

EDITORIAL

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Special issue on advances in 4G wireless and beyond

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Abstract

4G cellular systems envisions a comprehensive all-IP-based solution, including voice, data, and streamed multimedia at much higher data rates and spectral efficiency. Emerging standards and technologies like LTE and M-WiMAX are actually leading towards this vision. The objective of this special issue is to address specific research issues and solutions on different aspects of 4G wireless systems and beyond. The total six papers included in this special issue demonstrates research outcomes in different aspects of 4G wireless, like scheduling, resource allocation, cognitive and cooperative communications, multicast services and coverage and planning of small cells. We hope that the research results included in this special issue will serve as an important step for further research and development in 4G wireless communication systems.

Editorial

The commercial success of cellular networks, combined with advances in digital electronics, signal processing, and telecommunications research, have lead to the design of next-generation 4G wireless systems. The vision of 4G cellular systems lies in providing a comprehensive all-IP-based solution which facilitates voice, data, and streamed multimedia to users on an 'anytime, anywhere' basis and at much higher data rates and spectral efficiency, when compared to previous generations (like 3G wireless). The rapid advances in orthogonal frequency-division multiple-access (OFDMA) technologies, proliferation of M-WiMAX and long-term evolution LTE systems, ratification of IMT-advanced standards, and introduction of feature-rich smart phones have contributed significantly towards the eventual realization of this vision. The three major distinctive characteristics in which 4G wireless differs from the traditional wireless systems are the following:

1. A spectrally efficient system (in bits/s/Hz and bits/s/Hz/site), with high network capacity, i.e., more simultaneous users per cell and very high nominal

data rates, typically in the order of 100 Mbps with mobility.

2. Smooth handover, seamless connectivity, global roaming, and sustainable Quality-of-Service (QoS) across heterogeneous wireless access technologies for mobile multimedia.
3. Interoperability with existing wireless standards, with an all-IP packet switched network. To emphasize the development of standardized 4G wireless systems, the International Telecommunication Union (ITU) has come up with 'International Mobile Telecommunications (IMT) - Advanced'. 3GPP LTE is identified as the final step towards these 4G technologies.

The scope of this special issue is focused on various research challenges and solutions on different aspects of 4G wireless systems and beyond. There are in total six papers in this special issue dealing with different aspects of 4G wireless. Depending on the different aspects of 4G wireless, the papers in this special issue are classified into four different categories: (a) scheduling and resource allocation (two papers), (b) cognitive, opportunistic, and cooperative communications (two papers), (c) multicast services (one paper), and (d) coverage and planning of small cells.

Among the two papers on 'scheduling and resource allocation,' the paper entitled 'A capacity and minimum guarantee-based service class-oriented scheduler for LTE

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networks' by Salman Ali, Muhammad Zeeshan and Anjum Naveed, deals with LTE scheduler design with service class-oriented QoS requirements. The proposed LTE scheduler takes advantage of best available channel conditions while maintaining data rates corresponding to minimum resources guaranteed for all major classes, including the best effort traffic class. It also proposes a method to determine the scheduling resource capacity of active users in LTE networks with an admission control scheme. In addition to closely matched theoretical and simulated active users, it also demonstrates promising results for system delay, throughput, and user mobility. The other paper entitled 'Dual-based bounds for resource allocation in zero-forcing beamforming OFDMA-SDMA systems' by Diego Perea-Vega, Andre Girard and Jean-Francois Frigon focuses on resource allocation for OFDMA-SDMA beamforming systems. Motivated by numerous heuristic proposals in the literature for a near-optimal solution to this NP-hard problem, the paper seeks to answer the fundamental question of how close these existing heuristics perform as compared to the optimum. This manuscript develops performance upper and lower bounds for such optimization, which can be used to evaluate the performance of all those heuristics. Interestingly, it is also shown that the bounds can be close to each other and therefore can be useful to develop a much better heuristic.

Among the two papers dealing with 'cognitive, opportunistic, and cooperative communications,' the paper entitled 'An opportunistic cognitive radio communication through the exploitation of the small-scale fading mechanisms of the LTE mobile channel' by Gerardo Agni Medina-Acosta, Jose Antonio Delgado-Penin, and Katsuyuki Haneda proposes the use of prior knowledge collected at the modern primary networks for the benefit of the cognitive radios. The work uses 3GPP LTE networks as the primary system providing the information that the cognitive radio transceiver will be using for opportunistic co-transmitting at specific moments through the licensed radio resources. It also outlines a novel model to overlay the secondary transmission whenever extreme channel conditions is found in the radio link of a particular primary user. The other paper, in this category, entitled 'Variable packet splitting transmission in multi-relay cooperative communications with DF and DAF for SC-FDMA' is co-authored by Yuta Ida, Chang-Jun Ahn, Takeshi Kamio, Hisato Fujisaka, and Kazuhisa Haeiwa. The paper proposes optimal packet splitting for co-operative relay methods with decode-and-forward (DF) and decode-amplify-forward (DAF).

The single paper in 'multicast services,' entitled 'A novel multicast scheme for feedback-based multicast services over wireless networks,' by Kyungho Sohn, Han-Seok Kim, and Young Yong Kim, points out the possible reduction of unnecessary channel quality indicator (CQI) feedback

and transmission optimization by dynamically adapting modulation and coding selection (MCS) level according to the variations of the channel state. It also depicts that system throughput can be significantly enhanced by dynamic MCS adaptation according to CQI variations and reduction of CQI feedback by switching between feedback and non-feedback modes, based on the channel receiver's channel conditions.

The single paper in 'coverage and planning of small cells,' entitled 'Cell range expansion using distributed Q-learning in heterogeneous networks' by Toshihito Kudo and Tomoaki Ohtsuki, addresses cell range expansion (CRE) technique to expand a pico cell range virtually by adding a bias value to the pico-received power. Many studies have focused on inter-cell interference coordination (ICIC) in CRE, because macro base station's (MBS's) strong transmit power harms the expanded region (ER) user equipments (UEs) that select PBSs by bias value. The optimal bias value that minimizes the number of outage UEs depends on several factors such as the dividing ratio of radio resources between MBSs and PBSs. In addition, it varies from UE to another. This paper proposes a scheme to determine the bias value of each UE by using Q-learning algorithm, where each UE learns its bias value that minimizes the number of outage UEs from its past experience independently. Simulation results point out that, compared to the scheme using optimal common bias value, the proposed scheme reduces the number of outage UEs and improves network throughput.

The Guest Editors would like to thank the authors of all papers submitted (both those that were accepted and those that, unfortunately, could not be included) for considering our special issue to disseminate their work. We also would like to warmly thank all the reviewers for their difficult and conscientious work and for the time they spent in reviewing. We also extend our thanks to the JWCN staff, in particular Bernardino McCartney, and to the JWCN Editor-in-Chief Luc Vandendorpe, for offering us the opportunity to present this special issue. We hope that the readers can use the research results presented in these papers to further enhance their knowledge for research and development in 4G wireless communication systems.

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