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Recent Advances in Cloud Radio Access Networks
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IEE ACCESS SPECIAL SECTION EDITORIAL: RECENT ADVANCES IN CLOUD RADIO ACCESS NETWORKS

The demand for high-speed data applications, such as high-quality wireless video streaming, social networking, and machine-to-machine communication, has been growing explosively over the past 20 years and it is envisioned that asymmetric digital subscriber line-like user experience will be supported in the next generation wireless networks. The fifth generation (5G) system deployed initially in 2020 is expected to provide about 1000 times higher wireless area capacity and save up to 90% of energy consumption per service compared with the current 4G system. Furthermore, more than 1000-Gb/s/km² area spectral capacity in dense urban environments, 10 times higher battery life time of connected devices, and 5 times reduced end-to-end latency are expected in 5G systems. To meet such challenging goals, there is an urgent need for a revolutionary approach involving new wireless network architectures, as well as advanced signal processing and networking technologies.

The cloud radio access network (C-RAN) has emerged as a promising direction for providing high energy efficiency together with gigabit data rates across the software defined wireless communication networks. The virtualizations of the communication hardware and software elements are giving new challenges to the communication networks and protocols, especially when the large-scale cooperative signal processing and cooperative networking are centralized and cloud computed. Although the cloud computing technologies have been thoroughly investigated for the data computing networks, such as the software defined network and the Internet of Things, less attention has been devoted to the aspects of radio access virtualizations, including the signal processing in the physical layer, scheduling and resources allocation in the medium access control (MAC) layer, and self-organizing and radio resources managements in the network layer.

By bringing together academic and industrial researchers to identify and discuss technical challenges and recent results related to C-RANs, this Special Section aims to attract the attention of the academic and industrial communities for developing advanced and innovative methodologies and techniques of C-RANs. We have received a total of 11 original submissions, out of which 5 papers plus 1 invited paper were accepted for publication after peer reviewing. We regret that we were not able to accept the many other good papers due to the limited number of papers that can be published within this Special Section.

The invited paper entitled “Sparse Beamforming and User-Centric Clustering for Downlink Cloud Radio Access Network” by B. Dai et al. investigates the user scheduling, radio remote head (RRH) clustering and beamforming design problem with the per-Base Station (BS) backhaul capacity constraints from a network utility maximization perspective, in which two different models depending on whether the BS clustering for each user is dynamic or static over different user scheduling time slots are considered. Furthermore, the asymptotic extraction approach is presented when the source and field points are located in the same layer and different layers.

In a paper entitled “Recent Progress on C-RAN Centralization and Cloudification” by H. I et al., the authors present the latest progress on C-RANs in the areas of centralization and virtualization. Particularly, the major challenges for C-RAN, including fronthaul and virtualization, are analyzed with potential solutions proposed. Extensive field trials verify the viability of various fronthaul solutions, including CPRI compression, single fiber bidirection, and wavelength-division multiplexing.

A paper entitled “Potentials and Challenges of C-RAN Supporting Multi-RATs Towards 5G Mobile Networks” by R. Wang et al. discusses the ultradense network deployment based on C-RANs with focuses on flexible backhauling, automated network organization, and advanced mobility management. In addition, the long-term coexistence of multiple radio access technologies (multi-RATs) is considered, and some directions and preliminary thoughts for future CRAN-supporting multi-RATs are discussed, including joint resource allocation, mobility management, as well as traffic steering and service mapping. Another paper entitled “Cloud-RAN Architecture for Indoor DAS” by Y. Beyene et al. proposes the practical implementation of C-RANs running on an off-the-shelf server in order to validate the flexibility of the architecture. Furthermore, the C-RAN implementation is able to realize various cellular networks including heterogeneous networks, distribute-antenna systems and transmission schemes, such as, transmit antenna selection, and open-loop transmit diversity.

In a paper entitled “Security and Reliability Performance Analysis for Cloud Radio Access Networks with Channel Estimation Errors” by J. You et al., both security and reliability performance for the downlink C-RANs with the optimal...
RRH selection are investigated in a practical scenario by considering channel estimation (CE) errors. Specifically, a three phase transmission scheme is proposed and the linear minimum mean-square error estimation method is utilized to obtain the CSI. Based on the CSI estimates and the statistics of CE errors, the outage probability and intercept probability are derived in closed-form expression to evaluate the security and reliability performance, respectively.

To discuss the data sources in the cloud computing-based architecture, a paper entitled “Compressed Vision Information Restoration Based on Cloud Prior and Local Prior” by F. Jiang et al. presents a compressed vision information restoration method based on two explored vision priors: 1) the cloud prior and 2) the local prior. In addition, an enhanced quantization constrained projection algorithm is proposed to refine the high-frequency components. The experiment results demonstrate that the proposed scheme can reproduce higher quality images compared to conventional H.264/AVC.

Before the end of this editorial, we would like to thank the anonymous reviewers for their great efforts in reviewing the submitted manuscripts, without which this Special Issue would not have been published as scheduled. We would also like to thank the Managing Editor, B. M. Onat, and M. Meyer, for their supportive guidance during the whole process in the organization of this Special Section.

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MUGEN PENG (M’05–SM’11) received the B.E. degree in electronics engineering from the Nanjing University of Posts and Telecommunications, Nanjing, China, in 2000, and the Ph.D. degree in communication and information systems from the Beijing University of Posts and Telecommunications (BUPT), Beijing, China, in 2005. After the Ph.D. graduation, he joined BUPT, where he has been a Full Professor with the School of Information and Communication Engineering since 2012. In 2014, he was an Academic Visiting Fellow with Princeton University, Princeton, NJ, USA. He leads a Research Group focusing on wireless transmission and networking technologies with the Key Laboratory of Universal Wireless Communications (Ministry of Education), BUPT. His main research areas include in wireless communication theory, radio signal processing, and convex optimizations, with a particular interests in cooperative communication, radio network coding, self-organization networking, heterogeneous networking, and cloud communication. He has authored or co-authored over 40 refereed IEEE journal papers and over 200 conference proceeding papers.

Dr. Peng is currently on the Editorial/Associate Editorial Board of the IEEE Communications Magazine, the IEEE Access, IET Communications, the International Journal of Antennas and Propagation, China Communication, and the International Journal of Communications System. He has been the leading Guest Editor of the special issues on the IEEE Wireless Communications Magazine, the International Journal of Antennas and Propagation, and the International Journal of Distributed Sensor Networks. He was a recipient of the 2014 IEEE ComSoc AP Outstanding Young Researcher Award, and the best paper award in GameNets 2014, CIT 2014, ICCTA 2011, ICBNMT 2010, and IET CCWMC 2009. He received the First Grade Award of the Technological Invention Award in the Ministry of Education of China for the hierarchical cooperative communication theory and technologies, and the Second Grade Award of Scientific and Technical Progress from the China Institute of Communications for the co-existence of multiradio access networks and the 3G spectrum management.
CHIH-LIN I received the Ph.D. degree in electrical engineering from Stanford University, Stanford, CA, USA. She is currently the Chief Scientist of Wireless Technologies with the China Mobile Research Institute (CMRI), Beijing, China, in charge of advanced wireless communication research and development effort. She established the Green Communications Research Center, CMRI, spearheading major initiatives, including 5G key technologies research and development, high-energy efficiency system architecture, technologies, and devices, green energy, C-RAN, and soft base station. She has over 30 years of experience in wireless communication technical domain. She has worked in various world-class companies and research institutes, including the Department of Wireless Communication Fundamental Research with AT&T Bell Labs, Murray Hill, NJ, USA, as the Director of Wireless Communications Infrastructure and Access Technology, the Industrial Technology Research Institute, Hsinchu, Taiwan, as the Director of Wireless Communication Technology, and the Hong Kong Applied Science and Technology Research Institute, Hong Kong, as the Vice President and the Founding GD of Communications Technology Domain.

Dr. I was a recipient of the IEEE TRANSACTIONS ON COMMUNICATIONS Stephen Rice Best Paper Award, and a winner of CCCP National 1000 talent program. She was an elected Board Member of the IEEE ComSoc, the Chair of the ComSoc Meeting and Conference Board, and the Founding Chair of the IEEE WCNC Steering Committee. She is the Chair of FUTURE FORUM 5G SIG, an Executive Board Member of GreenTouch, a Network Operator Council Member of ETSI NFV, and an Adjunct Professor with the Beijing University of Posts and Telecommunications, Beijing, China. She has shown frequent presence in many important and high-level public occasions for speech delivery. She is often invited as a Keynote Speaker for diverse audience from academia, industry, and governments. She is very active in many venues, such as conferences, summits, workshops, and panels. This year she has delivered nearly 30 speeches in lots of events, such as the IEEE WCNC, the IEEE ICC, the IEEE VTC, the IEEE PIMRC, and the Global Professional Services Forum, which included a 3-h long tutorial on C-RAN in Cloud RAN Conference in Paris.

CxEE-WEE TAN (M’08–SM’12) received the M.A. and Ph.D. degrees in electrical engineering from Princeton University, Princeton, NJ, USA. He is currently an Assistant Professor with the City University of Hong Kong, Hong Kong. He was a Post-Doctoral Scholar with the California Institute of Technology, Pasadena, CA, USA. His industrial experience includes corporate research at the Fraser Research Laboratory, Princeton, and Qualcomm Research and Development Center, San Diego, CA, USA. His research interests are in networks, inference in online large data analytics, smart grid, mobile computing, optimization theory, and its applications. He was a recipient of the 2008 Princeton University Wu Prize for Excellence and the 2011 IEEE Communications Society Asia-Pacific Young Researcher Award. He was selected as a participant with the U.S. National Academy of Engineering 2013 China-America Frontiers of Engineering Symposium. He currently serves as the Chair of the IEEE Information Theory Society Hong Kong Chapter and an Editor of the IEEE TRANSACTIONS ON COMMUNICATIONS.

CHUAN HUANG (S’09–M’13) received the Ph.D. degree in electrical engineering from Texas A&M University, College Station, TX, USA, in 2012. He is currently a Faculty Member with the National Key Laboratory of Science and Technology on Communications, University of Electronic Science and Technology of China, Chengdu, China. He was a Post-Doctoral Research Fellow and then promoted to Assistant Research Professor with Arizona State University, Tempe, AZ, USA. He was a Visiting Scholar with the National University of Singapore, Singapore, and Princeton University, Princeton, NJ, USA, respectively. His current research interests include energy harvesting communications, multicast traffic scheduling, and information theoretic studies and signal processing in wireless communications.