Guest Editorial
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Multiple Access Techniques for 5G

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YUAN Jinhong received his BE and PhD degrees in electronics engineering from Beijing Institute of Technology in 1991 and 1997. From 1997 to 1999, he was a research fellow at the School of Electrical Engineering, University of Sydney, Australia. In 2000, he joined the School of Electrical Engineering and Telecommunications, University of New South Wales, Australia, and is currently a professor of telecommunications there. Dr. Yuan has authored two books, three book chapters, and more than 200 papers for telecom journals and conferences. He has also authored 40 industry reports. He is a co-inventor of one patent on MIMO systems and two patents on low-density parity-check (LDPC) codes. He has coauthored three papers that won Best Paper Awards or Best Poster Awards. Dr. Yuan served as the NSW Chair of the joint Communications/Signal Processions/Ocean Engineering Chapter of IEEE during 2011–2014. He is an IEEE fellow and an associate editor for *IEEE Transactions on Communications*. His research interests include error-control coding and information theory, communication theory, and wireless communications.

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XIANG Jiying, PhD, is the Chief Scientist of ZTE Corporation. His research is focused on 3G, 4G, 5G, and multi-mode wireless infrastructure technologies. He led the development of the first commercial SDR base station in the industry in 2007. He proposed the first solution that support COMP on non-ideal backhaul (also called Cloud Radio) in 2012. In 2014, he proposed the "pre-5G" conception, which includes massive MIMO, D-MIMO, MUSA, and UDN. Pre-5G allows 5G-like user experience on legacy 4G handsets.

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YUAN Zhifeng received his MS degree in signal and information processing from Nanjing University of Post and Telecommunications, China in 2005. He has been working at the Wireless Technology Advance Research Department, ZTE Corporation since 2006 and as the leader of the New Multi-Access (NMA) for 5G Wireless System Team since 2012. His research interests include wireless communications, MIMO systems, information theory, multiple access, error control coding, adaptive algorithm, and high-speed VLSI design.

Over the past few decades, wireless communications have advanced tremendously and have become an indispensable part of our lives. Wireless networks have become more and more pervasive in order to guarantee global digital connectivity. Wireless devices have quickly evolved into multimedia smartphones running applications that demand high-speed and high-quality data connections. The upcoming fifth generation (5G) mobile cellular networks are required to provide significant increase in network throughput, cell-edge data rates, massive connectivity, superior spectrum efficiency, high energy efficiency and low latency, compared with the currently deployed long-term evolution (LTE) and LTE-advanced networks. To meet these demanding challenges of 5G networks, innovative technologies on radio air-interface and radio access network (RAN) are of great importance in PHY designs. Recently non-orthogonal multiple access (NOMA) has attracted increasing research interests from both academic and industrial fields as a potential radio access technique. A few examples include multiuser shared access (MUSA), sparse code multiple access (SCMA), resource spread multiple access (RSMA) and pattern division multiple access (PDMA) proposed by ZTE, Huawei, Qualcomm, DTmobile, etc. In the mean time, multicarrier (MC) technologies that divide frequency spectrum into many narrow subchannels, such as filter bank multicarrier (FBMC) and generalized frequency division multiplexing (GFDM), become attractive and new concepts for dynamic access spectrum management and cognitive radio applications.

With these new developments, this special issue is dedicated to multiple access transmission technologies and

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related for 5G cellular mobile communications. The main focus is on the cutting-edge research, review and application on non-orthogonal multiple access and related signal processing and coding methods for the air-interface of 5G enhanced mobile broadband (eMBB), mMTC, and ultra reliable and low latency communication (URLLC). Papers for this issue were invited, and after peer review, six were selected for publication. The selected papers cover reviews of various uplink and downlink NOMA schemes, novel designs for MIMO-FBMC systems, review and new designs on multiple access technologies for cellular M2M communications and IoT applications. This issue is intended to be a timely, high-quality forum for scientists and engineers.

In "Evaluation of Preamble Based Channel Estimation for MIMO-FBMC Systems" by Taheri, Ghoraishi, XIAO, CAO and GAO, the authors discuss a candidate waveform design for future wireless communications based on MIMO-FBMC and tackle the challenging problem of channel estimation facing the waveform design. Specifically, they propose a novel channel estimation method which employs intrinsic interference cancellation at the transmitter side. Their research results demonstrate that the proposed novel technique incurs less pilot-overhead compared to the well-known intrinsic approximation methods (IAM). In addition, it also has a better PAPR, BER and MSE performance.

In "Non-Orthogonal Multiple Access Schemes for 5G," YAN, YUAN, LI, and YUAN provide a comprehensive review of six potential multiple access schemes for 5G, including MUSA, RSMA, SCMA, PDMA, interleaver-division multiple access (IDMA) and NOMA. The principles, advantages and disadvantages of these multiple access schemes are discussed. More importantly, this review offers a comprehensive comparison of these solutions from the perspective of user overload, receiver type, receiver complexity, performance and grant-free transmission.

In "A Survey of Downlink Non-Orthogonal Multiple Access for 5G Wireless Communication Networks" by WEI, YUAN, Ng, Elkashlan and DING, the authors use a simple downlink model with two users served by a single-carrier to illustrate the basic principles of NOMA and its performance. The related questions and designs for a more general model with an arbitrary number of users and multiple carriers are discussed. In addition, an overview of existing works on performance analysis, resource allocation, and multiple-input multiple-output NOMA are summarized and discussed. The key features of NOMA and its potential research challenges in future networks are raised.

In "Unified Framework Towards Flexible Multiple Access Schemes for 5G", SUN, WANG, HAN and I provide a comprehensive overview for the multiple access schemes proposed for 5G networks. The authors distinguish three types of multiple access techniques in power, code and interleaver based solutions, respectively. The key features of these multiple access techniques are highlighted, and the authors also provide comparison among these multiple access techniques. Another important contribution of this paper is that a unified framework of the aforementioned multiple access techniques is provided.

In "Multiple Access Rateless Network Coding for Machine-to-Machine Communications" by JIAO, Abbas, LI and ZHANG, the authors propose a novel multiple access rateless network coding scheme for machine-to-machine (M2M) communications. The scheme is capable of increasing transmission efficiency by reducing occupied time slots yet with high decoding success rates. In addition, in contrast to existing state-of-the-art coding schemes, the novel rateless network coding is able to dynamically recode, making it suitable for M2M multicast networks with heterogeneous erasure features.

In "Multiple Access Technologies for Cellular M2M Communications", Shirvanimoghaddam and Johnson provide a comprehensive survey of the multiple access techniques for machine-to-machine (M2M) communications in future wireless cellular networks. In particular, the overview highlights the multiple access strategies and explains their limitations when used for M2M communications. The throughput efficiency of different multiple access techniques when used in coordinated and uncoordinated scenarios are illustrated. The authors demonstrate that in uncoordinated scenarios, NOMA can support a larger number of devices compared to orthogonal multiple access techniques.

We thank all authors for their valuable contributions and all reviewers for their timely and constructive comments on the submitted papers. We hope the content of this issue is informative and helpful to all readers.