TOPICS AND UPDATES ON 4G TECHNOLOGIES


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This decade is expected to bring many exciting changes to the wireless communications networks, enabling true mobile broadband Internet services on a wide range of user devices. These changes are part of the wireless networks evolution to fourth-generation (4G) technologies and networks in line with IMT-Advanced technology requirements and definitions in the Radio Sector of the International Telecommunications Union (ITU-R).

The evolution to 4G/IMT-Advanced systems is expected to enable new services and usage models with the higher efficiencies of a highly self-configurable network infrastructure. These challenges should be met with simpler Internet-friendly and flat network architectures that make the best use of multiple bands and multiple carriers in licensed and unlicensed spectrum to provide broadband quality of experience at competitive cost.

The main two candidates for 4G systems are WiMAX technology, based on IEEE802.16 standards, and the Third Genreation Partnership Project's (3GPP's) Long Term Evolution (LTE), both of which are being further enhanced at the time of this publication to be considered and potentially endorsed by ITU-R as IMT-Advanced systems.

While in details WiMAX and LTE have somewhat different designs, there are many concepts, features, and capabilities commonly used in both systems to meet a common set of requirements and expectations. For example, at the physical layer both technologies deploy orthogonal frequency-division multiple access (OFDMA)-based designs combined with various modes of multiple-input multiple-output (MIMO) configurations and fast link adaptation with time-frequency scheduling. Also, medium access control (MAC) of both systems support multicarrier operation and heterogeneous networks of cells, consisting of a mix of macrocells, femtocells, and relay nodes, which bring all kinds of challenges and solutions for mobility, interference, and traffic management.

The six articles selected for this issue are prepared by industry experts who are directly involved in driving the development of 4G standards by 3GPP and IEEE 802.16. Each of the articles addresses one of the main concepts or features of 4G systems. When feasible, comparative observations are provided by the authors on design choices made in IEEE 802.16m and LTE, which we hope add to the educational value of the articles.

The first article, by Kanchei Loa *et al.*, presents the status of relay standardization in 3GPP LTE-Advanced and IEEE 802.16m. Support for relay nodes to improve coverage and system capacity is agreed to be one of the key elements of both 4G systems. This article presents concepts and motivations of each relay standard along with comprehensive descriptions of the relay systems specifications, including subframe structure and protocol stacks as well as existing open issues.

The second and third articles, by I-Kang Fu *et al.* and Mikio Iwamura *et al.*, provide in-depth presentations of multicarrier design and operation in IEEE 802.16m and LTE-Advanced systems, respectively. Support for wideband carriers combined with bandwidth aggregation across contiguous and non-contiguous bands in both 4G technologies was driven by requirements for very high throughput up to 1 Gb/s and the ability to utilize limited and fragmented spectrum. The key concept of multicarrier design is to enable efficient management and use of multiple radio frequency (RF) carriers using a common medium and/or radio resource control (MAC/RRC) to allow cross-carrier scheduling, aggregation, and interference management.

The fourth article, by Ozgur Oyman *et al.*, focuses on design consideration and solutions for enhanced mobile video services over WiMAX and LTE systems. Given the ever growing demand for peer-to-peer and broadcasting video applications over mobile broadband networks, some video-specific optimizations are needed in the design of 4G systems to efficiently handle video traffic. This article presents an overview of technology options for enabling multicast and unicast video services over WiMAX and LTE networks. It also makes some comparative observations on performance and offers ideas to further enhance the video capacity and quality of user experience in these networks.

The fifth article, by Ronny Yongho Kim *et al.*, explains and compares the state-of-the-art handover schemes developed for and deployed in 3GPP LTE-Advanced as well as in next-generation WiMAX networks based on IEEE 802.16m. Considering various deployment scenarios, both

IMT-A candidate technologies minimize and optimize handover latency in comparison to existing handover schemes to fulfill the requirements for maintaining full quality of service during handover.

The final article in this issue, by Nageen Himayat *et al.*, focuses on interference management for 4G cellular standards. The authors present some observations on inherent challenges associated with aggressive spectrum reuse in 4G systems that lead to increased intercell interference and signal-to-interference-plus-noise ratio (SINR) degradation, and hence lower cell edge user data rate and overall system throughput. The article also compares the interference management solutions across the two main 4G radio standards, IEEE 802.16m (WiMAX) and 3GPP- LTE. While interference management has many facets and implications, the emphasis of this article is on the radio resource management schemes for interference mitigation, including power control and adaptive fractional frequency reuse.

We appreciate all the authors for their insights and contributions to this publication, and hope that this collection of articles provides readers with better up-to-date understanding of 4G systems while they are being refined and realized around the globe.

BIOGRAPHIES

KAMRAN ETEMAD (kamran.etemad@intel.com) received his B.S. degree in electronic engineering from Sharif University of Technology, and M.S. and Ph.D. degrees in electrical engineering from the University of Maryland. Currently, he is the director of technology standards at Intel Corporation where he is leading various technical and strategic initiatives related to 3GPP/LTE and IEEE 802.16/WiMAX standards development. Prior to Intel, he held senior technical and management positions with Sprint-Nextel as an executive technology consultant, with WFI as vice president of advanced technology, and with Hughes network systems as a senior member of technical staff. His current focus is on advanced wireless technology development for the next generation of mobile broadband networks. Among his key areas of research are radio network architecture/protocols design for multilayer and multicarrier networks, enhanced mobility, location, and multicast/broadcast services. Prior to his involvement in 3GPP and WiMAX he made many contributions in the development of cdma2000 technology in 3GPP2. He has numerous publications and patents in these areas, including two books, *CDMA2000 Evolution* and *WiMAX Technology and Network Evolution*.

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