MOBILE COMMUNICATIONS AND NETWORKS


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This October 2023 issue contains a Feature Topic titled "MIMO Evolutions: Capacity, Coverage, Reliability, AI-Enabled, and More," aiming to provide a comprehensive presentation of the state-of-the-art findings potentially shaping future evolutions of multi-input multi-output (MIMO) in research and standardization. The special issue drew ten submissions, resulting in three accepted papers after rigorous reviews. These three papers covers energy efficient extreme MIMO, gigantic MIMO channel characterization, and orbital angular momentum (OAM) for future MIMO.

A significant part of the RAN energy consumption is attributed to the radio unit. Hence, the future extreme MIMO systems should be carefully designed to have energy-efficient operation while providing higher capacities. For example, one challenge is to ensure that energy consumption scales down gracefully with traffic, approaching zero energy at zero traffic. Towards this end, the article titled "Energy Efficient Extreme MIMO: Design Goals and Directions" targets to identify potential operational and component technology innovations that can enable an energy-efficient evolution towards the next generation MIMO systems with extremely large arrays (more than 1000 antenna elements) in the new mid band (7 to 20 GHz) spectrum. For this, several possible improvements in scheduling, waveform design, network architecture and hardware have been presented. A high-level power consumption model has also been developed to evaluate the possible energy savings and the supported network load for several aforementioned improvements.

The sixth-generation (6G) communication system will leverage the evolving MIMO technology, referred to as gigantic MIMO, with a substantial number of antenna elements. This will allow to unlock new use cases and applications with extreme requirements. Radio channel characterization plays a crucial role in the design, optimization, and performance evaluation of these radio systems. The channel characterization of the gigantic MIMO systems is challenging since there are bottlenecks in channel modeling approaches, channel sounders, and channel parameter estimation algorithms. The article "Gigantic MIMO Channel Characterization: Challenges and Enabling Solutions," discusses key challenges and potential solutions for radio channel characterization of gigantic MIMO systems, including channel modeling approaches, experimental platform development i.e., channel sounder design, and radio channel parameter estimation. A channel measurement campaign based on a virtual antenna array and a corresponding ray tracing (RT) simulation are performed for a practical indoor scenario as examples to characterize a realistic gigantic MIMO channel.

Various physical resources of electro-magnetic waves, for example, frequency, time, code, and MIMO, have been used to transmit data in wireless communications so far. These are mainly electric field strength specific physical resources, and have been mostly exhausted for the current need of data transmission, as the number of parallel orthogonal channels produces a diminishing marginal effect on the capacity. As we will need to support much higher transmission rates in 6G and beyond, there is a need for additional physical resources. The article titled "Orbital Angular Momentum: New Physical Resource and Dimension for Future MIMO" investigates OAM, which cannot be represented in terms of traditional electric field strength, for a possible new physical resource. OAM reflects the rotation characteristics of electro-magnetic wave, while waves with different OAM modes are orthogonal to each other. As the objective is to maximize the utilization of spatial domain resources, the analysis tries to find a combination of OAM and MIMO. As such, both types of OAM — intrinsic OAM and extrinsic OAM — are evaluated in combination with MIMO. The article also outlines the challenges of OAM for future research.

Overall, the three papers in this special issue solidify the critical role of MIMO in communication architectures for the future. We would like to acknowledge the reviewers for their expert opinions, timely reviews, and constructive comments. We are also grateful for the generous support of the editors and staff members. The editors would like to thank Arogyaswami J Paulraj for his role as a guest editor. As this will be. As this will be the last issue for Miraj as an editor for the Series, we would also like to take this opportunity to thank him for his great contributions over the years.

BIOGRAPHIES

WANSHI CHEN [SM] (wanshic@qti.qualcomm.com) is a Sr. 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 the 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, USA.

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