

MOBILE COMMUNICATIONS AND NETWORKS



Wanshi Chen



Ilker Demirkol



Miraj Mostafa



Stefano Ruffini

The evolution of mobile communication is taking 5G forward to achieve its target metrics, and at the same time, providing a sense of what would be possible with 6G. The evolution is enabled by both the advancements of the existing technology areas and the emergence of newer areas. This issue of the Mobile Communications and Networks Series presents seven different articles to the readers covering both emerging and existing areas. For example, the issue covers emerging topics like reconfigurable intelligent surface and edge intelligence. Similarly, advancements of a few existing topics are also covered, like near field communication for large-scale antenna array, network performance, security aspects of HTTP/2 in 5G service-based architecture, and open radio access network (O-RAN)-enabled heterogeneous networks for enhanced video service. The intention is to meet the needs of wider interest groups with the outcome of concurrent research on mobile communication taking place all over the world.

Despite the increasing interest in the application of reconfigurable intelligent surface (RIS) in wireless networks, many daunting challenges still need to be addressed before its potential commercial reality. The first article, “Reconfigurable-Intelligent-Surface-Assisted B5G/6G Wireless Communications: Challenges, Solution, and Future Opportunities,” is an attempt towards this direction. In particular, the article covers three challenging issues of RIS-aided operation for millimeter-wave multiple-input multiple-output (MIMO) communications: channel state information (CSI) acquisition, imperfect cascaded CSI for beamforming, and co-channel interference coordination. For each issue, after problem formulation, a scheme is proposed to tackle the respective challenge, whose performance and effectiveness are also verified via careful simulations. The article is concluded by presenting some further research issues and opportunities.

The second article is also related to RIS, titled “Metasurface Manipulation Attacks: Potential Security Threat of RIS-Aided 6G Communications.” It discusses the threats of physical layer security in communications aided by RIS. RIS hardware interface designs are examined to show that RIS is preferable to generic relay nodes to aid communication. The article also introduces metasurface manipulation attack types to classify and combat different communication risks on the RIS-aided environment in the next-generation wireless networks. Conventional vulnerability cases of different attacks are also studied to evaluate performance of communication over a network configuration with an RIS-relay node in terms of bit error rate and positive secrecy capacity.

Latency is, and will be, an important constraint for many applications, including extended reality (XR), autonomous driving, remote surgery, and so on. In the article “Toward Enabling Performance-Guaranteed Networking in Next-Generation Cel-

lular Networks,” the authors study the application-level latency limitations for the next-generation cellular networks. For this, they focus on i) first-byte delay and ii) transmission delay for the remaining bytes. The authors claim that the network slicing is not enough to guarantee latency due to challenges such as varying data unit sizes and radio channel quality. As a solution, the authors propose a new framework, where the application server and the RAN interact with each other, and machine learning solutions are used for radio channel prediction, and for proactive radio resource management (RRM). The open issues of this solution that need to be tackled are also provided.

Extremely large-scale antenna arrays, which are currently studied within the research domains of ultra-massive MIMO, RIS, and so on, are a potential technology to be used for 6G. The article “Near-Field Communications for 6G: Fundamentals, Challenges, Potentials, and Future Directions” argues that such technology results in fundamentally different electromagnetic (EM) radiation characteristics. This is achieved by using an interesting example: In the current 5G massive MIMO systems, the Rayleigh distance is up to several meters, while in a 3200-element antenna array at 2.4 GHz, the Rayleigh distance is about 200 m. The article surveys the recent studies specific to near-field communications by classifying them into two categories: those addressing the relevant challenges and those exploiting the potential in near-field regions. Future research directions, such as improvement of Rayleigh distance and hybrid-field transmissions, are also presented.

In light of the potential cybersecurity challenges to 5G networks, the article titled “A Security Assessment of HTTP/2 Usage in 5G Service-Based Architecture” presents various security features based on 5G architecture, and subsequently explores the corresponding security challenges and potential solutions. In particular, the article focuses on HTTP/2-related use cases, and the related security implications in 5G SBA. Existing security challenges and potential research opportunities are summarized for aspects including broken service access control, broken authentication, application programming interface (API) exploitation, and HTTP/2 attacks and interconnect security.

Open-RAN is a new radio access network architecture defined by the O-RAN Alliance allowing for a multi-supplier RAN solution. Among other things, it promotes a software defined component, the RAN intelligent controller (RIC), which governs and supplies intelligence to optimize radio resource allocation, implement handovers, manage interference, and balance load between cells. RIC has two parts: non-real-time (RT) and near-RT. The article “QoE-Driven Optimization in 5G O-RAN-Enabled HetNets for Enhanced Video Service Quality” introduces a QoE Enhancement Function (QoE2F) xApp to enhance the functionality of near-RT RIC through efficient resource provisioning to users

requesting high-resolution video services.

The last article, “MEET: Mobility-Enhanced Edge Intelligence for Smart and Green 6G Networks,” proposes a new framework called MEET to address some of the deployment and operation costs (e.g., energy cost) implied by the emerging paradigm of edge intelligence. According to this proposal, operators incorporate infrastructural vehicles as movable base stations or edge servers, and schedule them in a more flexible way to align with the communication and computation traffic fluctuations. In this way, the deployment and operation costs are spread over the available vehicles so that the edge intelligence is realized cost-effectively and sustainably.

It is encouraging to see the continuous flow of submissions of manuscripts from all over the world, helping us to have a higher number of articles in this issue.

The reviewers contributed to multiple rounds of reviews for revisions. As usual, their continuous support is critical to ensure high quality and strong relevance of the articles. We also acknowledge the continuous support we have been enjoying from the Editors and staff members.

We are starting the year of 2023 with this relatively loaded issue, and hope that the readers will enjoy this set of articles of diverse but relevant and important topics.

BIOGRAPHIES

WANSI CHEN (wanshic@qti.qualcomm.com), [SM] is a senior director, Technology at Qualcomm Inc., where he is involved in 5G research and standardization. He

is currently 3GPP TSG RAN plenary Chair appointed in April 2021. Previously, he was 3GPP TSG RAN WG1 Chair and successfully led the group to deliver both the first and second 5G releases on time and with high quality. The highest degree that he received is a Ph.D. degree in electrical engineering from the University of Southern California.

ILKER DEMIRKOL (ilker.demirkol@upc.edu) [SM] is an associate professor in the Department of Mining, Industrial and ICT Systems Engineering at the Universitat Politècnica de Catalunya, Barcelona, Spain, where his research currently is focused on network algorithmics, the Internet of Things, and mobile networks. Over the years, he has worked in a number of research laboratories and industrial corporations in Europe and the United States. He has co-authored more than 75 ACM/IEEE journal and conference papers, including the recipients of the Best Paper Award at IEEE ICC '13 and the Best Demo Award at IEEE MASS 2019.

MIRAJ MOSTAFA (miraj.mostafa@americantower.com), is a senior manager for Network Engineering at American Tower Corporation. Previously, he worked for Nokia and Microsoft. He also contributed to standardization and industry collaboration activities in 3GPP, IEEE 802.11, Wi-Fi Alliance, and GSM Association. He received his Ph.D. in communications engineering, Master's of Engineering in telecommunications, and B.Sc. in EEE from Tampere University of Technology, Asian Institute of Technology, and Bangladesh University of Engineering and Technology, respectively.

STEFANO RUFFINI (stefano.ruffini@calnexsol.com) graduated in telecommunication engineering from the University of Rome La Sapienza. After long experience at Ericsson, he is currently working as strategic technology manager at Calnex Solution. He is currently contributing to ITU-T SG15 Q13 (serving as Rapporteur), IEEE1588, and other relevant synchronization standardization bodies and forums. He has published several international journal papers and delivered talks at various conferences. He is part of the Executive Steering Group of the International Timing and Sync Forum and a member of the Workshop on Synchronization in Telecommunication Systems Executive Committee.