5G WIRELESS COMMUNICATION SYSTEMS: PROSPECTS AND CHALLENGES PART 2


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In the February 2014 issue of *IEEE Communications Magazine*, the first part of this Feature Topic included nine articles that covered the range of visions for fifth generation (5G) wireless systems. This technology is expected to be standardized and deployed in the next five to ten years. This part of the Feature Topic will address in more detail many technical issues and technology approaches for 5G systems.

The issue starts with two overview articles on 5G use cases and technology developments. The first, "Scenarios for 5G Mobile and Wireless Communications: The Vision of the METIS Project" comes from a large European research project, METIS, addressing 5G communications technology. It describes some of the new use cases that are likely to arise in 5G wireless networks as well as some of the key technologies and concepts that will be used. The second article, from the Chinese Academy of Telecommunications Technology, "The Requirements, Challenges and Technologies for 5G of Terrestrial Mobile Telecommunication," provides an overview of 5G systems from a Chinese perspective. The article foresees that small cells will become a major part of future wireless networks, alongside current macrocells, in order to meet the high traffic growth projections.

The next two articles address improvements in data capacity for 5G wireless, particularly through interference mitigation. "The Role of Small Cells, Coordinated Multipoint, and Massive MIMO in 5G" from Fraunhofer in Germany shows how capacity improvements can be achieved through further improvements in multiple antenna technology, particularly cooperative multipoint (COMP) and large antenna arrays or massive multiple-input multiple-output (MIMO) technology. This article also foresees small cells as a major part of future networks. The next article, "Advanced Interference Management for 5G Cellular Networks" from Samsung, takes a complementary approach by considering the potential gains of improving interference cancellation at the user terminal side.

The following two articles address network coordination and optimization of 5G networks. The article from the Shanghai Research Center on Wireless Communications in China, addresses "Cooperative Distributed Optimization for the Hyper-Dense Small Cell Deployment." Given that many articles in this Feature Topic highlight small cells as important, this article describes how small cells may optimize their performance through simple algorithms that only require local communications among neighboring small cell devices. The next article, from the European iJOIN project, discusses the alternative cloud radio access network (Cloud-RAN) approach, where high-speed backhaul links connect many base station antennas to a centralized processor farm, which can perform joint processing of all radio signals.

Another important topic addressed in the next two articles relates to innovative use of radio spectrum for 5G systems. The article "Accelerating 5G QoE via Public-Private Spectrum Sharing" from Federated Wireless in the United States, discusses how spectrum may be shared between mobile operators and other licensed spectrum users in order to meet traffic growth projections. The next article, "Device-to-Device (D2D) Communication in 5G Cellular Networks: Challenges, Solutions, and Future Directions" from the University of Waterloo in Canada, addresses innovative sharing of spectrum between cellular and direct device-to-device communications. The article describes some of the difficulties toward, and pricing solutions to enable, D2D adoption.

The final article, "An Energy- and Spectrum-Efficient Wireless Heterogeneous Network Framework for 5G Systems" from Utah State University in the United States, addresses a key trade-off that is expected in 5G systems between spectrum efficiency and energy efficiency. The article considers a heterogeneous network with different cell types and studies the trade-off between higher capacity and better energy efficiency.

In closing, the Editors would like to thank Editor-in-Chief Sean Moore, the IEEE Comsoc magazine staff, and all of the authors and reviewers who enabled this exciting Feature Topic to come to fruition.

BIOGRAPHIES

JOHN THOMPSON (john.thompson@ed.ac.uk) currently holds a personal Chair in Signal Processing and Communications at the School of Engineering at the University of Edinburgh. He specializes in antenna array processing, cooperative communications systems, and energy-efficient wireless communications. His work in these areas is highly cited, and his h-index is currently 18 according to the Web of Science. He is an elected Member-at-Large for the Board of Governors of the IEEE Communications Society from 2012–2014, the second largest IEEE Society. He was a Technical Program Co-Chair for the 2013 IEEE Vehicular Technology Spring Conference in Dresden, Germany, and serves as a track chair on Green Communications for the 2014 IEEE ICC in Sydney, Australia. He is Lead Editor for this Feature Topic.

XIAOHU GE is currently a professor with the Department of Electronics and Information Engineering at Huazhong University of Science and Technology (HUST), China. He received his Ph.D. degree in communication and information engineering from HUST in 2003. He has worked at HUST since November 2005. His research interests are in the area of mobile communications, traffic modeling in wireless networks, green communications, and interference modeling in wireless communications. He has published about 80 papers in refereed journals and conference proceedings, and has been granted about 15 patents in China. He is leading several projects funded by NSFC, China MOST, and industry. He is taking part in several international joint projects, such as the RCUK funded UK-China Science Bridges: R&D on (B)4G Wireless Mobile Communications.

HSIAO-CHUN WU received his B.S.E.E. degree from National Cheng Kung University, Tainan, Taiwan, in 1990, and M.S. and Ph.D. degrees in electrical and computer engineering from the University of Florida, Gainesville, in 1993 and 1999, respectively. From March 1999 to January 2001, he was with Motorola Personal Communications Sector Research Laboratories as a senior electrical engineer. Since January 2001, he has been with the faculty of the School of Electrical Engineering and Computer Science, Louisiana State University, Baton Rouge. He has published more than 170 peer-refereed technical journal and conference articles in electrical and computer engineering. His current research interests include the areas of wireless communications and signal processing. He is an IEEE Distinguished Lecturer and is currently an Associate Editor for several IEEE journals.

RALF IRMER is currently leading Wireless Access Research in Vodafone Group R&D, United Kingdom. He received his Dr.-Ing. (Ph.D.) degree from Technische Universität Dresden in 2005 after studies in Dresden and Edinburgh. He joined Vodafone in 2005, where his major achievements were working with Verizon Wireless, China Mobile, and others to make LTE a global standard meeting operator requirements. He defined the WiFi and small cell strategies and the future wireless network blueprint for Vodafone. He was also responsible for proving key strategies in pre-commercial trials, such as LTE TDD, LTE-Advanced, and 3G/LTE/WiFi small cells including backhaul. He currently leads the 5G activities in Vodafone. He holds several patents, and has published over 30 conference and journal publications, covering coordinated multipoint, multiuser MIMO, relaying, heterogeneous networks, and quality of user experience.

HONG JIANG is a researcher and project leader with Alcatel-Lucent Bell Labs, Murray Hill, New Jersey. He received his B.S. degree from Southwest Jiaotong University, Chengdu, China; his Master's degree in mathematics from the University of Waterloo, Canada; and his Ph.D. from the University of Alberta, Canada. His research interests include signal processing, digital communications, and image and video compression. He invented key algorithms for VSB demodulation and HDTV video processing in the first generation ATSC system, which won a Technology and Engineering Emmy Award. He pioneered hierarchical modulation for satellite communication that resulted in commercialization of video transmission. He has published more than 50 articles in peer-reviewed scientific and engineering journals, and more than 40 U.S. patents in digital communications and video processing.

GERHARD FETTWEIS [F] earned his Ph.D. under H. Meyr's supervision from RWTH Aachen in 1990. After one year at IBM Research in San Jose, California, he moved to TCSI Inc., Berkeley, California. Since 1994 he is Vodafone Chair Professor at the Technical University of Dresden (TU Dresden), Germany, with 20 companies from Asia, Europe, and the United States currently sponsoring his research on wireless transmission and chip design. He coordinates two DFG centers at TU Dresden, cfAED, and HAEC. He is a member of acatech, has an honorary doctorate from TU Tampere, and has received multiple awards. In Dresden he has spun out 11 startups, and set up funded projects of close to €0.5 billion volume. He has helped organize IEEE conferences, most notably as TPC Chair of IEEE ICC 2009 and IEEE TTM 2012, and General Chair of VTC Spring 2013 and DATE 2014.

SIAVASH ALAMOUTI received B.A.Sc. and M.A.Sc. degrees in electrical engineering from the University of British Columbia. He is currently an independent entrepreneur helping to build new companies with a focus on mobile personalization. He was group R&D director for Vodafone from March 2010 until September 2013. Before that he was an Intel Fellow and CTO of the Mobile Wireless Group. Prior to joining Intel in 2004, he was the CTO of Vivato, and held various positions at Cadence, AT&T, and MPR Teltech. He is most well known for the invention of the Alamouti Code.