

Editorial

Advances in Quality and Performance Assessment for Future Wireless Communication Services

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Wireless communication services are evolving rapidly in tandem with developments and vast growth of heterogeneous wireless access and network infrastructures and their potential. Many new, next generation and advanced future services are being conceived. New ideas and innovations in performance and QoS, and their assessment, are vital to the success of these developments. These should be open and transparent, with not only network-provider driven, but also service-provider-driven and especially user-driven options on management and control to facilitate always best connected and served ABC&S, in whatever way this is perceived by the different stakeholders. To wireless communication services suppliers and users alike, the complexity and integrability of the immense, diverse, heterogeneous wireless networks' infrastructure should add real benefits, and always appear as an attractive user-friendly wireless services enabler, as a wireless services performance enhancer, and as a stimulant to wireless services innovation. Effecting the integration of services over a converged IP platform supported by this diverse and heterogeneous wireless infrastructure presents significant QoS and traffic engineering challenges. This is the context and setting for our special issue of the Journal on Wireless Communications and Networking. The issue addresses questions, advances, and innovations in quality and performance assessment in and for future heterogeneous wireless service delivery. Of the 25 excellent papers submitted, nine were selected following a comprehensive review process. These deal with aspects of

quite new wireless paradigms such as wireless billboard channels in the ubiquitous consumer wireless world environment, to network planning for a large scale role out of WiMAX across the populous megacity of Bangkok, to technology and performance issues arising in the new vehicle-to-vehicle and vehicle-to-road-side IEEE 802.11p WAVE wireless protocol, and to ideas for performance improvement in standard IEEE 802.11 WiFi-based LANs, IEEE 802.15.3 UWB-based wireless personal area networks, and generic end-to-end QoS performance access models.

The "Ubiquitous Consumer Wireless World" (UCWW) paradigm introduces new perspectives and dimensions to performance in wireless communications. UCWW is a radical proposal to create a consumer-centric wireless communications techno-business environment to at least complement if not replace the existing legacy subscriber-based network-centric one. It holds the potential to be the next "big thing" on the macro-scale of wireless communications environments, with a promise of significant benefits for future generations of wireless networking. In particular with its concept of user-driven ABC&S, the consumer is handed new powers to manage their connection and its performance. One of the key novel underpinning infrastructural pillars to enable this shift of control is the wireless billboard channels (WBCs). These narrowband broadcast channels serve primarily for network providers advertising their wireless access services to consumers and for consumers to discover the existence of such services and be enabled to make association

decisions with the networks for use of the advertised services. WBCs can be created within existing broadcast platforms established for pervasive services such as TV. However, QoS requirements for the WBCs will be different. As access network providers will rely on this broadcast advertised data to attract mobile consumers to use their network services, transmission performance on the WBCs should be predictable, controllable, and good. In their paper “*Performance analysis of “WBC over DVB-H” link layer,*” authors Zhanlin Ji et al. of the Telecommunications Research Centre in the University of Limerick, Ireland address this performance issue in WBCs. Considering WBCs established over digital video broadcast-handheld (DVB-H) platforms, they present novel “smart” cross-layer error-control coding schemes for improving error protection performance. The algorithms for these schemes are jointly executed by the link layer and service layer cross-layer algorithms. In their paper, they show that the schemes improve error protection reliability relative to existing DVB-H IP datacasting schemes and can operate without detriment to flexibility or throughput efficiency.

While the major cellular mobile operators globally are coming down on the side of rolling out LTE for future broadband communications, there is a real market opportunity for fixed broadband by WiMAX, the IEEE802.16 wireless standard. Complementing broadband fixed line xDSL solutions, it is an immediate attractive solution in populous, and not so populous, areas without any significantly pervasive broadband access network infrastructure. Designing a scaled broadband fixed wireless access (BFWA) network based on WiMAX for populous Bangkok megacity, with its some 10 million inhabitants, is the challenge addressed by Pichet Ritthisoonthorn et al. of the Asian Institute of Technology (AIT), Thailand. In their paper “*Planning of efficient wireless access with IEEE 802.16 for connecting home network to the internet*”, they set out a method for planning such a BFWA network. By defining population density-based environments, they subdivide the megacity into more manageable internally homogenous areas. They analyse relationships between coverage area and access rate for subscribers in each kind of environment area. With the inclusion of studies on throughput and channel capacity under different access rates, and also of considerations on both non-engineering and engineering factors—such as frequency bandwidth and spectrum allocation for the former, and estimation of traffic per subscriber and choice of adaptive modulation from subscriber terminal for the latter—they show that while the BFWA is a capacity limited system, a scaled WiMAX network plan is feasible and has a real potential as a broadband Internet access solution for individual homes.

In the paper entitled “*Fractional frequency reuse for hierarchical resource allocation in mobile WiMAX networks*” by Tara Ali-Yahiya and Hakima Chaouchi of CNRS in France, a frequency planning based on a zone switching diversity scheme for multicell OFDMA mobile WiMAX networks is proposed. The focus of the article is on fractional frequency reuse for guaranteeing quality of service for different service flows. The proposed resource allocation algorithm attempts to capture three types of diversity, namely, mutual interference diversity, traffic diversity, and selective fading channel

diversity providing a trade-off between maximizing overall throughput of the system while guaranteeing the quality of service requirements for a mixture of real-time and nonreal-time service flows under different diversity configurations.

In the paper “*Linking users’ subjective QoE evaluation to signal strength in an IEEE 802.11 b/g Wireless LAN environment,*” authors Katrien De Moor et al. of Ghent University, Belgium have looked into the relationship between the signal strength and the achievable user satisfaction of a certain service when run over a wireless LAN connection. Based on an interdisciplinary approach for measuring QoE as a multidimensional concept, authors developed a distributed software monitoring tool that facilitates the measurement of QoE. Based on this tool, several test users evaluated a mobile web browsing application on a PDA in an indoor IEEE 802.11b/g Wireless LAN environment. Observations made during the test indicate that the perceived speed, frustration, and general user satisfaction can be related to the signal strength. Although this study simplifies some aspects, the proposed approach and software tool offer interesting opportunities for future large-scale research on user-centric QoE evaluation measures.

In “*A QoS-based dynamic queue length scheduling algorithm in multiantenna heterogeneous systems,*” the authors, Nizar Zorba of the University of Jordan, Amman, Jordan and Christos Verikoukis of the Telecommunications Technological Center of Catalonia (CTTC) in Barcelona, Spain, develop a cross-layer based dynamically tuned queue length scheduler for the downlink of multiuser and multiantenna WLAN systems with heterogeneous traffic requirements. The scheduler allows DLC queue length control, enabling the potential for the highest average system throughput, notwithstanding performance requirements arising from other QoS measures. The practical value of the study is providing a wireless network operator with the means to choose among QoS measures, as presented in this paper, for the ones most suitable for particular scenario characteristics and users’ QoS requirements. How applications and the protocol layers in general may profit from the advances introduced by multiple antennas and signal processing techniques in the physical layer is another outcome of this study.

Wireless communication serving vehicles for road safety, reduced accident risks, and improved transportation system efficiencies will be an important new development for vehicular environments. A further important indirect “green” benefit of this technology will be reduced carbon emissions. The IEEE protocol addressing this application is the IEEE 802.11p Wireless Access in Vehicular Environments (WAVE). The system is built on an infrastructure of roadside wireless stations and onboard vehicle radio units, and its primary goal is the sharing of safety-related information with road vehicles. WAVE’s MAC protocol to mediate competition for the transmission medium is the Enhanced Distributed Channel Access (EDCA). Jose R. Gallardo et al. in their paper “*Mathematical analysis of EDCA’s performance on the control channel of an IEEE 802.11p WAVE vehicular network*” present improvements to analytical tools which can be used to evaluate the performance of WAVE as a technology under the

specific conditions of the WAVE control channel (CCH). The conditions include the fact that all safety-critical data frames are broadcasted which in turn means no acknowledgments or retransmissions, and therefore the binary exponential backoff technique cannot be implemented. Using Markov chains in the modelling of the protocol, they show how to obtain performance results relating throughput, frame-error rate, buffer occupancy, and delay obtained under different traffic-load conditions.

In the paper entitled “*FPGA-based vehicular channel emulator for real-time performance evaluation of IEEE 802.11p transceivers*” by T. M. Fernandez-Carames et al. of the University of La Coruña in Spain, a framework is proposed to evaluate the PHY layer of IEEE 802.11p systems in realistic situations. To this end a flexible and reconfigurable FPGA based channel emulator supporting high speed scenarios as well as a reference software for IEEE 802.11p PHY is introduced. Exemplarily the importance of coding and the benefits of using IEEE 802.11p instead of IEEE 802.11a in vehicular environments are studied.

Performance of IEEE 802.15.3 WPAN MAC layer algorithms is the main focus of the paper “*Performance analysis of binary exponential backoff and Improved backoff for WPAN*” by S. Mehta and K. S. Kwak of the UWB Wireless Communications Research Center, Inha University in Incheon, Korea. They analyse and compare two contention process algorithms, an “Improved Backoff” algorithm versus binary exponential backoff (BEB) under saturated and nonsaturated traffic conditions. The results demonstrate that Improved Backoff provides an edge over BEB in terms of channel efficiency, channel access delay, and energy efficiency.

A great challenge for future networks is end-to-end Quality of Service (QoS) performance assessment. Gerardo Gómez, Javier Poncela González, Mari Carmen Aguayo-Torres, and José Tomás Entrambasaguas Muñoz of the University of Malaga in Spain propose a model for such assessment over networks with wireless access. They constrain their focus to data services. The proposed model deals with performance degradation across protocol layers using a bottom-up strategy, from the physical layer to the application layer. As the approach makes a per-layer performance assessment possible, the potential for optimization is greater. In a scenario to demonstrate the model’s validity, they examine a set of mobile terminals connected to a streaming server through an IP access node. For a testbed, they employ a real-time emulator of an end-to-end network with wireless access. This emulator enables them to consider radio interfaces consisting of a variable-rate multiuser and multichannel subsystem, which include normal retransmissions and adaptive modulation and coding functionalities. Interestingly in their analytical and emulation validation work, they include the new TCP-Friendly Rate Control (TFRC) protocol along with UDP and TCP.

We hope you enjoy and receive benefit from this special issue. As guest editors, we would like to thank all authors who invested a lot of work in their really valuable contributions. Very important to us also is expressing our gratefulness to our reviewers, who dedicated their precious time to provide in-depth assessments, helpful comments, and suggestions in

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