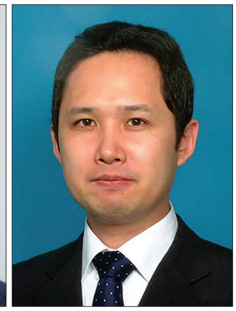
LTE-Advanced Pro: Part 3


Robert W. Heath Jr.


Michael Honig


Satoshi Nagata


Stefan Parkvall


Anthony C. K. Soong

The mobile Internet that will be enabled by LTE-Advanced Pro and the way in which we interact with it will change significantly within the next few years. From a usage point of view, it is anticipated that by 2020, each person, globally speaking, will consume on average as much as 5 GB of data each month, in addition to the traffic generated by 20–30 billion connected things. More significantly, not only will the mobile network be significantly faster, but even more applications will become possible. The video experience will be improved globally; mobile virtual reality will be available; networked vehicles and perhaps self-driving cars will roam our streets; the Internet of Things will enrich and make our lives more productive; and a mobile cloud will allow access to our data anytime, anywhere.

The requirements to support the anticipated applications can be classified into three main types: higher speed, massive connections, and low latency. Applications such as virtual reality and 4k video will boost the demand for network capacity beyond 1 Gb/s [1]. Massive connectivity on the order of 1000 connections per cell will be required for IoT [2]. Industry 4.0, enabled by cyber physical systems, will need to control physical equipment, and real-time cooperation will require end-to-end latency of less than 10 ms.

2016 will be pivotal in the development of LTE-Advanced Pro networks. Mainstream global operators have unveiled large-scale deployments with over 100 networks expected to be operational by the end of the year [3]. Already by the end of 2015, over 1 Gb/s transmissions rates were demonstrated in numerous commercial networks, and many countries have started pre-commercial deployments of IoT services.

This third and concluding part of the LTE-Advanced Pro Feature Topic presents several articles on potential technologies that will help to meet the above mentioned expected demand for network capacity.

The first article provides a review of the recent results on advanced coordinated beamforming techniques with less overhead than joint transmission CoMP. The discussion focuses on assessing the resilience of these schemes to uncoordinated interference. The article identifies key roadblocks and research directions to address.

The second article elucidates the multi-carrier ultra-dense network for LTE-Advanced Pro. Key advanced carrier aggregation technologies such as carrier switching and dynamic on/off are discussed, and performance benefits are demonstrated based on numerical simulations.

The third article discusses several key techniques for non-orthogonal transmission. Multi-user superposition transmission is proposed for the downlink, while multi-user shared access and sparse coded multiple access schemes are promising for the uplink. MIMO techniques for non-orthogonal transmissions are also considered.

The fourth article addresses the flexible use of spectrum in the future to increase the usage efficiency of radio spectrum. In particular, the business and technology enablers for sharing the ultra high frequency broadcasting spectrum with digital terrestrial TV and mobile broadband are reviewed. The results indicate that the scale, cost synergies, adaptability to regulatory regimes, and differentiation regarding user orientation inherent in the LTE standard are critical for flexible spectrum usage.

In the fifth article, the authors propose a unified traffic steering framework as an approach for orchestration of various traffic steering related issues that impact scheduling decisions for mobile data requests. The approach assumes awareness of the traffic demand and the ability to optimize power consumption in heterogeneous networks.

The last article in this Feature Topic discusses the trends and challenges in wireless channel modeling, which are foundational to system evaluation. Key drivers for new channel models are given, and new trends in channel modeling are reviewed. The article concludes with remarks on the paths taken to resolve current issues.

As is clear from this Feature Topic, LTE-Advanced Pro will be a significant evolution of LTE while maintaining good support for legacy user equipment. The key technologies leading to a more powerful network that provides enhanced user experience on capacity and latency will still be orthogonal frequency-division multiplexing-based but with evolution in the directions of flexible spectrum utilization, service extension, network optimization, massive multiple-input multiple-output and massive carrier aggregation. With the enhancements discussed within this Feature Topic, users will be able to enjoy a rich experience with ultra high definition voice and video, virtual reality shopping, and maybe even virtual reality social networking. Such a network will allow for a quantum leap in the human-machine interface. Together with artificial intelligence, the promise of seamless and almost magical connections between systems and humans can finally be realized. Moreover, the integration of different systems will bring unprecedented productivity gain to mankind. It will usher in the anywhere, anytime, hyper-connected world of our near future.

Finally, the Guest Editors would like to thank the many reviewers and the IEEE publications staff for their support. Without their hard work, this Feature Topic would not have been possible.

REFERENCES

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BIOGRAPHIES

ROBERT W. HEATH JR. is a Cullen Trust Endowed Professor in the Department of Electrical and Computer Engineering at the University of Texas at Austin and a member of the Wireless Networking and Communications Group. He received his Ph.D. in electrical engineering from Stanford University. He is a co-author of the book *Millieter Wave Wireless*. His current research interests include millimeter-wave for 5G, cellular system analysis, communication with low-resolution ADCs, and vehicle-to-X systems.

MICHAEL HONIG (mh@eecs.northwestern.edu) is a professor in the Department of Electrical Engineering and Computer Science at Northwestern University. He received his B.S. degree in electrical engineering from Stanford University in 1977, and his Ph.D. degree in electrical engineering from the University of California, Berkeley, in 1981. Prior to joining Northwestern he worked at Bellcore in the Systems Principles Research Division. His recent research has focused on resource allocation for wireless networks and spectrum markets.

SATOSHI NAGATA received his B.E. and M.E. degrees from Tokyo Institute of Technology, Japan. He joined NTT DoCoMo, Inc., and worked on the research and development of wireless access technologies for LTE and LTE-Advanced. He is currently working on 5G and 3GPP standardization. He has contributed to 3GPP for many years, and contributed to 3GPP TSG-RAN WG1 as a Vice Chairman. He has been Chairman of 3GPP TSG-RAN WG1 since 2013.

STEFAN PARKVALL [S'92, M'96, SM'05] is a principal researcher at Ericsson Research, active in the area of 5G research and 3GPP standardization. He received his Ph.D. degree from the Royal Institute of Technology in 1996, served as an IEEE Distinguished Lecturer 2011–2012, and co-authored several popular books such as *4G-LTE/LTE-Advanced for Mobile Broadband*. He received the Ericsson Inventor of the Year award and the Swedish government's Major Technical Award for contributions to HSPA, and was nominated for the European Inventor Award for contributions to LTE.

ANTHONY C. K. SOONG [S'88, M'91, SM'02, F'14] (anthony.soong@huawei.com) is the chief scientist for wireless research and standards at Huawei Technologies Co. Ltd., in the United States. His research group is active in the research, development, and standardization of the next generation cellular system. He has published numerous scientific papers and has over 90 patents granted or pending. He received his Ph.D. from the University of Alberta, and the 2013 IEEE Signal Processing Society Best Paper Award and 3GPP2 2005 Award of Merit.