# MOBILE COMMUNICATIONS AND NETWORKS


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As 5G is being widely commercially deployed around the world, it is of great interest to continue investigating how it can be further improved in the near term or evolved aiming at a longer term. This issue of Mobile Communications and Networks explores the above directions covering several aspects. These include the exploration of joint slicing and functional split in the 5G radio access network (RAN), addressing coverage issues in 5G focusing on the uplink data channel, tackling the issue of temporal blockages and outdated channel feedback in an Internet of Vehicles setting, and investigation of the inter-play between rate-splitting multiple access (RSMA) and intelligent reflecting surface (IRS).

The first article, "Impact of Network Densification on Joint Slicing and Functional Splitting in 5G," investigates a slice-based functional split between a central unit (CU) and a distributed unit (DU) in a 5G RAN. In particular, selection of a functional split is proposed to allow the implementation of multiple functional splits per slice in a shared DU in order to facilitate different RAN density scenarios. After presenting the advantages and constraints of the proposal, the authors provide evaluation results to demonstrate throughput enhancements of the proposed multiple slices per DU vs. a single slice per DU. A list of open issues and research challenges are also provided.

Coverage has been an important operator requirement for deploying cellular networks from the beginning. With the potential of operating in higher frequencies in 5G New Radio (NR), the coverage becomes even more critical. This is mostly due to the natural phenomenon of larger path and penetration loss in higher NR frequencies of sub-6 GHz and millimeter wave bands. The second article, "NR Coverage Enhancements for PUSCH," discusses the coverage performance for one of the most critical channels of NR — physical uplink shared channel (PUSCH). The article analyzes why coverage enhancement for PUSCH is very critical. Besides discussing different potential solutions to improve performance, the article proposes four joint schemes for enhancing coverage performance for voice over Internet Protocol (VoIP) and enhanced mobile broadband (eMBB) services. Supporting simulation results are also presented, showing additional gain compared to the baseline. The article also provides directions for further development in coverage performance of other channels.

One challenge faced by the use of millimeter-wave (mmWave) frequencies in vehicle mobility scenarios is the difficulty of achieving up-to-date channel state information (CSI) and blockage prediction. For this, a potential solution proposed is predictor antennas (PAs). The third article of our series, "High-Rate Uninterrupted Internet of Vehicle Communications in Highways: Dynamic Blockage Avoidance and CSIT Acquisition," extends this recent idea into a large-scale cooperative one, where base stations and vehicles cooperate to tackle the aforementioned challenges. Through simulations, the authors show the potential throughput and outage probability improvements achieved by their cooperative PA in different scenarios, also analyzing the effect of multiple-input multiple-output (MIMO) transmission and the carrier frequency used. The article also presents the ongoing 3GPP standardization efforts for V2X communications, and positions the proposed approach within these efforts.

MIMO systems can implement spatial-division multiple access (SDMA) to communicate with multiple spatially separated users simultaneously and at the same frequency, and in this way improving system rate, scalability, reliability, and latency. The fourth article of this issue of the series, "Rate-Splitting Multiple Access and Its Interplay with Intelligent Reflecting Surfaces," addresses the problem of inter-user interference that can be experienced when users have overlapping spatial directions or are located close to one another in overload scenarios. In particular, RSMA has recently appeared as a powerful technique for improving the downlink performance of MIMO systems, while IRS has emerged as a method to control the wireless environment through software-configurable, near-passive, sub-wavelength reflecting elements. The article presents the potential of synergy between IRS and RSMA. Improvements achievable by these techniques are identified and mapped to beyond 5G use cases, along with future research directions.

As always, we would like to thank our reviewers who helped us to select these high-quality articles, and also the Editor-in-Chief and Associate Editor-in-Chief for their guidance during the editorial process. We encourage readers to submit their novel and high-impact articles within the mobile communications and networking domain to our series, to help us shape together the future of this prevalent domain.

## BIOGRAPHIES

WANSHI 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.

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