the strength of the forward error correction code, Automatic Repeat reQuest (ARQ) functionality, packet size at different layers, and rate with which traffic is generated. The core of the proposed system is the change-point detection algorithm that is adopted to detect parameter changes in time-varying arrival and channel processes. Numerical results demonstrate that the proposed system provides significant performance gain compared to static configuration of protocols at different layers.

Guillermo Díaz Delgado, Víctor Carrascal Frías, and Mónica Aguilar Igartua have contributed the second paper, entitled "Cross-Layer Optimization for Video-streaming Transmission with QoS over ad Hoc Networks: A Holistic Approach". In this paper, the authors present ViStA-XL, a cross-layer design aiming to optimize the overall performance of video-streaming services over Mobile Ad Hoc Networks (MANETs). This study is based on some IEEE 802.11x standards and drafts. In ViStA-XL, a real-time optimizer periodically gathers information on the state of node and network from different layers of the protocol stack, takes optimization decisions, and then modifies some parameters of the protocols accordingly. The obtained results prove that ViStA-XL represents an appropriate cross-layer design to provide QoS to video-streaming applications over a MANET. Also, the proposed multipath routing MM-DSR algorithm showed to have a better performance than DSR. The different parameters involved in the algorithm would vary dynamically depending on the network evolution, taking into account the mobility of the scenario, and the number of paths between source and destination.

Nedo Celandroni, Erina Ferro, Giovanni Giambene, and Mario Marandola authored the third paper entitled "Satellite-3G Hybrid Networks: Impact of ACM and ARQ on TCP Performance". The scenario considered in this paper is a hybrid network architecture, where a geostationary satellite forward link and a terrestrial 3G return link are used in order

to exploit both the high bandwidth of a satellite channel and the lower propagation delay of a terrestrial path. The authors have used a simulation approach to compare the goodput of four of the most popular TCP variants, in the presence of a GOOD-BAD satellite channel, Adaptive Coding and Modulation (ACM) technique and an ARQ scheme of the Selective Repeat (SR) type. The main result of this paper is that ACM does not yield any TCP goodput improvement if ARQ is not used as well. Furthermore, the relevance of the timeout mechanism in the ARQ protocol has been pointed out.

The fourth paper is "Reliable Multicast Transport for Heterogeneous Mobile IP Environment using Cross-Layer Information", authored by *Ilka Miloucheva, Karl Jonas, Nilson Reyes, Jens Mahnke, and Riccardo Pascotto*. This work deals with a reliable multicast transport architecture designed for heterogeneous mobile IP environments, using cross-layer information for enhanced QoS and seamless handover. In particular, application-specific reliable multicast retransmission schemes are proposed that are aimed to minimize the protocol overhead taking into account the behavior of mobile receivers (loss of connectivity and handover) and the specific application requirements for reliable delivery (such as carousel file transfer, one-to-many download, on-demand content delivery, etc.). Then, cross-layer interactions in order to enhance reliable transport and to support seamless handover are discussed, based on the IEEE 802.21 media independent handover mechanisms. The implementation of the proposed application-specific reliable multicast transport is based on Linux IPv6 environment. Compared to the IETF NORM protocol, simulations have shown that the new strategies behave better in the discussed application scenarios, especially for multicast receivers without losses.

Chin-Tser Huang, Manton Matthews, Matthew Ginley, Xinliang Zheng, Chuming Chen, and J. Morris Chang authored the fifth paper, "Efficient and Secure Multicast for WirelessMAN: A Cross-layer Design". Effectively adding security measures to a multicast service is an intriguing problem for the wireless scenario. Next-generation IEEE 802.16 WirelessMAN networks are a perfect example for this problem, and the latest draft specification of the standard includes a secure protocol solution, called Multicast and Broadcast Rekeying Algorithm (MBRA). This paper describes the security problems of MBRA and provides new proposals, named ELAPSE and ELAPSE+ that are based on cross-layer information. These new approaches have backward and forward secrecy and outperform the 802.16 MBRA in simulations.

Finally, the sixth paper "A Cross-Layer Design Framework for Wireless Sensor Networks with Environmental Monitoring Applications" has been contributed by *Kejie Lu, Yi Qian, Domingo Rodriguez, Wilson Rivera, and Manual Rodriguez*. This paper addresses the design of an important type of Wireless Sensor Networks (WSNs), i.e., WSNs that enable environmental monitoring applications also referring to an ongoing research project for coastal-area acoustic monitoring. Then, a new cross-layer design framework has been proposed

for future WSNs that provide environmental monitoring services. The focus of the framework is the network layer design and the key idea is to fully understand and exploit both the physical layer characteristics and the requirements of upper layer applications and services. Such framework can enable cooperative communication and network coding, can utilize the transmission characteristics for identifying/authenticating a sender, can exploit the communication pattern as a mean of sensing. A case study has been presented to illustrate the advantages of this framework.

In closing, we would like to thank all the authors for their excellent work. We also thank the reviewers for their valuable comments and suggestions in refining the quality of the papers. We appreciate Professor Nikola Rozic for his support and encouragement. Finally, we hope that the readership will find these papers interesting.

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Giovanni Giambene was born in Florence, Italy, in 1966. He received the Dr. Ing. degree in Electronics in 1993 and the Ph.D. degree in Telecommunications and Informatics in 1997, both from the University of Florence, Italy. From 1994 to 1997, he was with the Electronic Engineering Department of the University of Florence, Italy. He was Technical External Secretary of the European Community COST 227 Action ("Integrated Space/Terrestrial Mobile Networks"). He also contributed to the SAINT Project ("Satellite Integration in the Future Mobile Network", RACE 2117). From 1997 to 1998, he was with OTE of the Marconi Group, Florence, Italy, where he was involved in a GSM development program. In the same period he also contributed to the COST 252 Action ("Evolution of Satellite Personal Communications from Second to Future Generation Systems") research activities by studying PRMA protocols for voice and data transmissions in low earth orbit mobile satellite systems. In 1999, he joined the Information Engineering Department of the University of Siena, Italy, first as research associate and then as assistant professor. He teaches the advanced course of Telecommunication Networks at the University of Siena.

From 1999 to 2003 he participated to the project "Multimedialità", financed by the Italian National Research Council (CNR). From 2000 to 2003, he contributed to the "Personalised Access to Local Information and services for tOurists" (PALIO) IST Project within the EU FP5 programme. At present, he is involved in the SatNEx network of excellence of the FP6 programme in the satellite field, as work package leader of two groups on radio access techniques and cross-layer air interface design (www.satnex.org). He is also vice-Chair of the COST 290 Action (www.cost290.org), entitled "Traffic and QoS Management in Wireless Multimedia Networks" (Wi-QoST). He has recently published the following books: G. Giambene, "Queuing Theory and Telecommunications: Networks and Telecommunications", Springer, May 2005; G. Giambene (Ed.), "Resource Management in Satellite Networks: Optimization and Cross-Layer Design", Springer, April 2007.

Boon Sain Yeo received the B.Eng and Ph.D. degrees in Electrical and Electronics Engineering from University of Glasgow and Imperial College of Science, Technology and Medicine, respectively. He has been with the Institute for Infocomm Research (I^2R, formerly also known as Centre for Wireless Communications, NUS and Institute for Communications Research), an institute under Agency for Science, Technology and Research, since 1998. From 2004 – 2005, he was appointed as the laboratory head of Wireless Sensor Networks Laboratory in the Networking Department. From 2005 - 2007, he was the Technology and Development Director of Wavex Technologies and Wavex Innovations, a small medium enterprise focusing on RFID, under a government initiative. Since October 2007, has been seconded as the R&D director of SensiMesh Pte Ltd, startup company that focus on R&D for mesh technologies, wireless and wired sensor networks, RTLMS and monitoring and control systems. The secondment is part of a government initiative to help to technologically upgrade the small medium enterprise in Singapore. He is also an adjunct Assistant Professor in NUS.

His research interests are in technologies relating to wireless systems and network, and operational approaches to optimize telecommunication systems. He has been actively participating in numerous conferences, including, TPC co-chair for IEEE GLOBECOM 2004 Wireless symposium, TPC chair for IEEE GLOBECOM 2005 General symposium, TPC co-chair for IEEE GLOBECOM 2006 Wireless Symposium, General co-chair and Steering Committee Chair for ISWCS 2004, 2005, 2006, 2007 and 2008, General co-chair and Steering Committee Co-chair for ISWPC 2006, 2007 and 2008, General co-chair for VTC Spring 2008, TPC chair for WOCN 2005, Workshop chair for SensorWare 2006, General co-chair or vice-chair to IWSSC for 2005, 2006, 2007 and 2008 and Organizing chair for IEEE MWCN 2003. He is also currently serving as a editorial board member for several reputable journals.

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