Saxena *et al. EURASIP Journal on Wireless Communications and Networking* 2013, **2013**:157
http://jwcn.eurasipjournals.com/content/2013/1/157

EURASIP Journal on Wireless Communications and Networking
a SpringerOpen Journal

EDITORIAL Open Access

Special issue on advances in 4G wireless and beyond

Navrati Saxena[1], Shamik Sengupta[2], Kai-Kit Wong[3] and Abhishek Roy[4*]

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 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

*Correspondence: abhishek.roy@samsung.com
[4]System Design Lab, Network Systems Division, Samsung Electronics, Suwon, South Korea
Full list of author information is available at the end of the article

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.

Authors' information

NS is an associate professor in the Electrical Engineering Department of the College of Information and Communication Engineering, Sungkyunkwan University, South Korea. During 2007 to 2011, she worked as assistant professor in the same university. Prior to that, she worked as an assistant professor in Amity University India and as a visiting researcher in the Computer Science and Engineering Department of the University of Texas at Arlington. She completed her Ph.D. degree from the Department of Information and Telecommunication, University of Trento, Italy. Her prime research interests involve 3G/4G wireless and ubiquitous/smart environments. She is serving as the Guest Editor of Springer *EURASIP Journal of Wireless Communications and Networking* and in the technical program committee of many international conferences. She has co-authored one book (published by

Taylor and Francis, USA) and published more than 20 international journals and more than 20 international conferences. She is a recipient of the Best Masters Award from Agra University, India.

SS is an assistant professor in the Department of Mathematics and Computer Science, John Jay College of Criminal Justice of the City University of New York. SS received his Ph.D. degree from the School of Electrical Engineering and Computer Science, University of Central Florida, Orlando in 2007. His research in wireless networking, cognitive radio networks, cybersecurity, covert networking, and interdisciplinary studies has been funded by the National Science Foundation (NSF), National Institute of Justice (NIJ), NY GRTI and PSC-CUNY. SS served as the vice-chair of Mobile Wireless Network (MobIG) special interest group of the IEEE COMSOC Multimedia Communications Technical Committee. He is in the organizing and technical program committee of various ACM/IEEE conferences and also serving editorial assignments in journals. SS is the recipient of IEEE Globecom 2008 Best Paper Award. He is also the recipient of NSF CAREER Award in 2012 (homepage: http://jjcweb.jjay.cuny.edu/ssengupta/).

KKW (Ph.D., HKUST 2001) is a reader in wireless communications at the Department of Electronic and Electrical Engineering, University College London (UCL). Prior to this, he took faculty positions at the University of Hong Kong and University of Hull and visiting positions at Alcatel-Lucent in Holmdel and the Smart Antenna Research Group at Stanford University. His research interests are in the areas of wireless communications and signal processing with particular emphasis on massive MIMO, cognitive radio, cooperative communications, and physical layer security. KKW is a senior member of IEEE and serves as senior editor of *IEEE Communications Letters* and editor for *IEEE Wireless Communications Letters*, *Physical Communication* (Elsevier), *IET Communications IEEE ComSoc/KICS Journal of Communications and Networks*, and *Journal of Optimization (Hindawi)*. He also has served as review editor of the *IEEE Communications Letters* from 2009 to 2012, associate editor of the *IEEE Signal Processing Letters* from 2009 to 2012, and editor of the *IEEE Transactions on Wireless Communications* from 2005 to 2011. In addition, he was a guest editor for the special issue on virtual MIMO for *IEEE Journal on Selected Areas in Communications* and the special issue on Advances in 4G Wireless and Beyond for *EURASIP Journal on Wireless Communications and Networking*.

AR is currently working in the System Design Lab of Networks Systems Division, Samsung Electronics in South Korea. He received his Ph.D. degree in 2010 from Sungkyunkwan University in the College of Information and Communication Engineering, M.S. degree in 2002 from the University of Texas at Arlington, USA, and B.E. degree in 2000 from Jadavpur University, India. His research interests include different mobility and resource management aspects of 4G wireless systems. He served as the lead guest editor of Springer *EURASIP Journal of Wireless Communications and Networking* and in the technical program committee of many international conferences. He has co-authored one book (published by Taylor and Francis, USA) and published more than 20 international journals and more than 20 international conferences. He is the recipient of Best Masters Award from the University of Texas, Arlington in 2002 and Employee of Excellence Award from Samsung Electronics in 2011.

Author details
[1]Electrical and Computer Engineering Department, Sungkyunkwan University, Suwon, South Korea. [2]Mathematics and Computer Science Department, John Jay College of Criminal Justice, City University of New York, New York, NY, USA. [3]Department of Electronic and Electrical Engineering, University College London (UCL), London, UK. [4]System Design Lab, Network Systems Division, Samsung Electronics, Suwon, South Korea.

Received: 15 April 2013 Accepted: 15 April 2013
Published: 10 June 2013

doi:10.1186/1687-1499-2013-157
Cite this article as: Saxena *et al.*: Special issue on advances in 4G wireless and beyond. *EURASIP Journal on Wireless Communications and Networking* 2013 **2013**:157.