Planning and optimization of wireless communication networks

Welcome to this special issue of Elsevier Journal of Physical Communication (PHYCOM). The goal of future wireless networks is to provide ubiquitous connections and to support high data rates. Recent standardizations of Wi-Fi, WiMAX, LTE, and LTE-Advanced technologies have been charging toward this direction, but significant breakthroughs are still required to meet the goal. Network planning and optimization faces many challenges arising from the use of new air interfaces and new technologies, the mix of voice, video and data traffic, the co-existence of different radio access technologies, and the growing importance of indoor coverage and paradigm shifts. Unless these challenges are properly addressed, future wireless networks cannot operate efficiently.

The aim of this special issue is to collect high-quality research papers from both the mobile communications industry and academia that present various aspects of the state of the art of wireless networks planning and optimization. To ensure the quality of this special issue, we have conducted a rigorous review process on all submissions, from which eight papers are selected and clustered into four groups: two papers on channel modeling, two on resource allocation and scheduling, two on performance analysis and simulations, and two papers on future wireless communications. Detailed overviews of these selected works are given below.

The first group addresses channel modeling. The first paper, written by Zhang et al., studies the wideband propagation characteristics of an indoor multi-floor environment. Statistics of path loss models and time dispersion parameters are abstracted to characterize indoor radio propagation. All of those results are tailored for the indoor network deployment and optimization. The paper by Jing et al. extends the WINNER II/+/3-D channel model by deriving an expression of array response for a polarized structure and Doppler shift induced by the vertical component of velocity. The distributions of the departure and arrival angle for the azimuth and elevation domains in both LOS and NLOS cases were evaluated. The system-level simulation results have showed a significant performance gain of 3D-Multiple Input Multiple Output (MIMO) over traditional 2D-transmission.

The second group mainly investigates MAC and network layer resource allocation and scheduling issues. The first of these papers, by Aydin et al., deals with the issue of multi-user radio resource scheduling on the downlink of a Long Term Evolution (LTE) cellular communications system. The results obtained by exploiting meta-heuristic methods such as Genetic Algorithm and Simulated Annealing approach near-optimal solutions with a significant reduction in complexity. The second paper, by Lu et al., studies inter-cell interference to improve inter-cell spectrum efficiency, including inter-cell interference randomization, inter-cell interference cancellation and inter-cell interference coordination. This paper analyzes three important inter-cell spectrum efficiency improvement technologies, namely, soft frequency reuse, uplink power control, and downlink coordinated multi-point transmission/reception.

The third group focuses on performance analysis and simulation aspects. The paper by Elayoubi et al. examines radio capacity simulation tools, and proposes a hybrid system simulation methodology that combines the advantages of system simulators in accurately modeling the physical/MAC interfaces with the robustness of queuing theory analysis to capture the flow dynamics. The second paper, by Sheikh et al., presents the performance analysis of Dual-Cell High Speed Downlink Packet Access (DC-HSDPA) plus MIMO supported by sophisticated power control using LTE integrated with adaptive MIMO switching. A simple approach of power allocation for DC-HSDPA in the downlink direction is presented in this paper, in which power resources are dynamically allocated to the users, irrespective of the number of code utilizations.

The fourth group explores future wireless communication systems. The first paper, by Papavassiliou et al., proposes a novel utility-based game theoretic framework to address the problem of joint transmission power and rate allocation in the uplink of a cellular wireless network. The introduced joint utility-based power and rate allocation framework, engineered with the adopted utility function in determining the optimal power and rate allocation, provides an enhanced flexible framework which can be used to uniformly facilitate multiple user services' diverse expectations in the next generation wireless networks. The last paper, by Wang et al., proposes two subspace-projection-based precoding schemes, namely, full- and partial-projection-based precoding, for a cognitive radio
(CR) MIMO network to mitigate its interference to a primary time-division-duplexing system. The proposed precoding schemes are capable of estimating interference channels between CR and primary networks, and incorporating the interference from the primary to the CR system into CR precoding via a novel sensing approach.

In conclusion, this issue of PHYCOM offers a state-of-the-art view into recent advances in wireless planning and optimization, and also attempts to cover advances of wireless communications that tackle the research challenges particularly arising from the adoption of new technologies. This issue also offers both academic and industry appeal—the former as a basis toward future research directions and the latter toward viable industrial commercialization.

Finally, we would like to thank all the authors who have submitted their papers for consideration for publication in this issue. We are grateful to the anonymous reviewers who spent much of their precious time in reviewing all submissions. Their timely reviews and comments greatly helped us select the best papers for inclusion in this special issue. We would also like to thank the devoted staff of Physical Communication for professionalism, and particularly express our gratitude to the Editor-in-Chief of PHYCOM, Professor Ian Akyildiz, for his advice, patience, and encouragement from the beginning until the final stage.

We hope you will enjoy reading the great selection of papers in this issue.

Lingyang Song (Professor/Ph.D.) received his Ph.D. from the University of York, UK, in 2007, where he received the K.M. Stott Prize for excellent research. He worked as a postdoctoral research fellow at the University of Oslo, Norway, and Harvard University, until rejoining Philips Research UK in March 2008. In May 2009, he joined the School of Electronics Engineering and Computer Science, Peking University, China, as a full professor. His main research interests include cooperative and cognitive communications, physical layer security, and mobile social networks. He is co-inventor of a number of patents (standard contributions), and author or co-author of over 100 journal and conference papers. He received the best paper award in the IEEE International Conference on Wireless Communications, Networking and Mobile Computing (WiCOM 2007), the best paper award in the First IEEE International Conference on Communications in China (ICCC 2012), the best student paper award in the 7th International Conference on Communications and Networking in China (ChinaCom2012), the best paper award in the IEEE International Conference on Wireless Communications and Signal Processing (WCSP 2012), and the best paper award in the IEEE Wireless Communication and Networking Conference (WCNC2012). He is currently on the editorial board of IEEE Transactions on Wireless Communications and IET Communications. Song is the recipient of the 2012 IEEE Asia Pacific (AP) Young Researcher Award, and 2012 NSFC Outstanding Young Investigator Award. He is a senior member of IEEE.

Jie Zhang received his M.Eng. and Ph.D. degrees from the Department of Automatic Control and Electronic Engineering, East China University of Science and Technology, Shanghai, China. From the beginning of 1997 to the end of 2001, he was a postdoctoral Research Fellow with the Department of Electronic and Electrical Engineering, University College London (UCL), Centre for Process Systems Engineering, Imperial College London, the Department of Engineering Science, Oxford University, and a Software Engineer with Aircom.

From Jan. 2002 to Jan. 2011, he was with the Department of Computer Science and Technology, University of Bedfordshire (Uob), UK, first as a Senior Lecturer, then becoming Reader in Wireless Communications and Professor of Wireless Communications and Networks in 2005 and 2006 respectively. He is an Area Editor of Computer Communications (Elsevier) and an Associate Editor of Telecommunication Systems (Springer).

Yan Zhang received a Ph.D. degree from Nanyang Technological University, Singapore. From August 2006, he has been working with Simula Research Laboratory, Norway. He is currently senior research scientist at Simula Research Laboratory, Norway. He is an adjunct Associate Professor at the University of Oslo, Norway. He is on the editorial board, or guest editor of a number of international journals. His research interests include wireless networks and smart grid communications.

Nirwan Ansari received the B.S.E.E. (summa cum laude with a perfect GPA) from the New Jersey Institute of Technology (NJIT), the M.S.E.E. degree from the University of Michigan, Ann Arbor, and the Ph.D. degree from Purdue University, West Lafayette. He joined NJIT’s Department of Electrical and Computer Engineering as Assistant Professor in 1998, and has been Full Professor since 1997. He has also assumed various administrative positions at NJIT. He has been Visiting (Chair) Professor at several universities. His current research focuses on various aspects of broadband networks and multimedia communications. He authored Media Access Control and Resource Allocation for Next Generation Passive Optical Networks (Springer, 2013) with J. Zhang, Computational Intelligence for Optimization (Springer, 1997, translated into Chinese in 2000) with E.S.H. Hou, and edited Neural Networks in Telecommunications (Springer, 1994) with B. Yuhas. He has contributed over 450 technical papers, over one third of which were published in widely cited refereed journals/magazines. He has also guest-edited a number of special issues, covering various emerging topics in communications and networking. Ansari has served on the Editorial Board and Advisory Board of nine journals, including as a Senior Technical Editor of the IEEE Communications Magazine (2006–2009). He was elected to serve in the IEEE Communications Society (ComSoc) Board of Governors as a member-at-large (2013–2015). He has chaired ComSoc technical committees, and has been actively organizing numerous IEEE International Conferences, assuming various leadership roles. Some of his recognitions include IEEE Fellow (ComSoc, Class of 2009), several Excellence in Teaching Awards, IEEE MGA Leadership Award (2008), a couple of best paper awards, Thomas Alva Edison Patent Award (2010), NJ Inventors Hall of Fame Inventor of the Year Award (2012), Outstanding Service Recognition Award (2013, ComSoc Ad Hoc and Sensor Network Technical Committee), and designation as an IEEE Communications Society Distinguished Lecturer (2006–2009, two terms). He has also been granted over twenty US patents.

Shaohui Sun was born in Shaoguan, Guangdong, China, in 1972. He received the M.S. degree in computer engineering and Ph.D. degree in communication and information systems from XiDian University, Xi’an, China, in 1999 and 2003, respectively. From March 2003 to June 2006, he was a postdoctoral fellow with the China Academy of Telecommunication Technology, Beijing, China. From June 2006 to December 2010, he was with the Datang Mobile Communications Equipment Company Ltd., Beijing, where he has been deeply involved in the development and standardization of the Third-Generation Partnership Project Long-Term Evolution (3GPP LTE). Since January 2011, he has been the Chief Technical Officer with Datang Wire-
less Mobile innovation Center of the China Academy of Telecommunication Technology. Now, his research area of interest includes multiple antenna technology, heterogeneous wireless networks, and relays.

Guest Editors
Lingyang Song*
Peking University, China
E-mail address: lingyang.song@gmail.com.

Jie Zhang
University of Sheffield, United Kingdom

Yan Zhang
Simula Research Laboratory and University of Oslo, Norway
E-mail address: yanzhang@ieee.org.

Nirwan Ansari
New Jersey Institute of Technology, United States

Shaohui Sun
China Academy of Telecommunication Technology (CATT), China

Available online 29 August 2013

* Corresponding editor.